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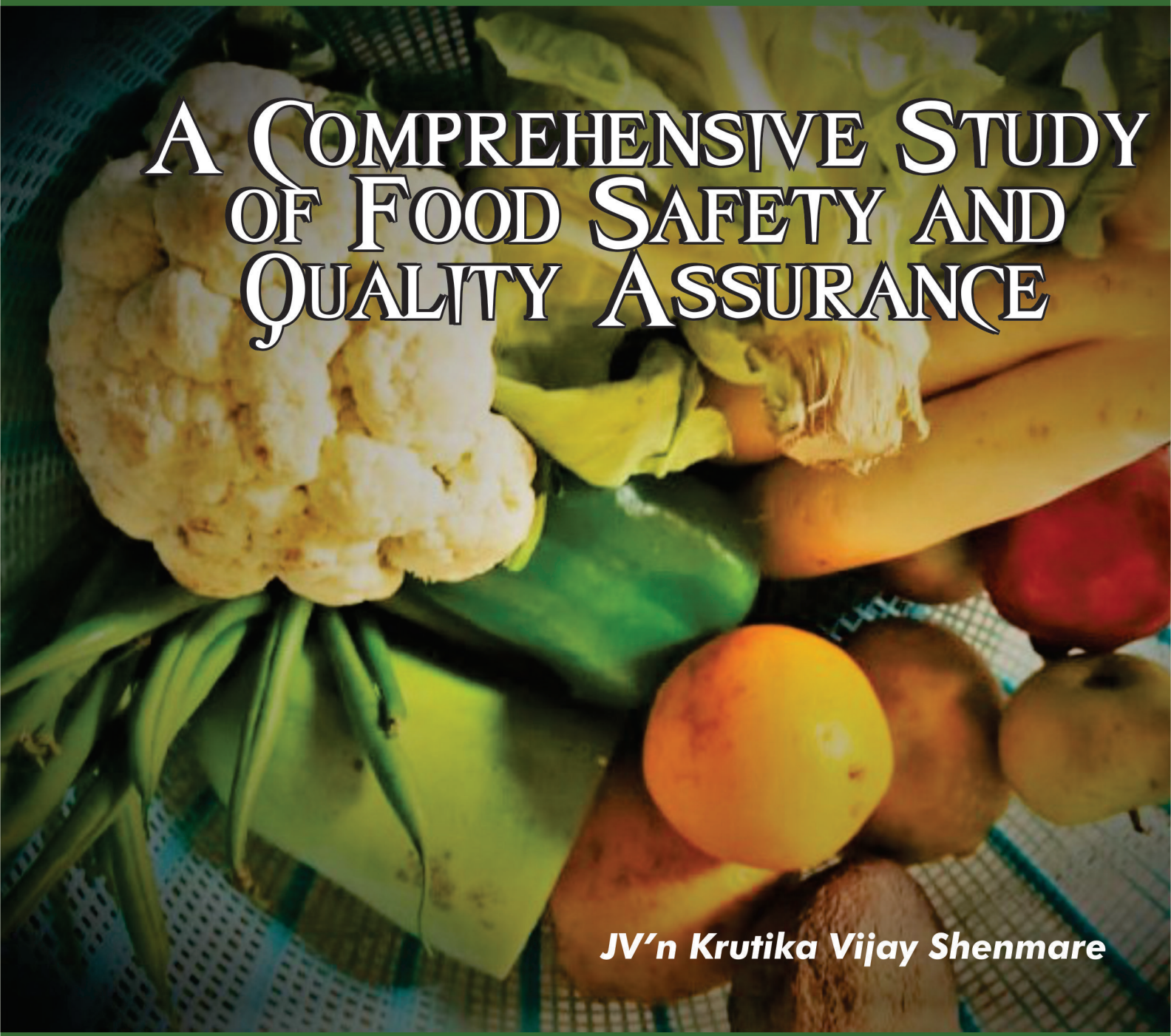
A Comprehensive Study of Food Safety and Quality Assurance



JV'n Krutika Vijay Shenmare

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JAYOTI VIDYAPEETH
WOMEN'S UNIVERSITY

Krutika Vijay Shenmare

[A COMPREHENSIVE STUDY OF FOOD SAFETY AND QUALITY ASSURANCE]

A quick guide to Food Safety and Quality Assurance written in a simplified way which can be understood by everyone in all aspects of life.

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Chapter 1

Sampling and Labelling Specifications

Abstract:- Sampling involves the selection of a certain portion, number of container and product units from a particular lot of the same food. Samples are usually collected from a lot of food for random surveillance, collection of data for a specific purpose, or monitoring/and to determine the conformity to product standards specified in the regulation. FSO may collect samples from any place where any article of food is manufactured, or stored for sale, or stored for the manufacture of any other article of food by Authorized officer for sale, or exposed or exhibited for sale or where any adulterant is manufactured or kept. Food Safety officer while taking samples of food or imported article of food for analysis shall, follow the specified procedure for taking samples and sending them for analysis[1].

Three activities in analysis include :-

- Collection of representative sample
- Sample preparation
- Analysis using proper methods & instruments

Precautions during Sampling : The condition of the sample received for examination is of primary importance.

- A representative sample is essential when pathogens or toxins are sparsely distributed within the food.
- The number of units that comprise comprise a representative sample from a designated lot of a food product must be statistically significant.
- The proper statistical sampling procedure, according to whether the food is solid, semisolid, viscous, or liquid, must be determined by the FSO at the time of sampling
- Clean, dry, leak-proof, wide-mouthed and sterile containers of a size suitable for sample of the product must be used.
- Sample must be submitted in original and in sealed condition.
- Dry or canned foods that are not perishable and are collected at ambient temperatures need not be refrigerated.

- Collect frozen samples in pre-chilled containers.
- Follow storage norms.

The Sampling Plan:- The following factors should be considered while formulating a sampling plan.

- type of food product
- the size of food articles to be sampled
- the degree of hazard to human health
- the potential for fraud
- acceptance and rejection criteria:
  - adulteration,
  - tolerance limits
  - compositional standards
  - net contents

Sampling Tools and Containers:- Samples collected from bulk packages or unpackaged foods sold at retail must be placed in suitable containers for storage and handling to be presented for laboratory analysis.

Sampling tools: The tools available available to FSO/ Authorized Authorized Officer Officer range from common tools for general purposes to special tools to be used in specific situations and for specific examinations of particular food products. Common tools such as pliers, spoon, screwdriver and knife are useful for opening containers, cutting bags of food products.

Sample containers: In general, for liquids the FSO/ Authorized Officer should use clean, dry containers of appropriate waterproof and leak proof material, including glass, stainless metal, and suitable plastic material which can be sterilized by heat if necessary. The containers must have a secure closure of rubber or plastic stoppers, or a screw-cap of metal or plastic, coated with an insoluble, non-absorbent. For solids or semi-solids, clean, dry, wide-mouth, cylindrical receptacles of suitable waterproof, material should be used. For butter, suitable wide-mouth jars

should be used. The butter must not be allowed to come into contact with paper or any water or fat-absorbing surface.

Sample collection Techniques: The FSO/ Authorized Officer must obtained the following Information:-

- name of the food;
- lot number;
- container size or sizes;
- product code numbers;
- labelling information;
- condition of the lot, i.e., broken packages,
- evidence of rodent or insect infestation, debris, etc.;

Quantity of Food Samples to be collected for Analysis[1]:-

Article of food	Approximate quantity to be supplied
1. Milk	500 ml.
2. Sterilized Milk/UHT Milk	250 ml.
3. Malai/Dahi	200 gms.
4. Yoghurt/Sweetened Dahi	300 gms.
5. Chhana/Paneer/Khoya/Shrikhand	250 gms.
6. Cheese/Cheese spread	200 gms.
7. Evaporated Milk/Condensed Milk	200 gms.
8. Ice-Cream/Softy/Kulfi/Ice Candy/Ice lolly	300 gms.
9. Milk Powder/Skimmed Milk Powder	250 gms.
10. Infant Food/Weaning Food	500 gms.

[1] Method of Good Practice for the Feed Industry (Methods of sampling and analysis)(Food and Agriculture Organizations Manual)

11. Malt Food/Malted Milk Food	300 gms.
12. Butter/Butter Oil/Ghee/Margarine/Cream/ Bakery Shortening	200 gms.
13. Vanaspati, Edible Oils/Fats	250 gms.
14. Carbonated Water	600 ml.
15. Baking Powder	100 gms
16. Saffron	20 gms
17. Fruit Juice/Fruit Drink/Fruit Squash	400 gms
18. Tomato Sauce/Ketchup/Tomato Paste, Jam/ Jelly/ Marmalade/ Tomato Puree/Vegetable Sauce	300 gms
19. Pickles and Chutneys	250 gms
20. Instant Tea/Instant Coffee/Instant Coffee Chichory Mixture	100 gms
21. Sugar Confectionery/Chewing Gum/Bubble Gum	200 gms
22. Atta/Maida/Suji/Besan/Other Milled Product/ Paushtik and Fortified Atta/Maida	500 gms
23. Iodised Salt/ Iron Fortified Salt	200 gms
24. Bread/Cakes/Pastries	250 gms
25. Natural Mineral water/Packaged Drinking water.	4000 ml

Packing and Sealing the Samples

- In order to maintain integrity, packages containing exhibits should be secured or sealed to prove their authenticity, i.e., to ensure that they could not have been tampered.
- The stopper shall first be securely fastened so as to prevent leakage of the contents in transit.
- The bottle, jar or other container shall then be completely wrapped in fairly strong thick paper. The ends of the paper shall be neatly folded in and affixed by means of gum or other packing and sealing of the samples shall be neatly folded in and affixed by means of gum or other adhesive.
- A paper slip of the size that goes round completely from the bottom to top of the container, bearing the signature of the Designated Officer and code number of the sample, shall be pasted on the wrapper, the signature or thumb impression of the person from whom the sample has been taken, shall be affixed in such a manner that the paper slip and the wrapper both carry a part of this signature or the thumb impression.
- The outer covering of the packet shall also be marked with the code number of the sample.

Dispatch of Sample:

- All samples packaged for dispatch must be secured with shock-absorbing materials to protect them from damage en route.
- Samples Samples of frozen foods to be sent overnight overnight may be packed in insulated cartons containing dry ice that will last for that length of time.
- If special precautions in handling or storing samples are needed, the FSO/ Authorized Officer should ensure that persons who will be handling the samples are informed.

RECOMMENDATIONS FOR SAMPLING AND ANALYSING:-

- When defining the sampling procedures one should consider the purpose of

sampling, the laboratory analysis through which samples will undergo and the characteristic of the ingredients and finished products.

- The objectives and sampling purposes to be achieved should be clear when developing the sampling procedures to be adopted.
- Sampling should be done in a well defined area in order to avoid difficulties in the executing of procedures, reduce the risk of contamination and cross contamination, enable the proper execution of laboratory analysis and include all necessary safety and health precautions to the sampler and environment.
- Personnel responsible for the sampling activities should be trained on the applicable procedures.
- All tools and auxiliary materials should be inert, and in a clean condition before and after their use.
- Portions of the material that are non homogeneous should be sampled separately and should not make a composite as it can mask quality problems.
- With few exceptions, all incoming ingredients should be sampled upon arrival and inspected for identity, physical purity and compared with a reference sample and standard specifications.
- International methods of sampling should be used to ensure that valid sampling procedures are applied when feed is being tested for compliance to a particular standard or objective.
- A sampling procedure should stipulate the conditions based on which a lot should be inspected and classified.
- Accuracy, precision, specificity, sensitivity, dependability and practicality should be considered when choosing the most appropriate method.
- Laboratories operating under a recognized quality standard should seek independent approval of their quality assurance arrangements preferably by accreditation which will allow them to demonstrate competency and reliability

[1] . FSSAI Manual (2006). *Sampling Techniques of Food Analysis*

Introduction of Labelling Specifications in Food Industry

Overview:- Food Safety and Standards Authority of India (FSSAI) is an autonomous body established by the Government of India under the Ministry of Health & Family Welfare. It usually sets standards for food so that there is no chaos in the minds of consumers, traders, manufacturers and investors.In the food and beverage packaging, there is one important aspect called food labelling. On the food labelling, there are crucial aspects related to the product and even of the producer.

The information is usually for the safety of the consumer and it is mandatory that every packaged food article has to be labeled and it shall provide the following information.

1. “Best before” means the date which signifies the end of the period under any stated storage conditions during which the food shall remain fully marketable and shall retain any specific qualities for which tacit or express claims have been made and beyond that date, the food may still be perfectly safe to consume, though its quality may have diminished. However the food shall not be sold if at any stage the product becomes unsafe.

2. “Date of manufacture” means the date on which the food becomes the product as described;

3. “Date of packaging” means the date on which the food is placed in the immediate container in which it will be ultimately sold;

4. “Infant” means a child not more than twelve months of age;

5. “Lot number” or “code number” or “batch number” means the number either in numericals or alphabets or in combination thereof, representing the lot number or code number or batch number, being preceded by the words “Lot No” or “Lot” or “code number” or “Code” or Batch No” or “Batch” or any distinguishing prefix by which the food can be traced in manufacture and identified in distribution.

6. “Multipiece package” means a package containing two or more individually packaged or labelled pieces of the same commodity of identical quantity, intended for retail either in individual pieces or packages as a whole.

7. “Non- Vegetarian Food” means an article of food which contains whole or part of any animal including birds, fresh water or marine animals or eggs or products of any animal origin, but excluding milk or milk products, as an ingredient;

8. “Prepackaged” or “Pre-packed food”, means food, which is placed in a package of any nature, in such a manner that the contents cannot be changed without tampering it and which is ready for sale to the consumer. Note: The expression “package” wherever it occurs in these Regulations, shall be construed as package containing pre-packed food articles.

9. “Principal Display Panel” means that part of the container/package which is intended or likely to be displayed or presented or shown or examined by the customer under normal and customary conditions of display, sale or purchase of the commodity contained therein.

10. “Use – by date” or “Recommended last consumption date” or “Expiry date” means the date which signifies the end of the estimated period under any stated storage conditions, after which the food probably will not have the quality and safety attributes normally expected by the consumers and the food shall not be sold;

11. “Vegetarian Food” means any article of Food other than Non- Vegetarian Food.

12. “Wholesale package” means a package containing

(a) a number of retail packages, where such first mentioned package is intended for sale, distribution or delivery to an intermediary and is not intended for sale direct to a single consumer; or

(b) a commodity of food sold to an intermediary in bulk to enable such intermediary to sell, distribute or deliver such commodity of food to the consumer in smaller quantities.

PACKAGING REGULATIONS

1. A utensil or container made of the following materials or metals, when used in the preparation, packaging and storing of food shall be deemed to render it unfit for human consumption:—

(a) containers which are rusty;

(b) enameled containers which have become chipped and rusty;

(c) copper or brass containers which are not properly tinned

(d) containers made of aluminium not conforming in chemical composition to IS:20 specification for Cast Aluminium & Aluminium Alloy for utensils or IS:21 specification for Wrought Aluminium and Aluminium Alloy for utensils.

2. Containers made of plastic materials should conform to the following Indian Standards Specification, used as appliances or receptacles for packing or storing whether partly or wholly, food articles namely :—

(i) IS : 10146 (Specification for Polyethylene in contact with foodstuffs);

(ii) IS : 10142 (Specification for Styrene Polymers in contact with foodstuffs);

(iii) IS : 10151 (Specification for Polyvinyl Chloride (PVC), in contact with foodstuffs);

(iv) IS : 10910 (Specification for Polypropylene in contact with foodstuffs);

(v) IS : 11434 (Specification for Ionomer Resins in contact with foodstuffs); (vi) IS: 11704 Specification for Ethylene Acrylic Acid (EAA) copolymer.

(vii) IS: 12252 - Specification for Poly alkylene terephathalates (PET).

(viii) IS: 12247 - Specification for Nylon 6 Polymer;

(ix) IS: 13601 - Ethylene Vinyl Acetate (EVA);

(x) IS: 13576 - Ethylene Metha Acrylic Acid (EMAA);

(xi) Tin and plastic containers once used, shall not be re-used for packaging of edible oils and fats; Provided that utensils or containers made of copper though not properly tinned, may be used for the preparation of sugar confectionery or essential oils and mere use of such utensils or containers shall not be deemed to render sugar confectionery or essential oils unfit for human consumption.

General packaging requirements for Canned products.

(i) All containers shall be securely packed and sealed.
(ii) The exterior of the cans shall be free from major dents, rust, perforations and seam distortions.
(iii) Cans shall be free from leaks.

Product specific requirements

1. **Packaging requirements for Milk and Milk Products**

(a) Bottling or filling of containers with heat-treated milk and milk product shall be carried out mechanically and the sealing of the containers shall be carried out automatically.

(b) Wrapping or packaging may not be re-used for dairy products, except where the containers are of a type which may be re-used after thorough cleaning and disinfecting.

(c) Sealing shall be carried out in the establishment in which the last heat-treatment of drinking milk or liquid milk-base products has been carried out, immediately after filling, by means of a sealing device which ensures that the milk is protected from any adverse effects of external origin on its characteristic. The sealing device shall be so designed that once the container has been opened, the evidence of opening remains clear and easy to check.

(d) Immediately after packaging, the dairy products shall be placed in the rooms provided for storage.

2. **Packaging requirements for Edible oil/ fat:**

Tin Plate used for the manufacture of tin containers for packaging edible oils and fats shall conform to the standards of prime grade quality contained in B.I.S. Standards No. 1993 or 13955 or 9025 or 13954 as amended from time to time and in respect of Tin containers for packaging edible oils and fats shall conform to IS No. 10325 or 10339 as amended from time to time.

3. **Packaging requirements for Fruits and Vegetables Products**

(i) Every bottle in which any fruit product is packed shall be so sealed that it cannot be opened without destroying the licensing number and the special identification mark of the manufacture to be displayed on the top or neck of the bottle.

(ii) For Canned fruits, juices and vegetables, sanitary top cans made up of suitable kind of tin plates shall be used.

(iv) For Bottled fruits, juices and vegetables, only bottles/ jars capable of giving hermetic seal shall be used.

(v) Juices, squashes, crush, cordials, syrups, barley waters and other beverages shall be packed in clean bottles securely sealed. These products when frozen and sold in the form of ice shall be packed in suitable cartons. Juices and Pulps may be packed in wooden barrels when sulphited.

(vi) For packing Preserves, Jams, Jellies, and Marmalades, new cans, clean jars, new canisters, bottles, chinaware jars, aluminium containers may be used and it shall be securely sealed.

(vii) For Pickles, clean bottles, jars, wooden casks, tin containers covered from inside with polythene lining of 250 gauge or suitable lacquered cans shall be used.

(viii) For Tomato Ketchups and Sauces, clean bottles shall be used. If acidity does not exceed 0.5% as acetic acid, open top sanitary cans may also be used.

(ix) Candied fruits and peels and dried fruits and vegetables can be packed in paper bags, cardboard or wooden boxes, new tins, bottles, jars, aluminium and other suitable approved containers.

(x) Fruits and Vegetable products can also be packed in aseptic and flexible packaging material having food grade quality conforming to the standards laid down by BIS.

4. Packaging requirements for Canned Meat Products

(i) New sanitary top cans made from suitable kind of tin plate shall be used. The cans shall be lacquered internally; they shall be sealed hermetically after filling. The lacquer used shall be sulphur resistant and shall not be soluble in fat or brine.

(ii) Cans used for filling pork luncheon meat shall be coated internally with edible gelatin, lard or lined with vegetable parchment paper before being filled.

(iii) Meat products packed in hermetically sealed containers shall be processed to withstand spoilage under commercial conditions of storage and transport.

5**. Packaging requirements for Drinking Water (Both Packaged and Mineral Water)**

It shall be packed in clean, hygienic, colourless, transparent and tamperproof bottles/containers made of polyethylene (PE) (conforming to IS:10146 or polyvinyl chloride (PVC) conforming to IS : 10151 or polyalkylene terephthalate (PET and PBT) conforming to IS : 12252 or polypropylene conforming to IS : 10910 or foodgrade polycarbonate or sterile glass bottles suitable for preventing possible adulteration or contamination of the water. All packaging materials of plastic origin shall pass the prescribed overall migration and colour migration limits.

Labelling

General Requirements:

1. Every prepackaged food shall carry a label containing information as required here under unless otherwise provided, namely,—

2. The particulars of declaration required under these Regulations to be specified on the label shall be in English or Hindi in Devnagri script: Provided that nothing herein contained shall

prevent the use of any other language in addition to the language required under this regulation.

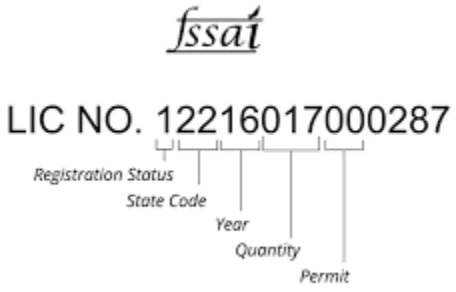
3. Pre-packaged food shall not be described or presented on any label or in any labelling manner that is false, misleading or deceptive or is likely to create an erroneous impression regarding its character in any respect;

4. Label in pre-packaged foods shall be applied in such a manner that they will not become separated from the container;

5. Contents on the label shall be clear, prominent, indelible and readily legible by the consumer under normal conditions of purchase and use;

6. Where the container is covered by a wrapper, the wrapper shall carry the necessary information or the label on the container shall be readily legible through the outer wrapper and not obscured by it;

7. 1 [License number shall be displayed on the principal display panel in the following format, namely:- Provided that the existing products of a unit shall comply with the requirement of this clause on and after the six months of commencement of the Food Safety and Standards (packaging and labeling)



Provided that the existing products of a unit shall comply with the requirement of this clause on and after the six months of commencement of the Food Safety and Standards (packaging and labeling) Ammendment Regulation ,2013. **]**

Labelling of Pre-packaged Foods

In addition to the General Labelling requirements specified in 2.2.1 above every package of food shall carry the following information on the label, namely,—

1. The Name of Food: The name of the food shall include trade name or description of food contained in the package.

2. List of Ingredients: Except for single ingredient foods, a list of ingredients shall be declared on the label in the following manner:—

3. The list of ingredients shall contain an appropriate title, such as the term "Ingredients";

4. The name of Ingredients used in the product shall be listed in descending order of their composition by weight or volume, as the case may be, at the time of its manufacture;

5. A specific name shall be used for ingredients in the list of Ingredients;

(a) Where an ingredient itself is the product of two or more ingredients, such a compound ingredients shall be declared in the list of ingredients, and shall be accompanied by a list, in brackets, of its ingredients in descending order of weight or volume, as the case may be:

Provided that where a compound ingredient, constitutes less than five percent of the food, the list of ingredients of the compound ingredient, other than food additive, need not to be declared;

(b) Added water shall be declared in the list of ingredients except in cases where water forms part of an ingredient, such as, brine, syrup or broth, used in the compound food and so declared in the list of ingredients:

Provided that water or other volatile ingredients evaporated in the course of manufacture need not be declared;

Provided further that in the case of dehydrated or condensed food, which are intended to be reconstituted by addition of water, the ingredients in such reconstituted food shall be declared in descending order of weight or volume as the case may be, and shall contain a statement such as "Ingredients of the product when prepared in accordance with the

directions on the label";

(c) Every package of food sold as a mixture or combination shall disclose the percentage of the ingredient used at the time of the manufacture of the food (including compound ingredients or categories of ingredients), if such ingredient–

(i) is emphasised as present on the label through words or pictures or graphics; or

(ii) is not within the name of the food but, is essential to characterise the food and is expected to be present in the food by consumers, and if the omission of the quantitative ingredient declaration will mislead or deceive the consumer.

Provided that where the ingredient has been used as flavouring agent, the disclosure of such ingredient is not required:

Provided further that where the drained net weight is indicated on the label as required or in case of such food products where specific provisions are stipulated under these Regulations or where a pictorial representation of a serving suggestion is made for consumer information and use, the disclosure of such ingredient is not required.

Provided further that in case of any bottle containing liquid milk or liquid beverage having milk as an ingredient, soft drink, carbonated water or ready-to-serve fruit beverages, the declarations with regard to addition of fruit pulp and fruit juice shall invariably appear on the body of the bottle.

3. Nutritional information :- Nutritional Information or nutritional facts per 100 gm or 100ml or per serving of the product shall be given on the label containing the following

(*i*) energy value in kcal;

(*ii*) the amounts of protein, carbohydrate (specify quantity of sugar) and fat in gram (g) ;

(*iii*) the amount of any other nutrient for which a nutrition or health claim is made:

Provided that where a claim is made regarding the amount or type of fatty acids or the amount of cholesterol, the amount of saturated fatty acids, monounsaturated fatty acids and polyunsaturated fatty acids in gram (g) and cholesterol in milligram (mg) shall be declared, and the amount of trans fatty acid in gram (g) shall be declared in addition to the other requirement stipulated above;

(*iv*) Wherever, numerical information on vitamins and minerals is declared, it shall be expressed in metric units;

(*v*) Where the nutrition declaration is made per serving, the amount in gram (g) or milliliter (ml) shall be included for reference beside the serving measure;

Provided that the food claimed to be enriched with nutrients, such as, minerals, proteins, vitamins, metals or their compounds, amino acids or enzymes shall give the quantities of such added nutrients on the label.

Provided that —

(*i*) the nutritional information may not be necessary, in case of foods such as raw agricultural commodities, like, wheat, rice, cereals, spices, spice mixes, herbs, condiments, table salt, sugar, jaggery, or non –nutritive products, like, soluble tea, coffee, soluble coffee, coffee-chicory mixture, packaged drinking water, packaged mineral water, alcoholic beverages or fruit and vegetables, processed and pre-packaged assorted vegetables, fruits, vegetables and products that comprise of single ingredient, pickles, papad, or foods served for immediate consumption such as served in hospitals, hotels or by food services vendors or *halwais,* or food shipped in bulk which is not for sale in that form to consumers.

(*ii*) The compliance to quantity of declared nutrients on the label shall be according to the established practices.

Explanation — For the purpose of this provision, at the time of analysis, due consideration, based on shelf-life, storage, and inherent nature of the food shall be kept in view in case of quantity declared nutrients;

[(iii) Every package of edible oils, interesterified vegetable fat, both hydrogenated or partially hydrogenated oils, edible fats, margarine and fat spreads (mixed fat spread and vegetable fat spread) and package of food in which fats, oils and fat emulsions is used as an ingredient shall declare the quantity of trans fat content and saturated fat content on the label.**]**

Provided further that, a health claim of 'trans fat free' may be made in cases where the trans fat is less than 0.2 gm per serving of food and the claim 'saturated fat free' may be made in cases where the saturated fat does not exceed 0.1 gm per 100 gm or 100 ml of food.

For the purpose of regulation 2.2.2 (3);

(*i*) "Health claims" means any representation that states, suggests or implies that a relationship exists between a food or a constituent of that food and health and include nutrition claims which describe the physiological role of the nutrient in growth, development and normal functions of the body, other functional claims concerning specific beneficial effect of the consumption of food or its constituents, in the context of the total diet, on normal functions or biological activities of the body and such claims relate to a positive contribution to health or to the improvement of function or to modifying or preserving health, or disease risk reduction claim relating to the consumption of a food or food constituents, in the context of the total diet, to the reduced risk of developing a disease or health related condition;

(*ii*) "Nutrition claim" means any representation which states, suggests or implies that a food has particular nutritional properties which are not limited to the energy value but include protein, fat carbohydrates, vitamins and minerals;

(*iii*) "Risk reduction" in the context of health claims means significantly altering a major risk factor for a disease or health-related condition;

Provided further that in the case of returnable new glass bottle manufactured and used for packing of such beverages on or after 19th March 2009, the list of ingredient and nutritional information shall be given on the bottle.

4. Declaration regarding Veg or Non veg –

(*i*) Every package of "Non Vegetarian" food shall bear a declaration to this effect made by a symbol and colour code as stipulated below to indicate that the product is Non-Vegetarian Food. The symbol shall consist of a brown colour filled circle having a diameter not less than the minimum size specified in the Table mentioned in the regulation 2.2.2 (4) (*iv*), inside a square with brown outline having sides double the diameter of the circle as indicated below :

Brown colour

(*ii*) Where any article of food contains egg only as Non-Vegetarian ingredient, the manufacturer, or packer or seller may give declaration to this effect in addition to the said symbol.

(*iii*) Every package of Vegetarian Food shall bear a declaration to this effect by a symbol and colour code as stipulated below for this purpose to indicate that the product is Vegetarian Food. The symbol shall consist of a green colour filled circle, having a diameter not less than the minimum size specified in the Table below, inside the square with green outline having size double the diameter of the circle, as indicated below :

Green colour

(*iv*) Size of the logo Sl No.	Area of principal display panel	Minimum size of diameters in mm
1.	Upto 100 cms. Square.	3
2.	Above 100 cms. square upto 500 cms square.	4
3.	Above 500 cms square upto 2500 cms square.	6
4.	Above 2500 cms. Square.	8

The symbol shall be prominently displayed

(*i*) on the package having contrast background on principal display panel; (*ii*) just close in proximity to the name or brand name of the product;

(*iii*) on the labels, containers, pamphlets, leaflets, advertisements in any media;

Provided also that the provisions of regulation 2.2.2(4) shall not apply in respect of mineral water or packaged drinking water or carbonated water or alcoholic drinks, or liquid milk and milk powders.

5. **Declaration regarding Food Additives-**

(*i*) For food additives falling in the respective classes and appearing in lists of food additives permitted for use in foods generally, the following class titles shall be used together with the specific names or recognized international numerical identifications:

Acidity Regulator, Acids, Anticaking Agent, Antifoaming Agent, Antioxidant, Bulking Agent, Colour, Colour Retention Agent, Emulsifier, Emulsifying Salt, Firming Agent, Flour Treatment Agent, Flavour Enhancer, Foaming Agent, Gelling Agent, Glazing Agent, Humectant, Preservative, Propellant, Raising Agent, Stabilizer, Sweetener, Thickener:

(*ii*) Addition of colours and/or Flavours—

(*a*) Extraneous addition of colouring matter to be mentioned on the label – Where an extraneous colouring matter has been added to any article of food, there shall be displayed one of the following statements in capital letters, just beneath the list of the ingredients on the label attached to any package of food so coloured, namely:

CONTAINS PERMITTED NATURAL COLOUR(S)

OR

CONTAINS PERMITTED SYNTHETIC FOOD COLOUR(S)

OR

CONTAINS PERMITTED NATURAL AND SYNTHETIC FOOD COLOUR(S)

Provided that where such a statement is displayed along with the name or INS no of the food colour, the colour used in the product need not be mentioned in the list of ingredients.

(*b*) Extraneous addition of flavouring agents to be mentioned on the label.

Where an extraneous flavouring agent has been added to any article of food, there shall be written just beneath the list of ingredients on the label attached to any package of food so flavoured, a statement in capital letters as below :

CONTAINS ADDED FLAVOUR (specify type of flavouring agent as per Regulation 3.1.10(1) of Food Safety and Standards (Food product standards and food additive) Regulation, 2011

(*c*) In case both colour and flavour are used in the product, one of the following combined statements in capital letters shall be displayed, just beneath the list of ingredients on the label attached to any package of food so coloured and flavoured, namely :—

CONTAINS PERMITTED NATURAL COLOUR(S) AND ADDED FLAVOUR(S)

OR

CONTAINS PERMITTED SYNTHETIC FOOD COLOUR(S) AND ADDED FLAVOUR(S)

OR

CONTAINS PERMITTED NATURAL AND SYNTHETIC FOOD COLOUR(S) AND ADDED FLAVOUR(S)

Provided that in case of artificial flavouring substances, the label shall declare the common name of the flavours, but in case of the natural flavouring substances or nature identical flavouring substances, the class name of flavours shall be mentioned on the label and it shall comply with the requirement of label declaration as specified under the regulation 2.2.2 (5) (ii)

Note: — When statement regarding addition of colours and/or flavours is displayed on the label in accordance with regulation 2.2.2(5)(ii) and regulation 3.2.1 of Food Safety and Standards (Food Product Standards and Food Additive) Regulation, 2011, addition of such colours and/or flavours need not be mentioned in the list of ingredients. Also, in addition to above statement, the common name or

class name of the flavour shall also be mentioned on label.

Provided further that when combined declaration of colours and flavours are given, the International Numerical Identification number of colours used shall also be indicated either under the list of ingredients or along with the declaration.

Provided also further that every package of synthetic food colours preparation and mixture shall bear a label upon which is printed a declaration giving the percentage of total dye content

6. Name and complete address of the manufacturer

(*i*) The name and complete address of the manufacturer and the manufacturing unit if these are located at different places and in case the manufacturer is not the packer or bottler, the name and complete address of the packing or bottling unit as the case may be shall be declared on every package of food;

(*ii*) Where an article of food is manufactured or packed or bottled by a person or a company under the written authority of some other manufacturer or company, under his or its brand name, the label shall carry the name and complete address of the manufacturing or packing or bottling unit as the case may be, and also the name and complete address of the manufacturer or the company, for and on whose behalf it is manufactured or packed or bottled;

(*iii*) Where an article of food is imported into India, the package of food shall also carry the name and complete address of the importer in India.

Provided further that where any food article manufactured outside India is packed or bottled in India, the package containing such food article shall also bear on the label, the name of the country of origin of the food article and the name and complete address of the importer and the premises of packing or bottling in India.

7. Net quantity

(*i*) Net quantity by weight or volume or number, as the case may be, shall be declared on every package of food; and

(*ii*) In addition to the declaration of net quantity, a food packed in a liquid medium shall carry a declaration of the drained weight of the food.

Explanation 1.— For the purposes of this requirement the expression "liquid medium" include water, aqueous solutions of sugar and salt, fruit and vegetable juices or vinegar, either singly or in combination.

Explanation 2.— In declaring the net quantity of the commodity contained in the package, the weight of the wrappers and packaging materials shall be excluded:

(*iii*) Where a package contains a large number of small items of confectionery, each of which is separately wrapped and it is not reasonably practicable to exclude from the net weight of the commodity, the weight of such immediate wrappers of all the items of the confectionery contained in the package, the net weight declared on the package containing such confectionary or on the label thereof may include the weight of such immediate wrapper if the total weight of such immediate wrapper does not exceed –

(*a*) eight per cent, Where such immediate wrapper is a waxed paper or other paper with wax or aluminium foil under strip; or

(*b*) six per cent. In case of other paper of the total net weight of all the items of confectionery contained in the package minus the weight of immediate wrapper.

8. Lot/Code/Batch identification

A batch number or code number or lot number which is a mark of identification by which the food can be traced in the manufacture and identified in the distribution, shall be given on the label.

Provided that in case of packages containing bread and milk including sterilised milk, particulars under this clause shall not be required to be given on the label.

9. Date of manufacture or packing.—

The date, month and year in which the commodity is manufactured, packed or pre-packed, shall be given on the label:

Provided that the month and the year of manufacture, packing or pre-packing shall be given if the "Best Before Date" of the products is more than three months:

Provided further that in case any package contains commodity which has a short shelf life of less than three months, the date, month and year in which the commodity is manufactured or prepared or pre-packed shall be mentioned on the label.

10. Best Before and Use By Date

(*i*) the month and year in capital letters upto which the product is best for consumption, in the following manner, namely:—

"BEST BEFORE ..... MONTHS AND YEAR

OR

"BEST BEFORE ..... MONTHS FROM PACKAGING

OR

"BEST BEFORE .....MONTHS FROM MANUFACTURE

(Note: — blank be filled up)

(*ii*) In case of package or bottle containing sterilised or Ultra High Temperature treated milk, soya milk, flavoured milk, any package containing bread, dhokla, bhelpuri, pizza, doughnuts, khoa, paneer, or any uncanned package of fruits, vegetable, meat, fish or any other like commodity, the declaration be made as follows:—

"BEST BEFORE …….DATE/MONTH/YEAR"

OR

"BEST BEFORE.....DAYS FROM PACKAGING"

OR

"BEST BEFORE …….. DAYS FROM MANUFACTURE"

Note:

(*a*) blanks be filled up

(b) Month and year may be used in numerals (*c*) Year may be given in two digits

(*iii*) On packages of Aspartame, instead of Best Before date, Use by date/recommended last consumption date/expiry date shall be given, which shall not be more than three years from the date of packing;

(*iv*) In case of infant milk substitute and infant foods instead of Best Before date, Use by date/ recommended last consumption date/expiry date shall be given,

Provided further that the declaration of best before date for consumption shall not be applicable to (*i*) wines and liquors

(*ii*) alcoholic beverages containing 10 percent or more by volume of alcohol.

Provided further that above provisions except net weight/net content, nutritional information, manufacturer's name and address, date of manufacture and "best before" shall not apply in respect of carbonated water (plain soda and potable water impregnated with carbon dioxide under pressure) packed in returnable glass bottles

11. Country of origin for imported food: (*i*) The country of origin of the food shall be declared on the label of food imported into India.

(*ii*) When a food undergoes processing in a second country which changes its nature, the country in which the processing is performed shall be considered to be the country of origin for the purposes of labelling.

12. Instructions for use:

(*i*) Instructions for use, including reconstitution, where applicable, shall be included on the label, if necessary, to ensure correct utilization of the food.

2.3: Manner of declaration

2.3.1: General Conditions

1. Any information or pictorial device written, printed, or graphic matter may be displayed in the label provided that it is not in conflict with the requirements of these Regulations.

2. Every declaration which is required to be made on package under these regulations shall be:

(*i*) Legible and prominent, definite, plain and unambiguous (*ii*) Conspicuous as to size number and colour,

(*iii*) as far as practicable, in such style or type of lettering as to be boldly, clearly and conspicuously present in distinct contrast to the other type, lettering or graphic material used on the package, and shall be printed or inscribed on the package in a colour that contrasts conspicuously with the background of the label

Provided that —

(*a*) Where any label information is blown, formed or moulded on a glass or plastic surface or where such information is embossed or perforated on a package, that information shall not be required to be presented in contrasting colours:

(*b*) Where any declaration on a package is printed either in the form of a handwriting or hand script, such declaration shall be clear, unambiguous and legible.

3. No declaration shall be made so as to require it to be read through any liquid commodity contained in the package.

4. Where a package is provided with an outside container or wrapper, such container or wrapper shall also contain all the declarations which are required to appear on the package except where such container or wrapper itself is transparent and the declarations on the package are easily readable through such outside container or wrapper.

5. Labels not to contain false or misleading statements: A label shall not contain any statement, claim, design, device, fancy name or abbreviation which is false or misleading in any particular concerning the food contained in the package, or concerning the quantity or the nutritive value or in relation to the place of origin of the said food:

2.3.2 Principal display panel: The information required under these Regulations shall be given on the principal display panel of the package or container and such information may be given in the following manner.

(*a*) All information should be grouped together and given at one place. OR

The pre-printed information be grouped together and given in one place and , (*b*) Online information or those not pre-printed be grouped together in another place. 1. Area of the principal display panel

The area of principal Display panel shall not be less than —

(*a*) In the case of a rectangular container, forty percent of the product of height and width of the panel of such container having the largest area;

(*b*) In case of cylindrical or nearly cylindrical, round or nearly round, oval or nearly oval container, twenty percent of the product of the height and average circumference of such container; or

(*c*) In the case of container of any other shape, twenty percent of the total surface area of the container except where there is label, securely affixed to the container, such label shall give a surface area of not less than ten percent of the total surface area of the container.

Provided that in the case of package having a capacity of five cubic centimeters or less, the principal display panel may be card or tape affixed firmly to the package or container and bearing the required information under these regulations. All these are the sampling and labelling specifications as per FSSAI (FSSAI, 2018)

Questions:- 1) Explain the sampling specifications as per FSSAI.

2) Enlist the Labelling Specifications of Canned Foods.

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Chapter 2

Quality assessment of Fruits and Vegetables

Overview: - The color, flavor, texture, and the nutritional value of fresh-cut fruit and vegetable products are factors critical to consumer acceptance and the success of these products. In this chapter, desirable and undesirable quality attributes of fresh-cut fruit and vegetable products are reviewed. Both instrumental and sensory measurements for determining these critical quality attributes are discussed. The advantages and disadvantages of sensory and instrumental quality measurements are described. A review of typical unit operations involved in the production of fresh-cut products is presented. The effects of fresh-cut processing techniques and treatments on sensory quality, including the appearance, texture, flavor (taste and aroma) of vegetables, and fruits are detailed. Quality of foods may be defined as the composite of those characteristics that differentiate individual units of a product, and have significance in determining the degree of acceptability of that unit to the user.

Attributes of Fruit and Vegetable Quality

In reference to fruits and vegetables, the characteristics that impart distinctive quality may be described by four different attributes—

1) color and appearance,
2) flavor (taste and aroma),
3) texture and
4) nutritional value.

As consumers, these four attributes typically affect us in the order specified above, for example we evaluate the visual appearance and color first, followed by the taste, aroma, and texture. Kramer (1965) stated that the appearance of the product usually determines whether a product is accepted or rejected; therefore this is one of the most critical quality attributes. Nutritional value is a hidden characteristic that affects our bodies in ways that we cannot perceive, but this quality attribute is becoming increasingly valued by consumers, scientists, and the medical profession.

We eat with our eyes. The shape, size, gloss, and vibrant color of a fruit or vegetable attract us and entice us into picking it up by hand or fork. Once we are attracted by the appearance and color of a product, we put it into our mouths, where the aroma and taste take over. Freshness, spiciness, sweetness, and other flavor attributes are critical to our eating pleasure. Aroma refers to the smell of a fruit or vegetable product, whereas flavor includes both aroma and taste.

CHEMICAL AND PHYSICAL BASIS FOR FRUIT AND VEGETABLE QUALITY

Color

Color is derived from the natural pigments in fruits and vegetables, many of which change as the plant proceeds through maturation and ripening. The primary pigments imparting color quality are the fat soluble chlorophylls (green) and carotenoids (yellow, orange, and red) and the water soluble anthocyanins (red, blue), flavonoids (yellow), and betalains (red). In addition, enzymatic and non-enzymatic browning reactions may result in the formation of water soluble brown, gray, and black colored pigments. The enzymes involved in browning reactions include polyphenol oxidase, which catalyzes the oxidation of polyphenolic compounds, and phenylalanine ammonia lyase, which catalyzes the synthesis of precursors to phenolic substrates.

The chlorophylls are sensitive to heat and acid, but stable to alkali whereas their counterpart carotenoids are sensitive to light and oxidation but relatively stable to heat. Carotenoids may be bleached by an enzyme called lipoxygenase, which catalyzes the oxidation of lipid compounds. Anthocyanins are sensitive to both pH and heat, while the flavonoids are sensitive to oxidation but relatively stable to heat. Betalains are heat sensitive as well (Clydesdale and Francis, 1976).

Appearance is determined by physical factors including the size, the shape, the wholeness, the presence of defects (blemishes, bruises, spots, etc.), finish or gloss, and consistency. Size and shape may be influenced by cultivar, maturity, production inputs, and the growing environment. It is important for fruits and vegetables to be of uniform size and characteristic shape (Mitcham et al., 1996). Some consumers associate larger size with higher quality. The wholeness and absence of defects will be affected by exposure to disease and insects during the growing period and the harvest and postharvest handling operations. Mechanical harvesting, for example, may incur more bruises and cracks in fruits and vegetables than hand harvesting. Fruit and vegetable gloss are related to the ability of a surface to reflect light and freshly harvested products are often more glossy (Mitcham et al., 1996). Gloss is affected by moisture content, wax deposition on the surface, and handling practices postharvest. Consistency or smoothness may be used as an appearance term, but is typically applied to semi-solid products, where it indicates the product thickness.

Flavor—Aroma and Taste

Flavor has been defined (Anon, 1959) as: A mingled but unitaryexperience which includes sensations of taste, smell, and pressure, and often cutaneous sensations such as warmth, color, or mild pain. Flavor is typically described by aroma (odor) and taste. Aroma compounds are volatile—they are perceived primarily with the nose, while taste receptors exist in the mouth and are impacted when the food is chewed. While color and appearance may be the initial quality attributes that attract us to a fruit or vegetable product, the flavor may have the largest impact on acceptability and desire to consume it again. Taste has been divided into five primary tastes—sweet, sour, salty, bitter, and umami. Umami can be described as a taste associated with salts of amino acids and nucleotides (Yamaguchi and Ninomiya, 2000). Odors are much more diverse and difficult to classify, but an attempt by Henning (Gould, 1983) includes the following— spicy, flowery, fruity, resinous or balsamic, burnt, and foul. In the evaluation of fruit and vegetable flavor, it is important to consider "off-flavors" as well as desirable ones. These off- flavors may be produced through the action of enzymes such as lipoxygenase or peroxidase, which form reactive free radicals and hydroperoxides that may catalyze the oxidation of lipid compounds. When these reactions occur, the result may be the development of undesirable flavors described as rancid, cardboard, oxidized, or wet dog. However, there are instances of enzyme-catalyzed reactions that result in desirable flavors. For example, hydroperoxide lyase catalyzes the production of typical tomato flavors (Anthon and Barrett, 2003).

Texture

Textural parameters of fruits and vegetables are perceived with the sense of touch, either when the product is picked up by hand or placed in the mouth and chewed. In contrast to flavor attributes, these characteristics are fairly easily measured using instrumental methods. Most plant materials contain a significant amount of water and other liquid-soluble materials surrounded by a semi-permeable membrane and cell wall.

The texture of fruits and vegetables is derived from their turgor pressure, and the composition of individual plant cell walls and the middle lamella "glue" that holds individual cells together.

The greatest contributor to the texture of tomato products are the insoluble solids, which are derived from cell walls. The three-dimensional network of plant cell walls is still unresolved, but is a topic of great interest to scientists in that to a large degree it dictates the perception of consistency, smoothness, juiciness etc. in fruit and vegetable tissues (Waldron et al., 2003).

According to Bourne (1982) the textural properties of a food are the "group of physical characteristics that arise from the structural elements of the food, are sensed by the feeling of touch, are related to the deformation, disintegration and flow of the food under a force, and are measured objectively by functions of mass, time, and distance." The terms texture, rheology, consistency, and viscosity are often used interchangeably, de- spite the fact that they describe properties that are somewhat different. In practice the term texture is used primarily with reference to solid or semi-solid foods; however, most fruits and vegetables are viscoelastic, implying that they exhibit combined properties of ideal liquids, which demonstrate only viscosity (flow), and ideal solids, which exhibit only elasticity (deformation).

Nutritional Value

Fruits and vegetables are a major source of both "macro" nutrients such as fiber and carbohydrates, and "micro" nutrients such as Vitamin C, B complex (thiamin, riboflavin, B_6, niacin, folate), A, E, minerals, and the lesser-studied polyphenolics, carotenoids, and glucosinolates. Nutrients may be classified as either water or lipid soluble—meaning they dissolve in water or a lipid medium. Water soluble nutrients include Vitamin C, B complex, polyphenolics, and glucosinolates. Fat soluble nutrients include Vitamin A, E, and other carotenoids such as lycopene and β-carotene. Vitamin C is one of the most sensitive vitamins, being degraded relatively quickly by exposure to heat, light, and oxygen. For this reason it is often used as an index of nutrient Department of Health and Human Services and the degradation.

The 2005 Dietary Guidelines for Americans, published jointly by the U.S.Department of Agriculture (http://www. health.gov/DietaryGuidelines/), suggest that both males and fe- males increase their overall fruit and vegetable consumption to 9 servings (about 4.5 cups) a day for a 2000 calorie diet. This is an increase of 50 to over 100 percent from current average consumption by U.S. consumers.

DESIRABLE AND UNDESIRABLE QUALITY ATTRIBUTES IN FRESH-CUT FRUITS AND VEGETABLES

Fresh-cut fruits and vegetables must have an attractive appearance, acceptable flavor, appropriate texture, and a positive nutritional image to attract initial and continued purchases by consumers. Consumers may try a new product if attracted by its appearance, but they are unlikely to repurchase an item if it fails to deliver on the promise of that appearance. Quality can be viewed from either a product or a consumer orientation (Shewfelt, 1999). A consumer orientation views the product through the sensory perspective of the consumer at the points of purchase and consumption (Shewfelt and Prussia, 1993). Consumers often buy the first time based on appearance, but repeat purchases are driven by expected quality factors determined by flavor compounds and texture (Beaulieu, 2006a; Waldron et al., 2003).

Color and Appearance

Color and appearance attract the consumer to a product and can help in impulse purchases. At the point of purchase the consumer uses appearance factors to provide an indication of freshness and flavor quality. External appearance of a whole fruit is used as an indicator of ripeness, although it can be a misleading one (Shewfelt, 2000a). Consumers have a preferred color for a specific item (Crisosto et al., 2003). Bananas are supposed to be yellow with no brown spots, tomatoes red not orange, cherries red not yellow, and kiwifruit green-fleshed not yellow. With the exception of the outside of a few fruits like Bosc pears and kiwifruit, fresh fruits and vegetables should not be brown. Gloss on the outside of whole fruits tends to be a desirable attribute for whole fruits. Fresh-cut fruits and vegetables must appear to be fresh, generally indicated by the brightness of color and the absence of visual defects or drip. Sheen on the out- side of most cut fruits is preferred to a dried appearance. Color and appearance of the package can also influence the purchase decision.

Just as an attractive product can stimulate impulse purchases, an unattractive appearance can repel a consumer away from an intended purchase.

White blush in cut carrots is a quality defect (Emmambux and Minnaar, 2003). Russet (brown) spotting and brown stain (Kader and Saltveit, 2003) (two separate disorders) are undesirable visual defects in lettuce. Visible wilting in lettuce and celery and shriveling in fruits reduce consumer acceptability. Yellowing in green vegetables due to loss of chlorophyll is un-acceptable (Shewfelt, 2003). Less intensity of color indicates lack of ripeness in fresh-cut fruits. Browning is a serious quality defect in fresh-cut fruits. Many purchasers of organic fruits and vegetables may actually favor items with visual defects as evidence of authenticity.

Flavor

Flavor of fresh-cut fruits is more important than for fresh-cut vegetables due to the way the products are consumed. Fresh-cut vegetables tend to be consumed as components of salads or sandwiches. Since fresh-cut fruits are more likely to be consumed without other ingredients, they must be sweet without the presence of off-flavors. Since sweetness increases with ripening and ripe fruits deteriorate more rapidly, most fruits are harvested before full sweetness has been achieved. Sweetness does not increase in coated, cut cantaloupe during storage (Eswaranan-dam et al., 2007), and it is unlikely that significant increases in sweetness will occur in other fresh-cut fruits after packaging. Development of more intense aroma has been achieved by feeding precursors into the atmosphere of strawberry tissue cultures and fruit (Zabetakis and Holden, 1997), but this technique is not being used commercially.

Bitterness is an undesirable taste found in some fresh-cut vegetables such as salad greens (Dinehart et al., 2006). When Cruciferae cells are ruptured, glucosinolates undergo enzymatic hydrolysis with the endogenous myrosinase enzymes, releasing thiocyanates, isothiocyanates (Wattenberg, 1978), sulphate, and glucose (Ju et al., 1982). Processing and packaging precautions must be taken to ensure that off-odors and off-flavors do not jeopardize the marketability of shredded Crucifer products. Sourness is an indication of the use of immature fresh-cut fruits such as may occur in the case of apples (Harker et al., 2003).

Texture

Consumers have clear expectations for the texture of fresh- cut vegetables and fruits. Salad

vegetables like lettuce, carrot, celery, and radish should be crisp. Soft fruits such as cantaloupe and peach should yield to chewing without being mushy. Other fruits like apples should be crisp and crunchy. While consumers generally cite flavor as the most important quality attribute for fruits and vegetables, textural defects and the interaction of flavor and texture are more likely to cause rejection of a fresh product (Harker et al., 2003). Consumer and panel testing indicates that they are actually more sensitive to small differences in texture than flavor (Beaulieu et al., 2004; Shewfelt, 1999). Undesirable textural attributes are the opposite of the desirable ones. Wilted lettuce, limp carrots or celery, and flaccid radish are unacceptable as are crunchy or mushy cantaloupes and peaches. Soggy or mealy apples are also likely to be rejected.

Nutritional Value

Consumers expect fresh fruits and vegetables to be good sources of dietary fiber and many vitamins and minerals. Unfortunately they have no way of distinguishing between individual products that have high versus low concentrations of phytonutrients. Many factors contribute to the nutrient content of a fruit or vegetable available for sale including genetics, growing conditions (light, temperature, etc.) and production practices (fertilization, irrigation, etc.), maturity at harvest, and postharvest handling conditions. During storage little change occurs in dietary fiber and mineral content, but the vitamins are lost. Cutting stimulates ethylene production which in turn increases respiration and senescence leading to even more rapid loss of certain vitamins. Vitamin C is the vitamin that usually degrades most rapidly and can be used as an index of freshness. Vitamin C is un- stable in many vegetables such as asparagus (Saito et al., 2000) and jalapeno pepper (Howard and Hernandez-Brenes, 1997). Slight vitamin C losses in stored fresh-cut cantaloupe were also reported recently (Beaulieu and Lea, 2007; Gil et al., 2006).

Convenience

The attribute that drives fresh-cut products is convenience (Raegert et al., 2004). Consumers purchase cut fruits and vegetables for consumption right out of the package. The former International Fresh-Cut Produce Association defined fresh-cut produce as trimmed, peeled, washed, and cut into 100% usable product that is subsequently bagged or prepackaged to offer consumers high nutrition, convenience, and value while still maintaining freshness (Beaulieu and

Gorny, 2004). These products should be clean with no evidence of soil or odor of chlorine or other sanitizers. All pieces in the package should be edible and require no further preparation steps other than transfer from package to plate.

ADVANTAGES AND DISADVANTAGES OF SENSORY AND INSTRUMENTAL QUALITY MEASUREMENTS

The quality of fresh-cut fruits and vegetables can be measured by sensory and instrumental methods. Sensory evaluation of food products is divided into two components—analytical and affective measurements. Analytical measurements can be used to detect differences (difference tests) or to describe the product (descriptive analysis). Analytical sensory tests are usually conducted by small panels with some training of the panelists. Affective measurements determine preference (which samples are preferred over others) and usually require large numbers of naïve panelists (Institute of Food Technologists, 1981).

There are many advantages to sensory methods of quality measurement. Since human perception is involved in sensory testing, quality attributes are clearly defined in terms that are relevant to consumer acceptability. Affective consumer tests are the only way to determine what consumers like and what they do not like. Sensory descriptive panels can be used to identify small differences in quality between similar samples. Well-trained descriptive panels are able to screen out competing attributes to focus on an attribute of specific interest. Among the disadvantages of sensory methods, analytical and affective (consumer) sensory panels are the complex logistics. Descriptive panels require extensive training and can produce highly variable results if training is inadequate. The results from consumer panels tend to be highly variable. In addition, it is difficult to relate sensory data to chemical composition in an effort to determine mechanistic reasons for differences in samples.

Instrumental measurements encompass a wide range of techniques used to determine color, appearance, flavor, texture, and nutritional quality. Instrumental techniques are advantageous in that they tend to provide accurate and precise results. The results of instrumental tests can generally be related directly to chemical and physical properties allowing the investigator to gain a mechanistic understanding of observed differences. Instruments tend to be more sensitive to

small differences between samples and may be able to detect trends in quality loss before they can be detected by humans (Thai et al., 1990; Brosnan and Sun, 2004). Instruments do not object to working at nights and week- ends and can produce large amounts of data without complaint, making them excellent monitors in Quality Control operations. A primary disadvantage of instrumental testing is that many instrumental measurements have little relevance to consumer acceptability and thus should never be used to define quality attributes for a specific product. In other words "it is better to measure what is really important than to believe something is important because you measure it really well." (Shewfelt and Phillips, 1996).

Sensory and instrumental tests are best used in conjunction with each other using the most appropriate test to meet the desired objective. Affective testing helps determine which attributes are important to the consumer. Difference tests can determine if individual units are noticeably different, and sensory descriptive analysis can identify the attributes that cause the differences.

SENSORY METHODS OF QUALITY MEASUREMENT

In-depth descriptions of sensory techniques are available for measuring food quality in general (Institute of Food Technologists, 1981; Meilgaard et al., 1999; Lawless and Heymann, 1998) and fruit and vegetable quality specifically (Shewfelt, 1993). As described above, sensory evaluation is divided into two components—analytical and affective measurements. Two types of analytical tests are difference tests and descriptive analysis.

Analytical Measurements

Difference tests are conducted to determine if there is a detectable difference between two samples, for example two different varieties of cut cantaloupe. The most common difference test is the triangle test. Each panelist is given three samples, two are similar and one is different. The panelist is asked to identify the different sample. Panelists in this type of test are not trained. At least 30 panelists are required for difference tests, and 50 or more panelists are preferred. Samples should be presented as the item is normally consumed and presented in a controlled environment. The order of sample presentation must be randomized. Precautions in running a difference test include making sure that there are no unintentional clues to signal the difference. For example, if the test is to determine possible differences in flavor, steps must be taken to

make sure that differences in color, size, shape, and texture are not providing clues to the panelists. Also, investigators must ensure that all samples are at a similar stage of ripeness.

Descriptive analysis involves the development of a lexicon and panel training (Meilgaard et al., 1999). A lexicon is the list of terms used as descriptors and a precise definition of these terms. If the testing material is an item like tomatoes that has been well characterized (Krumbein et al., 2004), terms and def- initions are selected from previous studies. For other items such as eggplant (Sesena et al., 2002) the descriptive panel evaluates an extensive range of varieties for that item to develop terms that describe the range of products to be tested. Lexicons can be extensive with up to 50 descriptors of minimalist with as few as 5 descriptors. Upon selection or determination of a lexicon, the panel must go through training and calibration to ensure that the panel results are accurate and precise. Train- ing can be as extensive as two hours a week for six months to less intensive sessions over a one-to-two week period. Panelists who are outliers undergo additional training or are dismissed. Upon the completion of training, the evaluation of the samples is conducted in partitioned booths using one of several evaluation methods.

INSTRUMENTAL METHODS OF QUALITY MEASUREMENT

Instrumental methods of measuring appearance, color, tex- ture, aroma, and flavor in fruits and vegetables were first de- scribed by Kramer (1965), and later amended by Kader (2002). A modified list of methods of quality measurement appears in Table 2.

Color

Color may be determined using nondestructive methods founded on visual or physical measurements. These methods are based on evaluation of either the light reflected from the surface of a product or transmitted through it. There are three components necessary to the perception of color— 1) a source of light, 2) an object that modifies light by reflection or transmis- sion and 3) the eye/brain combination of an observer (Leggett, 2004). Simple color charts and dictionaries are routinely used in the field, packing house, fresh-cut processor facility or retail store. An example of a color disc used for canning peaches is shown in Fig.1.

Analytical sensory methods of evaluating color, as described above, are faster and easier in many ways than instrumental methods. They have the advantage of requiring no specialized equipment, but may be standardized through the use of color charts or discs such as those in Fig. 1. The disadvantages are that these methods may vary considerably due to human differences in perception and human error. Inadequate or poor quality available light may also affect accuracy

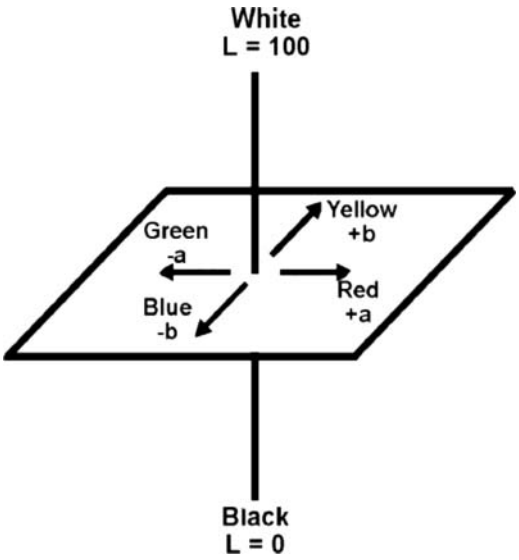

Figure 3 Diagram depicting three dimensional L, a and b color space.

(red to green) considers the positive values as red and negative values as green; 0 is neutral. The b axis (blue to yellow) ex- presses positive values as yellow and negative values as blue; 0 is neutral. Fruits and vegetables are often described in terms of their L, a, and b values. For fruits, the a/b ratio is quite useful, as the ratio is negative for green fruits, approximately 0 for yellow fruits, and positive for orange to red fruits (Gross, 1987).

Color may be determined instrumentally using either colorimeters or spectrophotometers. Colorimeters give measurements that can be correlated with human eye-brain perception, and give tristimulus (L, a and b) values directly (HunterLab, 1995). Colorimeters are typically quite rugged and desirable for routine quality control measurements. Spectrophotometers provide

wavelength-by-wavelength spectral analysis of the reflecting and/or transmitting properties of objects, and are more commonly used in research and development laboratories (HunterLab, 1995). Fruit and vegetable pigments may also be analyzed quantitatively by extraction with specific solvents, filtration, and the use of various methods based on spectrophotometry. Prior to extraction it is necessary to homogenize, grind, or cut up the fruit and vegetable material in order to improve the degree of extraction. Separation using reversed phase high performance liquid chromatography (HPLC) may be useful prior to measurement of absorption of light in the uv/visible wavelength spectrum. Colorimetric methods are based on the Lambert-Beer law, which describes the relationship between the concentration of a substance and its color intensity:

Appearance

Appearance factors other than color include the size, the shape, the wholeness, the pattern, the presence of defects, gloss, and consistency. Most appearance factors may be measured fairly easily using simple devices such as the ones listed in Table 1. Size may be determined either by dimensions, weight, or volume, and there is usually a good correlation between size and weight (Kader, 2002). Shape is actually a ratio of different dimensions to each other, for example the length/width dimensions may describe carrot shape. Glossmay be easily determined either with an instrumental (Table 1) or visual evaluation of wax platelets on the surface of a fruit or vegetable. In many cases, such as in the determination of defects, it is difficult to quantify the degree or severity of a defect. In

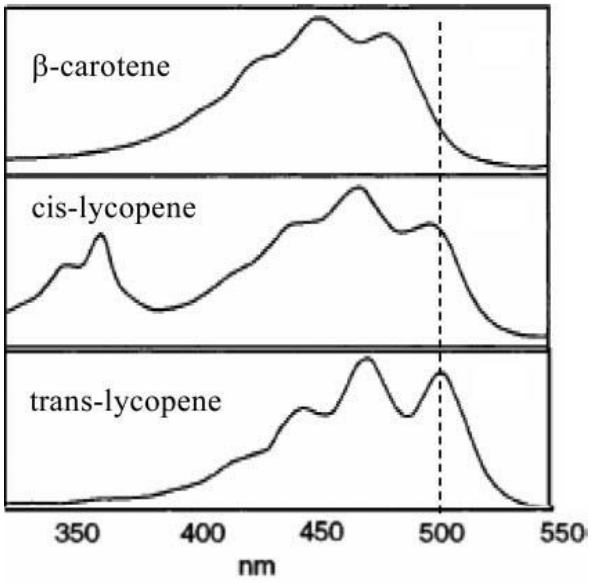

Figure 4 The absorbance spectra of *β*-carotene and cis- and trans- lycopene(adapted from Ishida et al., 2001). The dashed line indicates 503 nm.

this instance it is useful to take photographs, or use models or drawings to develop a somewhat quantitative scoring system. Kader (2002) has developed a five-grade scoring system (1 = no symptoms, 2 = slight, 3 = moderate, 4 = severe, 5 = extreme) for many fruit and vegetable defects, which may be accompanied by detailed descriptions and photographs. The recently published Produce Quality Rating Scales and Color Charts (Kader and Cantwell, 2006) includes color photos and descriptions for numerous commonly consumed fruits and vegetables.

Flavor—Aroma and Taste

Flavor may be evaluated with either instrumental or sensory methods, but most scientists would agree that sensory methods are the most critical to this particular quality attribute. Instrumental techniques may determine that tens or hundreds of compounds are present in a particular fruit or vegetable product, but such methods do not give a measure of the contribution of that specific compound unless they are accompanied by a sensory measurement of odor or flavor activity. For this reason, flavor may be the most challenging quality attribute to both measure and correlate to consumer acceptability. That said, there are some characteristics of flavor that may be determined instrumentally, and these will be described in the following section. Taste has been

described as being comprised of five primary components—sweet, salty, sour, bitter, and umami. It is possible to measure these basic taste components instrumentally. Sweetness can be approximated by HPLC determination of individual sugars, or more rapidly but less accurately by a refractometer or hydrometer that measures total soluble solids (Kramer, 1965). Indicator papers exist for rapid determination of glucose in some commodities, such as potatoes (Kader, 2002). It is possible to measure chloride and/or sodium content as an approximation of saltiness. Sourness may be determined by either pH or more accurately by measurement of total acidity. Both indicator papers and pH meters are available for the determination of pH. The total acidity methods involve adding 0.1 N NaOH to titrate the acid in a fruit or vegetable, and measuring how much of the base is required to reach a pH of 8.1. Finally, astringency may be indicated by measuring total phenolics and bitterness by analysis of compounds such as alkaloids or glucosides. A relatively simple estimation of flavor may be obtained by a comparison, or ratio, of the sugar and acid content of a specific fruit. This is referred to as the "sugar/acid" ratio and specific target values have been established by some companies. Kader (2002) proposed minimum soluble solids content (SSC) and maximum titratable acidity (TA) for acceptable flavor quality of some fruits. For example, it was proposed that apricots, cherries, and persimmons be harvested at minimum SSC values of 10, 14–16, and 18%, respectively. Likewise, the maximum TA values of 0.6, 1.0, and 1.4 were proposed for nectarine, pineapple, and pomegranate, respectively. Unless more sophisticated instrumentation is available, a rapid and inexpensive measure of general flavor may be obtained using sugar/acid ratios along with a minimum sugar and/or a maximum acid content. Aroma volatiles may be very accurately measured using gas chromatography, but this method is time-consuming and the equipment is relatively expensive. Estimation of volatile acids or amines has been suggested to be indicative of off-flavor in stored fruit and vegetables (Kramer, 1965). Hexanal is a compound typically produced as a result of the activity of lipoxygenase, and quantitative determination may correlate well to the sensory perception of off-flavor (Theerakulkait and Barrett, 1995). The determination of hexanal is also carried out using a gas chromatograph. Nonetheless, aldehyde generation in fresh-cut and damaged tissue is considered normal, and actually often contributes to important characteristic flavor/aroma profile in several commodities. Masticating food products in the mouth generates secondary products in situ, and numerous character impact aroma compounds in

foods are known to be secondary compounds (Buttery and Ling, 1993; Carson, 1987; Crouzet et al., 1990; Maarse, 1990). Some of the consequences are considered desirable such as allium flavor release (Carson, 1987), C6 and/or C9 aldehyde/alcohol generation in tomato (Riley and Thompson, 1998), cucumber (Fleming et al., 1968), and bell peppers (Wu and Liou, 1986), and the likely release of certain melon (Schieberle et al., 1990) and seedless watermelon volatiles (Beaulieu and Lea, 2006). Some off-flavors result from the accumulation of acetaldehyde, ethanol, and/or ethyl acetate due to fermentative metabolism when the product is exposed to very low oxygen and/or very high carbon dioxide concentrations. The presence of fungi or bacteria can result in musty or foul odors in the host fruit or vegetable product.

Texture

Instrumental or objective methods of texture evaluation can be grouped into three classes (Szczesniak et al., 1963)— fundamental, empirical, and imitative tests. Fundamental tests measure properties that are familiar to engineers, e.g. strength, Poisson's ratio, and various moduli such as Young's modulus, Shear modulus, and Bulk modulus (Bourne, 1982). Empirical tests cover a wide range of simple and rapid tests, including puncture, compression, extrusion, shear, and others, which measure one or more textural properties and are commonly used in quality control applications. Most methods used for the evaluation of the textural properties of fruits and vegetables are empirical or semi-empirical. Finally, imitative tests are those which utilize instruments in an attempt to mimic what occurs in the mouth as the food is masticated. Experience teaches us that these empirical and imitative tests correlate well with sensory judgments, but we usually have little or no fundamental understanding of the test. In choosing an objective test for measuring textural properties, one must first determine which specific textural properties are of interest, then evaluate which objective test(s) will best measure those properties, and finally correlate the results to sensory analysis prior to predicting consumer response (Barrett et al., 1998). The most commonly used methods for the evaluation of textural properties are those which apply large deforming forces (e.g. via puncture or compression) and are therefore destructive. The use of a texture analyzer has illustrated consistent firmness loss in stored fresh-cut cantaloupe with both a puncture test (Gil et al., 2006; Luna-Guzm´an and Barrett, 2000) and a compression test (Beaulieu et al., 2004). Because of the empirical nature of these tests,

however, they do not provide us with an understanding of food microstructure or force-deformation and failure mechanisms at the cellular level. Recently, there has been a resurgence of interest in nondestructive tests which rely on well-defined fundamental principles and thereby may provide a better understanding of tomato tissue microstructure and the forces which lead to tissue failure. Destructive (puncture, compression, and extrusion) and nondestructive tests will be briefly described below.

Destructive Texture Tests

The puncture test, which is a force measuring method that has the dimensions mass, length, and time, is probably the most frequently used method for textural evaluation. It consists of measuring the force and/or deformation required to push a probe or punch into a food to a depth that causes irreversible damage or failure. Hand-held puncture testers or penetrometers have been conveniently used by horticulturists in the field and laboratory for many years. Puncture probes of a specific diameter may also be easily fitted to laboratory-scale instruments such as the Maturometer, the Instron, and the Texture Technologies TA- XT2 machine for more controlled measurements (Barrett et al., 1998).

Flat plate compression is a technique very similar to that of puncture, except that the perimeter effect is eliminated through the use of flat plates of an area exceeding that of the sample. This test may be used in either a destructive or nondestructive manner. Flat plate compression is assumed to be nondestruc- tive when restricted to less than the elastic limit of 3% strain; however, in some cases permanent damage may occur. Similar to the puncture test, this is a force measuring method with the dimensions mass, length, and time. Extrusion tests are another example of a force-measuring test in which units are expressed as mass, length, and time. A number of different test cells, in- cluding the standard shear-compression cell (or Shear Press) and the back extrusion cell have been designed for the measurement of extrusion behavior. Although use of shear-compression cells primarily involves extrusion, some compression and shear also take place (Barrett et al., 1998).

Nondestructive Texture Tests

Pioneering efforts in the development of vibration tech- niques for the evaluation of fruit and vegetable texture were made by Abbott et al. (1968) and Finney and Norris (1968; 1972). Using vibrational responses in the frequency range from 20–10,000 Hz it was deemed possible to separate fruit by maturity and textural properties. In studies carried out pri- marily on apples, numerous investigators have since found good correlation between resonance (also termed dynamic os- cillation, acoustic, or sonic) methods and both sensory and destructive compression and puncture tests (Abbott, 1992; 1995).

The resonance theory has its basis in dynamics and is founded on the fact that any body that possesses both mass and elasticity is capable of vibrating. Free vibration may be exhibited at one or more frequencies, and is dependent on the specific physico- mechanical properties of the food itself. On the other hand, forced vibration over a range of frequencies results when an external force is applied periodically and a series of resonance peaks may be observed. The two lowest frequencies correlate with fruit firmness and overall elastic behavior, and stiffness factors are commonly used as indices of textural quality (Jack- man and Stanley, 1995; Peleg et al., 1990). Resonance tests may be used to measure solid samples of known dimensions or liquid samples placed in a container with standard dimensions. The sample is subjected to repeated small sinusoidal deforma- tions that are nondestructive and do not impart fracture (Bourne, 1993).

Nutritional Value

Fruits and vegetables are good sources of fiber, minerals, vita- mins, and some beneficial phytochemicals such as carotenoids, phenolics, and glucosinolates. The determination of the nu- trients in fruits and vegetables is carried out using chemi- cal methods following their extraction in either water or lipid mediums.

Soluble dietary fiber in plant tissues may be analyzed in a phosphate buffer extract using an enzymatic-gravimetric method (AOAC method 993.19; AOAC, 2006). Fiber may also be determined by the loss on incineration of dried residue remaining after digestion of a sample with dilute $H_2SO_4$and NaOH (Meloan and Pomeranz, 1980). Mineral analysis is typically carried

out using atomic absorption spectroscopy (AOAC method 968.08). Vitamins may be determined following extraction using high performance liquid chromatography (HPLC) or using older methods that employ microbi- ological, turbidimetric, or titrimetric methods (AOAC method 960.46).

There is increasing interest in the phytochemical content of fruits and vegetables, and these may be extracted according to their water or lipid solubility and are typically analyzed using HPLC. In the case of lycopene, it is possible to approximate its content by measuring the intensity of red color (Anthon and Barrett, 2005) or a/b value with a colorimeter, but such a physical method is not available for most nutrients. There is a wealth of papers available on appropriate methods for the analysis of specific nutrients.

Questions: -

1) Distinguish between Destructive and Non Destructive Tests for Quality determination of Fruits and Vegetables.
2) Enlist the various desirable and undesirable Quality Attributes in Fruits and Vegetables

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Chapter 3

Safety and Quality Assessment of Cereals, Pulses and Dairy Products.

CODEX STANDARD FOR CERTAIN PULSES

1. *SCOPE*

This Standard applies to the whole, shelled or split pulses defined below which are intended for direct human consumption. The Standard does not apply to pulses intended for factory grading and packaging, industrial processing, or to those pulses intended for use in the feeding of animals. It does not apply to fragmented pulses when sold as such, or to other legumes for which separate standards may be elaborated.

1. *DESCRIPTION*

Product definition

Pulses are dry seeds of leguminous plants which are distinguished from leguminous oil seeds by their low fat content. The pulses covered by this Standard are the following:

- Beans of *Phaseolus* spp. (except *Phaseolus mungo* L. syn. *Vigna mungo* (L.) Hepper and *Phaseolus aureus* Roxb. syn. *Phaseolus radiatur* L., *Vigna radiata* (L.) Wilczek);
- Lentils of *Lens culinaris* Medic. Syn. *Lens esculenta* Moench.;
- Peas of *Pisum sativum* L.;
- Chick peas of *Cicer arientinum* L.;
- Field beans of *Vicia faba* L.;
- Cow peas of *Vigna unguiculata* (L.) Walp., syn. *Vigna sesquipedalis* Fruhw., *Vigna sinensis* (L.) Savi exd Hassk.

2. ESSENTIAL COMPOSITION AND QUALITY FACTORS

Quality factors –general

Pulses shall be safe and suitable for human consumption.Pulses shall be free from abnormal flavour, odours, and living insects.Pulses shall be free from filth (impurities of animal origin, including dead insects) in amounts which may represent a hazard to human health.

Quality factors – specific

Moisture content

Two maximum moisture levels are provided to meet different climatic conditions and marketing practices. Lower values in the first column are suggested for countries with tropical climates or when long-term (more than one crop year) storage is a normal commercial practice. The values in the second column are suggested for more moderate climates or when other short-term storage is the normal commercial practice.

Pulse	Moisture content(percent)	
beans	15	19
lentils	15	16
peas	15	18
chick peas	14	16
cow peas	15	18
field beans	15	19

Lower moisture limits should be required for certain destinations in relation to the climate, duration of transport and storage. Governments accepting the Standard are requested to indicate and justify the requirements in force in their country.

In the case of pulses sold without their seed coat, the maximum moisture content shall be 2 per cent (absolute) lower in each case.

Extraneous matter is mineral or organic matter (dust, twigs, seedcoats, seeds of other species, dead insects, fragments, or remains of insects, other impurities of animal origin). Pulses shall have not more than 1% extraneous matter of which not more than 0.25% shall be mineral matter and not more than 0.10% shall be dead insects, fragments or remains of insects, and/or other impurities of animal origin.

Toxic or noxious seeds

The products covered by the provisions of this standard shall be free from the following toxic or noxious seeds in amounts which may represent a hazard to human health.

– Crotolaria (*Crotalaria* spp.), Corn cockle (*Agrostemma githago* L.), Castor bean

(*Ricinus communis* L.), Jimson weed (*Datura* spp.), and other seeds that are commonly recognized as harmful to health.

1. CONTAMINANTS

Heavy metals

Pulses shall be free from heavy metals in amounts which may represent a hazard to health.

Pesticide residues

Pulses shall comply with those maximum residue limits established by the Codex Alimentarius Commission for this commodity.

HYGIENE

It is recommended that the products covered by the provisions of this standard be prepared and handled in accordance with the appropriate sections of the *Recommended International Code of Practice – General Principles of Food Hygiene* (CAC/RCP 1-1969), and other Codes of Practice recommended by the Codex Alimentarius Commission which are relevant to these products.

To the extent possible in good manufacturing practice, the products shall be free from objectionable matter.

When tested by appropriate methods of sampling and examination, the products:

- shall be free from micro-organisms in amounts which may represent a hazard to health;
- shall be free from parasites which may represent a hazard to health; and
- shall not contain any substance originating from micro-organisms in amounts which may represent a hazard to health.

PACKAGING

Pulses shall be packaged in containers which will safeguard the hygienic, nutritional, technological, and organoleptic qualities of the product.

The containers, including packaging material, shall be made of substances which are safe and suitable for their intended use. They should not impart any toxic substance or undesirable odour or flavour to the product.

When the product is packaged in sacks, these must be clean, sturdy and strongly sewn or sealed.

LABELLING

In addition to the requirements of the Codex *General Standard for the Labelling of Prepackaged Foods* (CODEX STAN 1-1985), the following specific provisions apply:

Name of the product

The name of the product to be shown on the label shall be the commercial type of the pulse.

Labelling of non-retail containers

Information for non-retail containers shall either be given on the container orinaccompanying documents, except that the name of the product, lot identification and the name and address of the manufacturer or packer shall appear on the container.

However, lot identification and the name and address of the manufacturer or packer may be replaced by an identification provided that such a mark is clearly identifiable with the accompanying documents.

In those instances where more than one factor limit and/or method of analysis is given we strongly recommend that users specify the appropriate limit and method of analysis.

Quality Testing of Cereals and Grains

For example:

1. Using methods of EU Regulation 1272/2009. *The following are determined on Durum Wheat, Common Wheat, Barley, Maize, and Sorghum.*

- Moisture
- "Percentage of matter which is not basic cereal of unimpaired quality" including broken grains, grain impurities, misc. impurities etc.
- Tannin Content (%) - Sorghum
- Specific Weight (Test Weight) (kg/hL)
- Protein Content
- Hagberg Falling Number
- Zeleny Index

Other quality tests provided upon request are the detection of Mycotoxins, determination and identification of common poisonous / toxic weed seeds and storage insect pests.

2. Using USDA FGIS specifications and methods of analysis

These are applied to Barley, Corn (Maize), Oats, Rye, Sorghum, and Wheat.

3. Codex standards for Wheat, Durum Wheat, Maize, and Oats

Analysis according to the Codex Standard requirements.


Malting Barley Analysis

Malting Barley is analysed according to the methods of the European Brewing Convention (EBC) for parameters such as the following:

- Moisture
- Nitrogen
- Thousand Corn Weight
- Germinative Capacity (Tetrazolium Rapid Staining Method)
- Germinative Capacity (Hydrogen Peroxide & Peeling Technique)
- Germinative Energy (Aubry Method)
- Germinative Energy (BRF Method)
- Sieving test (Determination of admixture, broken grains etc)

Flour Analysis

Some of the analysis carried out on flour include;

- Moisture
- Ash

- Protein
- Wet Gluten - Hand Washing Technique
- Zeleny index

Testing according to Codex Standards for Wheat Flour, Durum Wheat flour, Semolina, and Corn Flour.

Rice Analysis

We are capable of analysing rice according to ISO 7301: "Specification for Rice", USDA specifications, and Codex Alimentarius standards.

Pulse Analysis

Pulses can be analysed to ISO specifications, Codex Alimentarius standards, to determine size, impurities, foreign odour, species or varieties.

Quality Testing of Pulses

The standards for testing are those of:

1. Codex Alimentarius Standard 171-1989 Standard for certain Pulses including Peas, Lentils, Beans, Chick peas.
2. USDA Standards for Pulses such as Peas, Split Peas, Feed Peas, Lentils, and Beans.

Safety and Quality Assessment of Dairy Products

Food safety and quality are critical issues that should be given more attention all over the world mainly from nutritional quality and human health point of view. Food safety is a scientific field of study which deals with handling, preparation, and storage of food in ways that prevent food borne illness. Food safety system is often categorized into two, namely traditional and science-based systems. Food can be used as a source of disease transmission from one person to another; it also serves as a nutrient growth medium for bacteria that can cause food poisoning, and hazardous agent for consumers' health. Factors which can be a source of potential hazards in foods include traditional milk production accompanied with improper agricultural practices and poor hygienic environment at all stages of the food chain. Quality assurance is mandatory before the milk is consumed. It is achieved up on planned and systematic activities performed in each steps of the quality system. Milk and milk products contaminants are classified into two, namely, infectious and non-infectious agents. Food-borne illnesses are generally infectious or toxic in nature and caused by major infectious diseases such as bacteria, viruses, parasites, or chemical substances getting access to enter into the body through contaminated food or water. Milk and milk products heading for export to global market need to pass through the strictest quality standards. Hazard analysis and critical control point system (HACCP) requires a critical examination through every step of food manufacturing process to determine the possibility of having physical, chemical, or microbiological contamination. To achieve this, it is necessary to control the quality of milk at the grass root level.

Food safety system

Food safety system is broadly categorized into two, namely traditional and science-based food safety systems (FAO, 2003).

Traditional food safety systems

Traditionally food safety system has been described as unsafe food and enforcement tools have been prescribed for removing unsafe food from commerce and punishing parties responsible for it. This shows that it has been reactive and enforcement oriented rather than preventive to reducing the risk of food borne illness. Most developing countries have already had some sort of food control system in place, usually based on hygiene and adulteration/fraud inspection. While these vary to some extent, they usually incorporate food laws and regulations, food control management, inspection and laboratory services, and sometimes mechanisms for information, monitoring, education and communication of the food supply (FAO, 2009). Traditional food safety system is reactive approach with the main responsibility lying on the government, relies on end product inspection and testing , involves no structured risk analysis and the level of risk reduction is not always satisfactory (FAO, 1995). Due to the above and other reasons traditional food safety system remains inefficient and being unable to investigate and resolve many prevailing problems; and cannot effectively deal with the entire range of complex, persistent and revolving challenges that damage different parts of the food chain (Committee on Animal Nutrition, 2003).

Food-safety hazards specific to milk and milk products

Biological hazards

Milk and dairy products can be damaged by a variety of micro-organisms, including many zoonotic bacteria and some viruses for example, retroviruses and cytomegalovirus (Kaufmannet al., 2002) (Table 1).

Generally, the microbiological quality of milk during milking is normally good. But, once the milk is secreted from the udder, it can be contaminated by pathogenic micro-organisms from many sources (Loessner and Golden, 2005). Pathogenic bacteria that can be contaminated at different stages of milk production, handling, processing and storage are *Genus pseudomonas* (*Pseudomonas fluorescens***,** *Pseudomonas fragi***,** *Genus Bacillus (Bacillus polymyxa, Bacillus cereus), Brucella spp, Genus Staphylococcus (Staphylococcus aureus), Genus Streptococcus (Streptococcus agalactiae), Genus Mycobacterium (Mycobacterium*

tuberculosis). There is also one bacterium, called *Genus Enterobacter (*Enterobacteraceae spp) categorized as pathogenic and spoilage.

Bacteria like *Genus pseudomonas (Pseudomonas fluorescens***,** *Pseudomonas fragi)***,** *Genus bacillus (Bacillus polymyxa, bacillus cereus)* said to be spoiling bacteria. Those bacteria earlier mentioned could cause severe health complications when the contaminated milk is consumed by human beings. Milk should be kept safe while being milked, processed and stored up on creating clean environment across areas where contamination could occur.

Along with keeping the milk quality and safety, a great deal of milk safety and quality measures should be put in place at any segment of milk production, handling, processing and storage to ensure the milk offered to the consumer is of high quality, safe and wholesome. Even though bacteria cause serious health problems, some bacteria, namely: *Streptococcus thermophilus, Lactococcus lactis sub spp cremoris,* and *Leuconostoclactis* cause the fermentation of milk to products like yoghurt which is safe to be consumed. The bacterium *Lactococcus lactis subspp diacetylactis* helps to provide good flavor to the milk (Table 2). As indicated in Table 2, microorganisms like *Brucella abortus, Listeria mycobacterium, Bovis monocytogenes, Coxiella burnetii* and *S. Aureus and Mycotoxins* for example, aflatoxin have been considered to be the main photogenic microorganisms posing a significant health hazard. It is therefore, mandatory to know the main source of infection for each photogenic microorganism and minimize pre disposing factors which could cause the deterioration of milk and milk products quality. Herd health management like vaccination, serological screening, tuberculin testing, tick control, mastitis control, feed hygiene and control, screening tests on animal feed need to be conducted on regular basis. Moreover, the dairy farmers should undertake appropriate controlling measures **(**pasteurization and hygiene precautions for at-risk workers) while the milk is being processed and handled before provision to consumer.

Pathogen	**Main source of infection**	**Main means of on-farm control**	**Main means of control in processing and food handling**

Brucella abortus	Contact infection (handling infected animals/ materials); Also via raw milk	Herd health management (vaccination, serological screening)	Milk pasteurization and hygiene precautions for at-risk workers
Listeria monocytogenes	Mainly via raw milk, soft cheeses and infected animals/materials	Hygienic husbandry and herd health management	Milk pasteurization: Good manufacturing and prevention of post processing contamination
Mycobacterium bovis	Mainly via raw milk	Hygienic husbandry, herd health management, tuberculin testing and slaughter of positive reactors	Milk pasteurization
Coxiella burnetii	Via aerosol, milk and tick bites	Tick control and herd health management	Milk pasteurization: Hygiene precautions for at-risk workers
Staphylococcus aureus, mycotoxins for example, aflatoxin	Mainly via raw milk	Milking hygiene, mastitis control, feed hygiene and control, screening tests on animal feed	Milk pasteurization and hygiene practices, testing of milk and dairy products for M1 aflatoxin metabolite

Chemical hazard	**Main means of on farm control – preventive controls**	**Main means of control in processing and food handling – secondary controls**
Antibiotics	Good animal husbandry and veterinary practices (GVPs)	Testing at milk collection point
Pesticides and Insecticides	Use of authorized products, safe application and observance of withdrawal times	Compliance with regulatory controls and periodic testing at milk collection point
Food additives	Use of registered substances, good manufacturing practices (GMP)	Testing of milk and dairy products

CHEMICAL HAZARDS

Chemical hazards can be described as contaminants of naturally occurring toxins, direct and indirect food additives, pesticide and veterinary drug residues and environmental contaminants (for example, dioxins) (WHO, 2009) (Table 3).

Physical hazards

A physical hazard can be defined as any physical material not normally found in a food which can cause illness or injury to the individuals who consume the product. It includes different types of materials often referred to as foreign materials or objects like dirt particles, hair, leaves, rubber and mettle which can get into the milk at the time of milking (Walstra et al., 2006) .

Hazard material	Origin/source	Control measures
Glass fragments	Bottle, jars, light fixtures and utensils	Examination of incoming materials
Insects or insect fragments and wood splinters	Fields, plant, pest-control process	Maintenance procedures designed to avoid contamination
Dirt, dust or hair	Unclean storage, environment and storm	Training in good personal hygienepractices

Contaminants of milk and milk products

Dairy product contaminants are described in terms of the extent of different factors that can make the food unsafe including poor handling, poor storage conditions, naturally occurring toxins found in the food itself, contaminated water, pesticides and drug residues and lack of adequate temperature control. Generally, milk and milk products contaminants are often classified into infectious and non-infectious (Mansel, 2010).

Infectious contaminants of milk and milk products

Contagion in the milk may occur in most cases when the disease- causing organisms (pathogens) get access to enter through cow feces, thus contaminating the outside of the udder and teats, the

farm environment (for example, bedding) and the milking utensils. The extent of contamination that occurs depends upon the hygienic measures taken before, during and after the milking process and storage. Microorganisms found in milk vary considerably and may include bacteria, yeasts, molds and bacteriophages. However, bacteria are the most common and numerous frequently occurring in milk and milk products. Generally, the main source of milk contamination includes: commensal or pathogenic flora of the udder or teat canal, the animal's skin, fecal soiling of the udder, contaminated milking equipment and water used to clean the milking equipment and milk storage containers. Moreover, pathogenic organisms from humans, insects, rodents, birds, and other animals may get access to enter into the milk (FSAUK, 2016).

Milk borne infections

A variety of microorganisms may enter into milk and its products from unprecedented diverse sources, and cause

different human health complications due to food-borne illnesses. Food-borne illnesses are usually pathogenic or toxic in nature and caused by bacteria, viruses, parasites, or chemical substances entering the body through contaminated food or water. Milk and milk products could carry organisms and/or their poisonous metabolites called toxins. Most often organisms shedding from human carriers, the environment, milk-producing or other animals, have been agents of milk borne disease (Table 5).

Non-Infectious contaminants of milk and milk products

In developing countries like Ethiopia, milk production has been very low due to poor genetic and management factors accompanied with small scale farming system carried out in villages and unorganized barns. The likelihoods of milk contamination have been very high. The non-infectious contaminants of milk and milk products may occur through the point of milk production all the way to processing. Some of these contaminants include: chemicals/toxins/ drugs (drugs of abuse), milk additives, environmental (heavy metals) and naturally occurring substances.

Quality assurance and control of milk and milk products

Quality assurance and certification schemes (QAS) is generally explained as any code of conduct, standard or set of requisites, which enables stakeholders of the food supply chain to guarantee compliance with what is declared and to signal this to the end or next user.

Generally, QAS tends to differentiate and guarantee products in relation to their biochemical composition; their origin and the origin of the raw material used to produce them; the production techniques used; residues of pesticides in products; the breeding and living conditions of animals and ethical aspects of production (European Communities, 2006).

Milk quality control

Milk quality refers to a blend of characteristics (chemical, physical, bacteriological and aesthetic) that boost up the acceptability of the milk product. Milk safety and quality assurance has been becoming an area of priority and necessity for consumers, retailers, manufacturers and regulators. Globally, the occurrence of food borne diseases has been increasing and international food trade has been disrupted by frequently ongoing disputes over food safety and quality requirements (Lemma et al., 2008; FAO, 2010). Milk and milk products destined to be exported to global market should pass through the strictest quality standards. To achieve the accepted quality standard, it is mandatory to monitor and control the quality of milk at the grass root level. Milk quality control is the utilization of internationally approved tests to ensure the application of approved practices, standards and regulations concerning the milk and its products (FAO, 2011).Milk quality testes are designed to ensure that milk products conform the accepted standards for chemical composition and purity as well as levels of variety of micro-organisms (Kavitha and Archana, 2015).

Area of quality control

At the farm

Quality control and assurance must start at the farm where the milk is produced (Mansel, 2010), by using approved practices of milk production and handling and observation of regulations

concerning the use of veterinary drugs on lactating animals and regulations against adulterations of milk, etc. (Battu et al., 2004).

At milk collection centers

All milk collected from different farmers having their own considerable management activities or milk which is bulked from various collecting centers must be checked for its wholesomeness, bacteriological and chemical quality (Felleke et al., 2010).

***At the dairy factory and within the dairy* factories**

Once the dairy factory has accepted the milk brought from different farmers and numerous collection centers, it holds the responsibility of ensuring that the milk is handled hygienically and processed to various products.

During marketing of processed products

The government of any country employs public health authorities abiding by the law to check the quality of food ingredients sold for public consumption and may reject substandard or contaminated foodstuffs from being consumed including possible prosecution of culprits. This is done in order to protect the health of the people and keep the interest of the milk consuming public (Felleke et al., 2010).

Milk quality indicators

Quality milk contains normal chemical composition, completely free from disease causing bacteria and harmful toxic substances, free from sediment and extraneous substances, have lower level of titratable acidity, has good flavor, sufficient in preserving quality and low in bacterial counts (FAO, 2010). It is also the lacteal secretion, practically free from colostrums, obtained by the complete milking of one or more healthy cows, five days after and fifteen days before parturition (U.S. Department of Health and Human Services, 1995) (Table 6).

Indicator of milk quality	Quality of cow fresh milk	Quality of ewe fresh milk	Quality of goat fresh milk
Density	1.028-1.034 g/cm^3	1.034-1.042 g/cm^3	1.024-1.040 g/cm^3
pH value	6.5-6.7	6.5-6.8	6.4-6.7
Freezing point	< - 0.517°C	< - 0.56°C	<- 0.54**°C**

Dairy product	Its density (kg/m^3)	Dairy product	Its density(kg/m^3)
Fresh whole milk	1030	Light cream 20% fat	1009
Skimmed milk	1035	Evaporated milk 26% solids	1066
Heated standardized milk	1030	Evaporated milk 32% solids	1085
Sweet condensed milk	1310	Heavy cream 40% fat	988
Sweet whey	1025	Buttermilk	1029

Quality testing methods

Density and freshness of products

The density of milk, among others, is usually used for quality test mainly to check for addition of water to milk or removal of cream. Addition of water to milk minimizes milk density, while removal of cream increases it (O'Connor, 1994) (Table 7).

Organoleptic test

Testing milk for organoleptic characteristics is often called sensory testing and done using the normal senses of sight, smell and taste in order to know the overall quality. Organoleptic tests are sometimes employed to determine if certain type of food or pharmaceutical products can transfer tastes or odors to the materials and components they are packaged in.

Clot-on-boiling test

It is one of the oldest test to determine too acidic milk (pH<5.8) or colostrums, containing mastitis. It is known when the milk is changed to form a curd which means the milk must contain many acids, rennet producing microorganisms and colostrums shed from the cow as soon as the cow gives birth. Such milk cannot stand the heat treatment in milk processing and must be rejected (O'Connor, 1994).

Alcohol test

It is conducted to check the instability of the proteins occurring when the levels of acid increased and acted upon by the alcohol. Also, elevated levels of albumen (colostrums milk) and salt concentrates (mastitis) result in a positive test by curd formation (O'Connor, 1994).

Titratable acidity test

Titratable acidity is defined as a measure of freshness and bacterial activity in milk. When the milk is left for a while, the bacteria will proliferate by utilizing lactose to convert it to lactic acid, thereby increasing the acidity and decreasing the pH value. This acidity is said to be developed or real titratable acidity (O'Connor, 1994; Vishweshwar and Krishnaiah, 2005).

Compositional quality measure of milk

Milk is a highly nutritious substance which contains macro and micro-nutrients, additionally possessing quite a lot number of active compounds that play significant role in both nutrition and health protection (Boza and Sanz Sampelayo, 1997). The composition of milk varies from one milk to another due to a considerable number of factors including breed, age, feed, disease, stage of lactation and milking techniques (McDonald et al., 1995) (Table 8).

Table 8. Approximate compositional quality measures of milk.

Components	Average content (%)	Ranges
Water	87.1	85.3-88.7
Lactose	4.6	3.8-5.3
Fat	4.0	2.5-5.5
Protein	3.3	2.3-4.4
Casein	2.6	1.7-3.5
Mineral substance	0.7	0.57-0.83
Organic acid	0.17	0.12 -0.21
Miscellaneous	0.15	-

Overview of milk quality standards and regulation

In most dairy industrialized countries, milk quality is defined by the level of somatic cells count (SCC) and the microbial load of milk in the pre-pasteurized bulk tank. These are the key components of international regulation put in place for milk quality, udder health and the prevalence of clinical and subclinical mastitis in dairy herds (Fatine et al., 2012). High levels of SCC and microbial load indicate poor milk quality due to the fact that it contains reduced curd firmness and increased fat and casein loss in whey. Moreover, reduction of milk shelf life, poor farm hygiene, antibiotic residues and the presence of pathogenic organisms and toxins increase the microbial load of the milk. Problems of public health associated with consumption of raw milk and traditional dairy products obtained from raw milk are common in the developing countries (Makita et al., 2012). As the industry keeps on growing, much attention needs to be paid on food safety measures to ensure a safe and high-quality product for consumers.

Quality regulation

Governments, all over the world, have put in place various mechanisms for protecting their citizens from food borne illnesses to ensure the socio-economic development of their country. Milk quality standards have been regulated by the respective Food and Drug Administration in the countries. As a result, the EU and USA legislations have been used as a common measure of milk quality standards. More or less in Ethiopia the application of milk quality standard and regulation is comparable world -wide. Regulation in the area of food quality and safety

protection has been one the features of regulatory mechanisms established for problems that are difficult to be identified by consumers using their sense of sight, smell, taste or touch when selecting or consuming foods (CAC , 2007). The responsibility of food regulation in Ethiopia has been shared among Ministry of Health, Ministry of Agriculture and Rural Development,

Ministry of Trade and Industry, and Quality and Standards Authority of Ethiopia. However, there has been poor coordination and cooperation among these government regulatory agencies towards implementing quality regulations laid down by the government. On top of this, the country does not possess an updated comprehensive food law that clearly defines and streamlines the activities of each regulatory body (Abegaz, 2004) (Table 9).

Milk quality grading

In the United States, Grade A milk (fluid grade milk), top quality milk, refers to milk produced in the farms where sufficiently sanitary conditions have been fulfilled to qualify for fluid (beverage) consumption. Grade B milk is referred to as manufacturing grade milk that does not meet the fluid grade standards and can only be used in cheese, butter and nonfat dry milk. Grade C milk is the last grade milk which violates any of the requirements for grade B milk but is not subjected to adulteration (U.S. Department of Health and Human Services, 2011) (Table 10).

Parameters	**Grade A**		**Grade B**
	Raw milk	**Pasteurized milk**	**Raw milk**
Temperature	Cooled to 45° F. within 2hrs of milking	Cooled to 45° F or less and maintained thereat	Cooled to 40° F within 2 h of milking
Bacterial Limits	Not to exceed 100,000 and 300,000 per ml prior to commingling with other producer milk and pasteurization respectively.	Not exceed 20,000 per ml	1 million per ml; the commingled count is 3 million per ml

Coliform	Nil per ml	Not to exceed 10 per ml; provided that in the case of bulk milk transport shipments shall not exceed 100 per ml.	> 10 and 100 per ml for individual and bulk transport respectively
Somatic Cell Count	Not to exceed 1,000,000 per ml	Not to exceed 750,000	When Exceed 1,000,000 per ml
Solids not Fat	8.5	8.25	-
Antibiotics or Other Inhibitors	No zone equal to or greater than 16 mm with the *Bacillus Stearothermophilus* disc assay method	No zone equal to or greater than 16 mm with the *Bacillus Stearothermophilus* disc assay method	Positive but, not harmful

Policy issues	**Challenges**	**Constraints**	**Policy recommendation**
Disease prevalence and control	Lack of inspection and quality control services to safeguard the public from zoonotic diseases	Lack of proper livestock movement control, quarantine and surveillance systems	Design and implementation of appropriate control and prevention strategies for milk born diseases, such as TB and mastitis
Standards and quality control	Safety and quality standard of dairy products supply to the consumer not guaranteed	Lack of enforcement of quality control regulations and standards	Mandatory certification and inspection service, implementation of standards, legislations on milk quality and assurance
Dairy information	Unavailability of information at production, marketing and consumption level	No organized body in charge of collecting, summarizing, archiving, analyzing and disseminating	Organizing or establishing an institution for dairy information system.

Milk processing	Operating under capacity	Low level and uneven supply of liquid milk with the required quantity and quality and Promoting demand	Facilitation of collection, chilling and transportation facilities

***Principles of HACCP and applications to food* safety assurance**

HACCP is a scientific and systemic system, which identifies a specific hazard throughout the food chain, that is, from primary production of milk until it reaches the consumer. With increasing demand for dairy products worldwide, it is necessary for every dairy industry to adopt HACCP in order to give quality assurance to consumers (DPC, 2001). A hazard is any aspect of the production chain that is unacceptable because it is a potential cause of harm activated by biological, chemical or physical agent in food with the potential to cause an adverse health effect in humans and animals (CFSAN, 2007). In a country where consumption of raw milk and milk products is common, provision of milk and milk products with superior hygienic quality is required to safeguard the consumers (Zelalem, 2003). HACCP requires a critical examination of the whole food manufacturing process to determine every step where there is a likelihood of physical, chemical, or microbiological contamination. This would make the food unsafe or unacceptable for human consumption. It identifies and sets critical control points (CCP) (DPC, 2001). Control points are the steps where food production starts at raw stage and passes through processing and shipping to consumption by consumer. Critical control points are the ones in food production system where loss of control can lead to health hazards. Traditionally these practices were used to reduce manufacturing defects in dairy products and ensure compliance with specifications and regulations. However, they have many drawbacks e.g. they are destructive and time-consuming, they have slow response, allow small sample size to work with and they delay in the release of food principles to HACCP. There are over seven principles to HACCP: Analyze hazards, Determine critical control points, Establish critical limits, Establish monitoring procedures, Establish deviation procedures, Establish verification procedures and Establish record keeping procedures (CFSAN, 2007; CAC, 2007).

Questions:-

1) What are the Quality Attributes of various Dairy Products.
2) What are the Food safety hazards associated with cereals and foodgrains?

References:-

1. IS: 8184 – 1976 Method for determination of Ergot in Food grains

2. AOAC 17th edn, 2000, Official method 970. 66 Light and Heavy Filth

3. 15.2.4.6 (2-14) of Food Safety and Standards (Food Products Standards and Food Additives) Regulations, 2011

4. IS 4333 (Part 1): 1996 Methods of analysis for Food grains Part I Refractions

5. AOAC 17th edn, 2000, Official method 941.16 Filth in grain products and brewers grits

6. AOAC 17th edn, 2000, Official method 993.26 Light filth in Whole Wheat Flour

7. AOAC Method No. 970.24

8. IS 4333 (Part 5) 1970 – Methods of Analysis for Food grains Part 5

9. IS 8184 :1976 Method of determination of Ergot in Food grains

10. AOAC 17th edn Official method 915. 03 Hydrocyanic acid in Beans/IS 11535:1986/ISO 2164- 1975 Method of test for determination of glycosidic hydrocyanic acid in pulses

11. AOAC 17th edn, 2000, Official method 925. 08 Sampling of flour

12. IS 1155 :1968 Method of Determination of Gluten

Chapter 4

QUALITY ASSESSMENT OF NUTRITIONAL VALUE AND SAFETY OF DIFFERENT MEAT, FISH AND POULTRY PRODUCTS

Introduction

Fresh meat considering one of the most perishable food due to its composition which, rich in protein, omega-3 polyunsaturated fats, vitamin and minerals, in addition to wide range of endogenous antioxidants and other bioactive substances including carnitine, taurine, carnosine, ubiquinone and creatine. These chemical components of meat varies according to the difference such as; animal species, age, breed, sex, feed and body weight. Consequently, quality of the meat is dependent upon changes in its chemical components; protein, moisture, fat and ash.

The abattoir is an important step in the production of meat as it presents some of the preferable opportunities for contamination. Biological, physical and chemical hazards may be encountered at an abattoir. The most important microbial contamination sources arise from endogenous sources as the microbial load of meat mainly due to its high water activity, high protein content and approximately neutral pH. Exogenous sources of meat were occurred during or after slaughtering, processing, abuse storage conditions including; and/or during the meat transportation.

The meat microbiological quality is very important concerning public health. There are more than a few reports on outbreaks of food poisoning because of meat consumption. Carcass contamination resulting in meat spoilage, reduced meat shelf-life and may cause a consumers health hazards either due to the presence of spoilage bacteria responsible for harsh changes or pathogenic bacteria leading to risky effects for consumers as food infection or intoxication.

Inspection of meat aimed to assessment of the quality control of slaughter animals and meat, which provide wholesome and safe meat for human consumption and achieved by abattoir meat inspectors (veterinarians) who is representing the authorities of public health.

Quality monitoring is important not only for protecting the consumer health but also for authority concern. Chemical and microbial quality of freshly meat and edible offal have been getting attention all over the global scales, from researchers, meat industry, governments and other health organizations due to its effect on the nutritive value of meat and susceptibility to food-borne illness affecting consumers. In addition, few studies discussed the chemical and microbial

quality of mutton and camel meat. Therefore, this study aimed to evaluate the chemical and microbiological quality of different fresh meat, which slaughtered at Ismailia abattoir level, Egypt.

Materials and Methods

Samples collection

A total of 30 musculus Biceps femoris muscles (Breed: Egyptian sheep, cattle; camel: male, one day postmortem, muscle pH: 5.75-5.95, 250 g weight) were purchased from Ismailia city abattoir. All samples were immediately transported to the Food Hygiene Laboratory. Meat was kept at cool chamber of refrigerator (3°C ±) until they were used for the experiments.

Preparation of the beef samples

The external fat was trimmed then samples were divided into two portions, one for chemical evaluation and the other for microbiological analysis.

Chemical analysis of the samples

Determination of moisture content: Performed using the AOAC

Official Method 950.46 moisture removal process. 2.0 g of meat samples was weighed out into aluminum tins and allowed to dry for 24 h at 100°C in an air-oven. After cooling, the loss in weight was calculated.

Determination fat content: Determined using the AOAC

A clean Soxhelt's flask was placed in a hot air oven at 105°C for 30 min, and then it was placed in desiccator and weighed just after cooling. The flask was fitted with a Soxhelt's extractor and secured in a stand on the bench. Mould a filter paper on a large test-tube and the homogenate meat sample was transferred into the paper and then plug the top of the paper with de-fattened cotton wool and push it into the lower part of the extractor. Then, light petroleum ether was added through the top of the extractor. A suitable condenser was attached and heating was

applied to the flask in the apparatus on special water bath. The extraction was begun and continued for about 16 h. Then replaced the ordinary extractor with one that is suitable for removing solvent and placed it on the apparatus and tap of the condensed solvent. The flask was placed in a hot air oven at 105°C for 3-5 h. Hence, the flask was removed from time to time during the heating and blow air onto the fat by using a hand bellows. Finally, the flask was transferred to desiccator, cooled and weighed to determine the weight of fat by difference. The fat percentage of the original sample was calculated.

Determination of protein content:

Protein was determined using the AOAC. Official Method 992.15 as follow: Digestion: One gram of the homogenate meat sample was placed in Kjeldahl's flask with 8 g catalyst mixture (96% anhydrous Sodium Sulfate, 3.5% Copper Sulfate and 0.5% Selenium Dioxide). Then, 20 ml of conc. H_2SO_4 were poured on the sample and vigorous shaking was applied. Vigorous boiling was carried out till the mixture become clear and transparent then allowed to cool. This is called "digestion mixture". Distillation: The digested mixture was transferred into another Kjeldahl's flask then 400 ml of distilled water and 75 ml of 50% NaOH were added. The flask was connected with condenser then, heating was applied and receiving of the liberated ammonia in a conical flask contains 50 ml of 2% boric acid with indicator (20 g boric acid with 200 ml Alcohol plus 700 ml distilled water plus 10 ml mixed indicator) was carried out. Approximately, 300-330 ml of the distillate was gained.

Boric acid containing ammonia was titrated against N/10 H_2SO_4 and determines the Number of ml of H_2SO_4. Calculation: Each ml of H_2SO_4 N/10 was equivalent to 0.0014 g nitrogen. The total nitrogen in the sample was estimate by the macro-Kjeldahl's technique by the following equation:

Percentage of nitrogen=Number of ml of N/10 H_2SO_4 × 0.0014 × 100.

Determination of ash content: Determined using AOAC. Official Method 920.153. Approximately 1.0 g of meat sample was placed into a dry, pre-weighed crucible. The samples

were then placed into a Thermolyne box furnace at 600°C for 24 h. Samples were allowed to cool and weighed. Ash was calculated by loss in weight as percent was calculated.

Microbiological analysis of the samples

Enumeration of aerobic plate count: Ten grams from each sample was aseptically cut and transferred into a sterile polythene stomacher bag and blended with 90 ml sterile normal saline in a stomacher homogenizer (Stomacher 400, Seaward medicals, UK.) at 230 rpm for 60 s. Then, one ml of the homogenate was aseptically transferred into 9 ml normal saline in test tube. Similarly, further dilutions required for inoculation was prepared by this decimal serial dilution process. The plating was done by adding a loopful from each dilution on Plate Count Agar medium using pour plate method. The colonies that formed after incubation at 35°C for 2 days under aerobic conditions were counted.

Determination of total proteolytic count: Carried out as recommended by APHA, [24] as follows: One ml of the previous decimal serial dilutions was inoculated in Skim Milk Agar medium aseptically then inoculated at 37°C for 48 h and examined for clear zone around the growth.

Enumeration of total lipolytic count : One ml of each dilution mixed with tributyrin nutrient agar media and incubated at 37ºC/48 h, lipolytic activity was determined by measuring clear zone.

Statistical analysis

Means and standard error were calculated among samples and the t- test was done for significant differences between meat samples using the Microsoft Office Excel 2007 and Graph Pad Instat 3 for Windows software. When P value>0.05 → the observed difference is “not significant” When P value ≤ 0.05 → the observed difference is “significant”.

Results

Food safety is of principal importance to the meat industry. Chemical and microbial contamination of meat is a critical global problem.

Content	mutton			beef			camel Meat		
	Min.	**Max.**	**Mean ±**	**Min.**	**Max.**	**Mean ±**	**Min.**	**Max.**	**Mean ±**
Moisture	69.6	76.5	73.4 ± 1.25	65.2	71.4	68.3 ± 3.46	71.2	76	75.8 ± 2.70
Fat	1.8	7.5	3.2 ± 1.32	18.1	25.3	12.2 ± 2.4	1.2	2.3	1.7 ± 0.32
Protein	18.2	23.1	22.3 ± 1.65	17.4	22.6	18.1 ± 3.41	18.3	23.1	21.3 ± 1.43
Ash	0.7	2.3	1.1 ± 0.19	0.7	1.8	1.3 ± 0.20	0.8	1.5	1.2 ± 0.30

Chemical composition: The mean moisture, fat, protein and ash values for the meat of slaughtered animals at Ismailia abattoir revealed in the table 1. The mean moisture content of mutton, beef, and camel meat were 73.4, 68.5, and 75.8 respectively. The mean fat content mutton, beef, and camel meat were 3.2, 12.3, and1.7 respectively. The mean protein content of mutton, beef, and camel meat were 22.3, 18.1, and 21.3 respectively. The mean ash content of mutton, beef and camel meat were 1.1, 1.3, and 1.5 respectively.

Bacteriological quality: Aerobic plate count is a commonly recommended microbiological method for estimating the shelf-life of meat. Bacteriological content for mutton, beef and camel meat at Ismailia abattoir were revealed in the table 2. The mean values of aerobic plate count for mutton, beef and camel meat were 6.0, 5.6, and 4.5 Log CFU/g respectively. Aerobic plate count is generally is an indicator of microbial contamination of carcasses and abattoir hygienic conditions. Meat is nutrient-rich food, but also they are highly perishable due to they provide the nutrients needed for multiplication and growth of a lot of microorganisms

	mutton	**beef**	**camel Meat**

content	Min.	Max.	Mean ±	Min.	Max.	Mean ±	Min.	Max.	Mean ±
*APC	4.5	5.3	6.0a ± 2.31	4.5	5.9	5.6b ± 4.06	3.4	4.9	4.5c ± 2.11
Proteolytic Counts	2.4	5.1	4.5a ± 2.30	3.4	3.9	3.5b ± 2.20	2.2	3.8	3.2c ± 1.02
Lipolytic Counts	2.3	5.6	4.4a ± 1.20	3.2	4.8	4.0b ± 1.01	1.1	2.9	2.2c ± 0.83

The mean values of total proteolytic counts for mutton, beef and camel meat were 4.5, 3.5, and 3.4 Log CFU/g respectively. The mean values of total lipolytic counts for mutton, beef and camel meat were 4.4, 4.3, and 2.2 Log CFU/g respectively.

The mean values of total yeast count for mutton, beef and camel meat were 4.01, 3.62, and 2.51 Log CFU/g respectively. The mean values of mold counts for mutton, beef and camel meat were 5.71, 5.00, and 3.12 respectively. The total yeast and mold counts were significantly higher ($P<0.05$) in mutton followed by beef then camel meat.

Content	mutton			beef			camel Meat		
	Min.	Max.	Mean ±	Min.	Max.	Mean ±	Min.	Max.	Mean ±
T. Yeast Counts	2.81	6.2	4.01a ± 1.21	2.62	5.2	3.62b ± 2.70	1.22	3.98	2.51c ± 1.01
T. Mold Counts	3.64	7.52	5.71a ± 3.60	3.68	6.66	5.00b ± 1.50	1.67	4.69	3.12c ± 1.72

Aerobic microorganisms can cause negative changes in flavor, appearance, odour, and consistency of the meat by their metabolic activity and may also include some pathogenic microorganisms which affects public health hazards and leading to economic losses by causing meat spoilage and/or food poisoning. In this study, on-floor slaughtering technique was applied during slaughtering the sheep, cattle, and camel, where various microorganisms might have contaminated the carcasses and may be responsible for increasing the initial microbial loads. Carcass contamination by soil, abattoir discharged and wastewater considers the main sources of meat microbial load inside the abattoir.

The mean values of total proteolytic counts for mutton, beef, and camel meat were 4.5, 3.5, and 3.4 Log CFU/g respectively. The mean values of total lipolytic counts for mutton, beef and camel meat were 4.4, 4.3, and 2.2 Log CFU/g respectively. The aerobic plate count, proteolytic and lipolytic counts were significantly higher ($P<0.05$) in mutton followed by beef then camel meat. Proteolytic and lipolytic microorganisms grow well in meat leading to loss of meat quality and reduction its shelf-life due to protein and fat hydrolysis which leads to deterioration in color, flavor, and texture of displayed meat Yeast slower grows than most bacteria and their growth limited by metabolic substances produced by bacteria. Yeast plays a mild role in spoilage because they constitute only a small portion of the initial population. Food spoilage by yeasts leading to undesirable changes in physical appearance of food. Some species of yeast resulting in a public health hazard such as some species of candida which cause gastrointestinal disturbances, pulmonary infection, endocarditis and occasionally fatal systemic disease. Most of the fungal isolates were soil-inhabiting microorganisms.

Mould also used as an index of proper sanitation and high-quality products. Abattoir is a good environment for the mold growth because of their high moisture content. Mould produces in its putrefactive processes a mycotoxin which is toxic substances leading to hemorrhages with hepatotoxic, carcinogenic or immunosuppressive effects.

QUALITY ASSESSMENT AND SAFETY OF DIFFERENT FISH AND FISH PRODUCTS.

The quality of fish and fishery products is a major concern in fish industry worldwide. Essentially, the objective of fish and fish product assessment is to avoid the ingestion of contaminated food; to evaluate the nutritive value of food by detecting the presence of biological, chemical and physical hazards and in the end to ensure the safety of the consumer. To assess the safety of fish and fish products both instrumental and sensory methods are used. Sensory methods are the most satisfactory way of assessing the spoilage and freshness of fish and fishery products. The use of raw, inadequately cooked, salted or smoked fish, common in many countries, has zoonotic potential and has been reported to cause serious disease conditions in humans. To avoid disease problems caused by parasite, bacteria and autolytic activity, fish that is going to be used for food should be frozen and cooked before use.

Introduction

Aquaculture has developed to become the fastest growing food producing sector in the world. A large proportion of fish products come from small-scale producers in developing countries or low income deficit countries. More than 80% of global aquaculture products are produced in fresh water. From its early development in Asia, aquaculture has undergone huge development and is highly diversified. Aquaculture consists of a broad spectrum of systems, from small ponds to large-scale, highly intensified commercial systems (Håstein et al., 2006). The quality of fish and fishery products has become a major concern in fish industry all over the world (Huss et al., 2003). Fish, being one of the exceptionally perishable foods and as a result of globalization of food trade fish products tend to be more susceptible to rejection due to poor quality especially if the initial raw materials are of poor quality despite the technological developments in fish production (FAO, 2009).

Seafood health hazards have been outlined in several guides in the literature (FDA, 2001) and can be classified as (i) biological hazards (biogenic amines - in some literature is classified under chemical hazards or bio toxins, parasites, pathogenic bacteria, viruses, bio toxins and allergens), (ii) chemical hazards (chlorophenicol and other antibiotic residues for farmed fish, fish

originated from contaminated waters such as heavy metals, dioxins, chemical contaminants originated from processing areas, chemicals formed by fish processing such as nitrosamines and polycyclic aromatic hydrocarbons and (iii) physical hazards such as bones, plastic, glass and metals (Huss et al., 2003)

Preservation techniques are needed to prevent fish spoilage and lengthen shelf life. They are designed to inhibit the activity of spoilage bacteria and the metabolic changes that result in the loss of fish quality. Traditionally processed fish products (TFPs) are reported to carry high potential risk for human health for halophilic pathogenic bacteria, histamine and parasites (Hansen, 2008).

Therefore, the objectives of this seminar paper are:

- To highlight better evaluation techniques of fresh fish
- To Characterize different hazards and to give guidelines for prevention of these hazards

2. Type of Hazards on Fish and Fish Product

Biological Hazards

Pathogenic bacterial

Bacteria represent a major and important group of microorganisms because of their frequent occurrence and activities that may have a negative impact on fish quality. Generally, seafood from cold waters harbors lower numbers of potentially pathogenic micro-organisms than seafood from warmer waters. The presence of human pathogenic bacteria in fish and fish products may also be attributed to contamination during processing. Several bacteria are, however, reported to cause infection and mortality in both fish and humans, and these represent a particular hazard, caused either by handling infected fish on fish farms, in grocery stores or by the ingestion of raw or inadequately processed infected fish and/or contaminated fish products (Austin et al., 2005).

Pathogenic and potentially pathogenic bacteria associated with fish and shellfish include mycobacteria, Streptococcus iniae, Vibrio vulnificus, Vibrio spp., aeromonads, Salmonella spp,

Clostridium botulinum type E, Erysipelothrix rhusiopathiae, Listeria and others (Chattopadhyay, 2000). People most often get infected as follows Aschfalk and Muller (2002): (i) through contact with infected fish while handling them, water or other constituents of fish life environment; the following cases of transmissions have been recorded so far: after injury by cleaning aquarium with bare hands, after exposure to fish tank water, by handling tropical fish ponds, by contact with rare tropical fish (Bhatty et al., 2000), after injuries from fish, e.g. by thorns, after fish bite (Seiberras et al., 2000), through contact with fish living in the wild, by contact with a fresh or salt water environment (Jernigan and Farr, 2000), infection of young children who are in contact with a fish tank, through processing fish in the food industry and preparation of dishes or (ii) orally by consumption infected fish or related products or food contaminated with water or other constituents of water environment. Apart from factors relating to the living environment (exposure), the development of an infectious disease is markedly affected by internal factors such as the physiological status of consumer, particularly by immune suppression and stress as in the case of HIV/AIDS (Novotny et al., 2004).

Aeromonad bacteria are ubiquitous in the environment and several Aeromonas species have been reported to cause disease in fish, as well as being potential food-borne pathogens that may cause disease in humans (Håstein et al., 2006). Although Salmonella spp. May be harboured and survive in fish, sea foods seldom harbour Salmonella. Fish may be exposed to Salmonella through consumption of contaminated feed or living in contaminated water. The occurrence of Salmonella in feed has, for a long time, been a well-recognized problem worldwide. However, research has shown that the level of Salmonella contamination in the feed must be extremely high if the bacteria are to persist in the fish for more than a few days (Nesse et al., 2005).

If Salmonellosis present in freshwater or marine fish species, this is mainly due to faecal contamination. Food-borne pathogenic bacteria such as Campylobacter, Shigella and Yersinia are seldom associated with fish. Nevertheless, the fish pathogenic bacteria Y. ruckeri has been reported to occur in humans. Edwardsiella tarda, which causes ‘red disease’ in eels as well as enteritis in penguins, is also sporadically reported as causing gastroenteritis and septicaemia in humans (Håstein et al., 2006).

Microbiological examinations are the prerequisites for correct diagnosis. However, quantification of the occurrence of these diseases is difficult because many cases, typically gastrointestinal illness, go unreported; the symptoms usually do not last long and are self-limiting in healthy people. It can be extremely difficult to detect certain slow growing causative agents of diseases such as those of mycobacterial infections or infections caused by anaerobic pathogens. Mycobacterial infections are quite often misdiagnosed with subsequent inappropriate therapy. Consequently, the disease can last for years.

Parasites

Among the animals, fishes are the most important hosts for maintenance of parasites mainly helminthes. Most of fishes have parasites and they not only serve as hosts of different parasites but also serve as carrier of many larval parasitic forms that mature and may cause serious diseases in many vertebrates including man (chandra, 2006).

Fish borne parasitic infections have recently been identified as an important public health problem with considerable economic impact in terms of morbidity, loss of productivity and healthcare costs. Poor sanitation and traditional methods of food preparation have accelerated the spread of fish borne parasitic infection (Ibrahim, 2014).

The most important of helminths acquired by humans from fish are the anisakid nematodes (particularly anisakis simplex and pseudoterranova decipiens), cestodes of the genus diphyllobothrium and digenetic trematodes of the families heterophyidae, Clonorchis, opisthorchiidae and nanophyetidae. The effect of parasites on the value of the fish is perhaps greater than their impact on human health. In addition to the health effect parasites can reduce the value of fish to harvesters by damaging the skin, infesting the meat, or spoiling the flavour or condition of the fish (Omar, 2014). Parasites are the most difficult hazards to monitor in marinated fish products since acidic pH conditions are not usually effective. In preventing parasites, especially anisakid nematodes (Murrel, 2002). The fish borne zoonotic trematodes (FZT) are well known causes of liver and intestinal trematode (fluke) diseases in humans (Chai et al., 2005)

The strong cultural preferences in many countries for eating raw or insufficiently cooked infected fish are believed to be the greatest risk factor for human infection. It has been estimated that about 680 million people worldwide are at risk of infection apart from more than

20 million humans already infected with liver flukes (Clonorchis sinensis and Opisthorchis spp.) (Keiser and Utzinger, 2005).

Chemical Hazards

Formation of biogenic amines and involved products Biogenic amines (BAs) are mainly formed in fish products by microbial decarboxylation of amino acids and transamination of aldehyde and ketones. Certain biogenic amines such antihistamine, cadaverine, putrescine and tyramine are of importance due to the risk of food intoxication and also they serve as chemical indicators of fish spoilage (Kim et al., 2009). Histamine is one of the main concerns in fisheries products formed by microbial decarboxylation of histidine as a result of time/temperature abuses in certain fish species. Histamine poisoning is often referred to as 'scombrotoxin poisoning' because of the frequent association of the illness with the consumption of spoiled scombroid fish such as tuna, bonito and mackerel. However, non-scombroid fish such as herring, anchovies and mahi-mahi have also been implicated in out breaks (Huss et al., 2003).

Nitrosamines

Nitrosamines are reported to cause cancer and are often associated with TFPs such as smoked, fermented, salted and salt-dried products. Although various causes have been indicated with the formation of nitrosamines in foods, the mechanisms of nitrosamine formation in fish products and factors influencing their formation have not been clearly elucidated. Nitrosamines are generally formed through reactions between secondary and tertiary amines and nitrite under certain conditions (Al Bulushi et al., 2009).

The presence of secondary amines such as dimethylamine (DMA) and tertiary amines such as TMA has been found to be implicated in nitrosamine formation. In fish products such as salted,

pickled, smoked, fermented and canned fish, the presence of nitrosodimethylamine (NDMA) which is formed from DMA and nitrite, has been widely reported. Primary amines such as putrescine and cadaverine have been suggested to cyclize during heating to secondary amines such as pyrrolidine and piperidine, which react with nitrite to form carcinogenic nitrosamines (Al Bulushi et al., 2009).

The International Agency for Research on Cancer (IARC, 1978) classified a number of NAs with respect to the cancer risk for humans. The IARC considers NDMA and nitrosodiethylamine (NDEA) into the group of probably carcinogenic to human, and nitrosodibutylamine (NDBA), nitrosopiperidine (NPIP) and nitrosopyrrolidine (NPYR) into the group of possibly carcinogenic to human (Yurchenko and Mölder, 2006).

Evaluation of Safety of Fish and Fish Products

Traditional methods for evaluation of fish and fish products

Sensory evaluation

Considering all the developments in instrumental methods that have occurred in the last decade, sensory methods remain the most satisfactory way of assessing the freshness of fish and fishery products. Objectives seafood sensory tests, based on certain attribute of raw fish (skin, eyes, gills, texture, etc.), are the most commonly used methods for quality assessment of raw whole fish in the inspection service and fishing industry (Martinsdottir et al., 2009).

Sensory evaluation of food is defined as the scientific means of quantifying and interpreting the variations in food characteristics (odour, taste, tactile, appearance) by using human senses of sight, smell, taste, touch and hearing. Studies have shown that assessment of food freshness/ characteristics using sensory methods are capable of giving objective and/reliable results when assessments are done under controlled conditions. Generally, trained and experienced taste panel is essential to obtain accurate and reproducible result. Sensory methods are divided into two groups; discriminative and descriptive tests however, the most commonly used is the descriptive test which measures the difference or absolute value indicating the different quantitative levels.

There are several grading methods used to assess freshness in fish and fish products for instance the European Union (EU) scheme and the Torry system (Connell, 2001).

Nonetheless, other new sensory schemes exist like the quality index method (QIM), originally developed in Tasmania (Bremner et al., 2002). QIM is a tool, for estimation of the quality attributes in a more objective way, based on the significant parameters for raw fish with a score system ranging from 0-1; 0-2; 0-3; 0-4 or more, demerit points (Frederiksen, 2002). The main advantage of the quality index method when compared to EU scheme is that quality index method is species specific and confusion about attributes is minimised. Each fish species has its own characteristic sensory attributes (flavour, appearance, odour, and texture) which change with time and temperature after harvest (Martinsdóttir, 2002). Quality index method schemes have been developed for species such as European cuttlefish (Sepia officinalis) Arctic charr (Salvelinus alpines) fresh cod (Gadus morhua) and fillets (Martinsdóttir, 2002).

However, sensory methods in general are known to be irrationally expensive due to the high training requirement of the panel; cost of running, need for individual scheme for individual fish species given the different spoilage patterns and physiological and psychological limitations of the analyst (Connell, 2001).

Microbiological methods

The major changes in fish freshness for instance unattractive change in food characteristics such as, flavours, odours and colour are largely due to bacterial growth and activity. Microbiological methods are used to estimate bacterial numbers, in order to determine fish freshness, hygiene and or evaluate the possible presence of bacteria or organisms of public health. Microbiological prediction/estimation of bacterial numbers therefore, in order to serve the purpose of food safety and shelf life determination, is expected to relate quantitatively to the characteristics of the food during storage (Dalgaard, 2002).

Chemical methods

The evaluations of food using chemical methods are considered to be more objective than sensory methods especially when it is done accurately using appropriate method. These methods involve determination of the concentration of a specific chemical in the food. Chemical methods of food evaluation are normally used to indirectly predict the level of a sensory attribute, which allows for immediate determination of freshness. To use chemical methods to serve this purpose, well set, quantified and standardized tolerance levels of chemical spoilage indicators need to be established. (Chebet, 2010).

With regard to evaluation of fish quality using chemical methods, the total volatile basic amines constitute to the commonly measured chemical indicators. Total volatile base is a general phrase used to include volatile amines such as, tri methylamine, ammonia produced by spoilage bacteria; di methylamine and produced by autolytic enzymes during frozen fish storage. The concentration of these chemicals in fish tissues can be determined by steam distillation method. Conversely the measurement of the amount of hypoxanthine in fish is one of the chemical methods of determining fish freshness. Hypoxanthine is one of the products of nucleotides degradation mediated by bacterial activity (Proteus bacterium) is known to be responsible for bitter, off flavours of spoilt fish. Freshness can be determined by calculating the ratio of inosine and hypoxanthine to the sum of ATP and all the other products of ATP degradation multiplied by 100 (Haard, 2002) .

Alternative "Rapid" methods of evaluation of fish and fish products

ATP determination technique

The measurement of the concentration of adenosine triphosphate (ATP) in foods is considered as a "rapid method" for the assessment of bacteriological quality of food. The basis of this technique is the inherent existence of ATP molecule in all living organism. ATP is a nucleotide, found in all living cells, including bacteria and is the universal agent for the transfer of free energy molecule. ATP technique of bacteriological assessment of food quality correlate well with bacterial counts in food however, caution must be taken in samples whose somatic cells dominate in the sample to avoid alteration of the measurement (Chebet, 2010).

Redox potential (Eh) technique

The measurement of the variation in Redox potential (Eh) is considered to be one of the "rapid" ways for the estimation of bacteriological quality of food Metabolically active microorganisms; especially aerobic microorganisms are capable altering the Eh their substrate (i.e. food), leading to lower Eh values (Jay et al., 2005).

The measurement of redox potential can be done by using an appropriate instrument such as redox electrodes and expressed in millivolt. The common electrodes used to serve this purpose are, silver Chloride electrodes and platinum electrodes with calomel reference electrodes. Similarly, the Dye reduction technique constitute to one of the ways of determining the bacteriological quality of food by estimating the detection time indicated by the dye discolouration time in hours (Adams and Moss, 2008) .

The common redox dyes used to serve this purpose include; Resazurin, methylene blue, 2, 3, 5-triphenyltetrazolium Chloride expressing the result as; Dye Reduction Time in hours (h). Longer Dye Reduction time is used to indicate lower bacterial numbers and shorter Dye Reduction time has been found to indicate higher bacterial numbers. However, the principle of operation of redox electrode and dye-reduction techniques in the method of microbial estimation is based on the variation in the Eh of the food due to microbial activity and their related metabolic by products, associated with spoilage (Chebet, 2010)

Electronic nose techniques

The electronic nose technique is used to detect and quantify the concentration of volatile compounds (bioamines) in fish, which occur during spoilage. The principle of operation of the Electronic nose involves the transfer of the total headspace of the sample to a sensor array that detects the presence of volatile compounds in the headspace and a pattern of signals is provided that are dependent of the sensors‟ selectivity and sensitivity and the characteristics of the volatile headspace. The electronic nose technique is considered produce as objective information as can

be obtained by sensory panellist regarding the freshness of fish during storage (Olafsdóttir, 2005).

Electrical technique

The change in the electrical properties, such as conductance; capacitance or impedance is one of the pertinent indicators of food quality deterioration due to microbial growth. Microbial growth in a substrate is known to lead into change in the chemical composition of the growth medium and may consequently lead to change in the electrical properties (capacitance, impedance and conductance) of the medium (Adams and Moss, 2008). The measurement of these changes can be done using instruments operating under the same principle and these include; Torrymeter, RT meter and Fischtester VI, Bactometer, Malthus system, BacTrac, and Rapid Automated Bacterial Impedance Technique (RABIT). This method has been applied with success in the analysis of variety of foods such as milk, meat, and fish to test for total counts of aerobic and selected groups of organisms such as coliforms, Salmonella and yeast as well as measurement of niacin

Texture measurement

The change in texture, resulting from autolytic, bacterial and chemical changes in fish during storage has a direct relationship to change fish freshness. The measurement of textural changes is considered as one of the ways of determining food quality deterioration. Fish texture can be determined by using Texturometer, a hand held device utilizing a cylindrical probe that is exerted on the food product with force, F that increases the present value the measurement of firmness using this technique has been found to correlate well with the sensory textural attributes like dehydration and firmness. This measurement is considered as a direct extension of the human sensory assessment “figure press test” (Bremner et al., 2002).

Immunological methods

Immunological methods include enzyme-linked rapid methods, referred to as “ready to use kits”. The principle of operation of immunological technique lies on the detection of the presence of gram-negative microorganisms and food borne pathogens through a chemical reaction between

the kits with the substrate (food product) leading to specified indication (colourations). Some of the examples of these kits include; Latex, agglutination kits, Quik Alert kit, SDI Rapid Chek, Path-CHEK swab, Transia card/plate and Assurance EHEC & Gold EIA (Fung, 2002).

Factors Affecting the Safety of Fish and Fish Products

Pre harvest related factors

Wild fish are harvested by a large variety of methods, such as different kind of nets, hooks, pots, and so on. Depending on the method used the capture of wild fish involves various degrees of desperate struggle followed by a period of asphyxiation once the fish is on board. To control stress produced by these conditions it is necessary to control mainly the fishing method and time; however, the method is often dictated by commercial considerations, and it is difficult to modify (Wiley et al., 2011).

Incorrect handling at this point will be detrimental to the quality during ice storage. Fish that have been trawled are subject to more stress from fighting the net for hours, and this stress has been shown to affect ice-storage quality. In the case of some species like tuna, when they are caught in a highly stressed state, the buildup of lactic acid in the muscle, combined with high muscle temperatures results in a dull muscle and acidic and metallic aftertaste. This has been reported in other species; for instance, wild salmon caught by gill netting die after stress exhaustion (Wiley et al., 2011). Handling of farmed fish has certain differences compared to wild fish and depending of species. The first operation for farmed fish is to carefully separate fish from the main cages into smaller holding units without causing more stress than necessary. At this stage, the fish are kept at a density of around 5 to 10 kg/m^3 until ready for collecting (Gelman et al., 2005).

The second very important operation is starvation for as long as is necessary to ensure that gut contents are evacuated. During feeding periods, the digestive tract of the fish contains many bacteria that produce digestive enzymes capable of causing intense postmortem autolysis, resulting in strong odors and flavors, especially in the abdominal area. By reducing the amount of feces in the intestines, spoilage is delayed, and digestive enzyme activity is reduced. If further

processing steps are considered, for example, filleting and freezing, feeding interruption may be a determinant of the product shelf life (Huidobro and Tejada 2004).

Starvation is also very important to prevent feces trailing from the anus, which is off-putting for consumers. In general, the starvation period is 1 to 3 days depending on temperature. Ferreira et al., 2007) observed that 1 d was considered to be the minimum feeding interruption period in sea bream, with 8 d being the maximum. Reasons for extending this period in some cases beyond 48 h included variations in the market price for the fish and the time needed to empty the fishpond. One problem is that around 1% of weight can be lost due to starvation at higher temperature than 20 °C. Mechanical properties of sea bream muscle change as the starvation time progresses, so the flesh is firmer when they are starved for up to 8 d compared to the standard 1 to 3 d, due to changes in protein solubility and pH (Gines et al., 2002).

Post harvest related factors

Stress in wild and farmed fish, which are very active before slaughter, can affect the quality of the fish in a physical and a biochemical way. From a biochemical point of view, if the fish is killed after muscle activity, its cells will contain more lactic acid from anaerobic respiration, so that ATP synthesis is stopped and rigor mortis sets in sooner. Spiking to instantaneously destroy the brain by puncturing, and so prevent muscle activity, delays the onset of rigor mortis as compared to a slower death such as immersion in chilled water. This happens because it retards the drop in ATP, which is the agent that prevents interlocking of thin and thick filaments. However, there is no difference in the final post slaughter pH of stressed and unstressed fish of the same species, despite differences immediately postmortem (Robb, 2001).

The degree of muscle activity prior to slaughter also affects how firm the flesh becomes during rigor mortis. Lactic acid concentration is lowest when horse mackerel (Trachurus japonicus) are killed by spinal cord destruction as opposed to other slaughtering methods, such as struggling and temperature shock; this slow rigor mortis onset results in slower muscle degradation in the

course of iced storage, as measured by the ratio between nucleotides and nucleosides, degradation products from ATP, which is called the K-value (Mishima et al., 2005).

Storage temperature masks most of the effects produced by pre slaughter stress; however, it is important to follow the stress management protocols when fillets are kept at the common storage temperatures under 4 °C. The temperature of the fish just after death will affect the course of various biochemical reactions during storage. This is caused by the reduction in ATPase activity as the temperature decreases, and by a reduction in the uptake of Ca^{++} (Robb, 2001).

In highly stressed fish, all muscles enter rigor very quickly and at the same time. As a result, the whole fish is very stiff and difficult to process. In fish with a low level of activity, only some muscles have been used and these are the ones that first enter rigor mortis, while the others do so later. Because of this difference in timing, not all the muscles are in rigor at the same time, so that the fish as a whole is less stiff.

Pre mortem handling stress significantly affects several color parameters of salmonids flesh this loss of color is caused by insolubilization of muscle proteins as a result of low pH and subsequent drip loss occurred in the prerigor and development of rigor mortis (Erikson and Misimi, 2008).

Slaughtering by electrical stunning can produce enough active movements to break vertebrae, rupture blood vessels, which can result in blood spots. Electricity as better method for salmon stunning than carbon dioxide as this causes an earlier onset and resolution of rigor mortis. Bleeding is frequently used in farmed fish. Large farmed fish needed to have the blood removed from the muscle and recommended cutting the gills with a sharp knife; this allows the fish to swim and so die from anoxia caused by blood loss (Van de Vis et al., 2003) Industrial gutting and beheading are mechanized in developed countries today, but on board this operation is traditionally done by hand with a knife, and only in large ships are machines used. The main reason for gutting is to prevent autolytic spoilage rather than bacterial spoilage. Gutting is usually done by cutting, but there are machines that perform gutting by sucking the viscera out and cleaning the belly part through the mouth. This method obviates the need to open the belly, but it makes it difficult to be sure how well the fish is cleaned. When gutting is performed, fish

should be thoroughly washed to remove traces of blood and debris and to wash bacteria and intestinal content out of the gut cavity, skin, and gills of the fish. The practice of washing after gutting is more effective in removing remnants that in eliminating bacterial contamination.

The Effect of Preservation on Fish and Fish Products Ancient methods of preserving fish included drying, salting, pickling and smoking. All of these techniques are still used today but the more modern techniques of freezing and canning have taken on a large importance. Preservation techniques are needed to prevent fish spoilage and lengthen shelf life. They are designed to inhibit the activity of spoilage bacteria and the metabolic changes that result in the loss of fish quality (Köse et al., 2009).

Spoilage bacteria are the specific bacteria that produce the unpleasant odours and flavours associated with spoiled fish. Fish normally host many bacteria that are not spoilage bacteria, and most of the bacteria present on spoiled fish played no role in the spoilage. To flourish, bacteria need the right temperature, sufficient water and oxygen, and surroundings that are not too acidic. Preservation techniques work by interrupting one or more of these needs (Özdan and Varlık, 2004). The effect of preservation can be summarized as (1) Surface drying providing physical barrier to bacterial pathogens and preventing aerobic microbial proliferation, (2) Salting decreases water activity and has inhibition effect on pathogenic bacteria (although a certain salt content is required), (3) Deposition of phenolic antioxidant substances delaying autoxidation (and rancidity), (4) Deposition of antimicrobial substances such as phenols, formaldehyde and nitrites. Heat can also be added as a preservative factor, especially for hot smoked fish products in killing some pathogens, histamine forming bacteria (HFB) and parasites. Additionally, packaging methods and storage conditions such as freezing can also help as preventing food safety hazards in smoked products. However, vacuum packing can also create bacterial health hazard if not applied appropriately (Zaitsev et al., 2004).

Conclusion and Recommendations

Seafood derived from wild fish as well as farmed fish has always been an important source of protein in the human diet. On a global scale, fish and fish products are the most important source of protein and it is estimated that more than 30% of fish for human consumption comes from

aquaculture. The first part of this paper outlines the hazards and challenges associated with handling fish during farming and capture. The authors describe infectious agents that cause disease in fish as well as humans, zoonotic agents, intoxications due to bacteria and allergies caused by the consumption of fish. Although only a few infectious agents in fish are able to infect humans, some exceptions exist that may result in fatalities. However, the greatest risk to human health is due to the consumption of raw or insufficiently processed fish and fish products.

Therefore, based on the above remarks, the following recommendations are for warded:

- In wild fish, it is important to use methods of capture that do not exhaust the fish as is the case of harvesting by hook and line.
- In farmed fish, quick slaughtering after non stressful handling make for a more humane death and the product will have better quality and a longer storage life. Also, starvation is an important step in farmed fish.
- An optimal slaughtering method from the standpoint of quality and welfare should render fish unconscious as soon as possible.
- Electrical stunning is an option, but blood spots sometimes appear on the muscle, so the electrical parameters need to be optimized.

Every processor shall conduct a hazard analysis to determine whether there are food safety hazards that are reasonably likely to occur for each kind of fish and fishery product processed by that processor and to identify the preventive measures that the processor can apply to control those hazards.

QUALITY ASSESSMENT AND SAFETY OF DIFFERENT POULTRY PRODUCTS

Poultry meat is the fastest growing component of global meat demand, and India, the world's second largest developing country, is experiencing rapid growth in its poultry sector. In India, poultry sector growth is being driven by rising incomes and a rapidly expanding middle class, together with the emergence of vertically integrated poultry producers that have reduced consumer prices by lowering production and marketing costs. Integrated production, market transition from live birds to chilled and frozen products, and policies that ensure supplies of

competitively priced corn and soybeans are keys to future poultry industry growth in India. There are number of small poultry dressing plants in the country. These plants are producing dressed chickens. In addition to these plants, there are five modern integrated poultry processing plants producing dressed chicken, chicken cut parts and other chicken products. These plants will manufacture egg powder and frozen egg-yolk for export.

BRIEF ON PROCESS DETAILS

Procurement & Quality inspection of raw material (Live Poultry Birds)

Poultry intended for slaughter shall be in good health. Precaution shall be taken to minimize injury to poultry birds. Flock health examination shall be done by qualified veterinary practitioner. Only healthy poultry / birds shall be transported in a well-ventilated transport system. Coops preferably made of plastic and specially designed to be used for transport of poultry shall be in good conditions to avoid injuries to poultry. Transport coops should not be over-crowded & it should provide enough space for birds. It is advisable not to use any damaged coops, crates or cages to avoid injury to birds during transportation.

Holding / Resting area

The holding/ resting area shall be adequate in size to rest the birds. The bird vehicle holding

/ resting area shall have suitable facilities to prevent excessive heat and must have overhead protective shelter. The holding area must have humidification and adequate air ventilation facility to provide comfort during summer season.

Ante-mortem Examination of Birds

Poultry birds shall subject to ante mortem examination by veterinarian before slaughter. Ante mortem examination shall be done on a lot basis while poultry birds are in the coops before or after their removal from the vehicle. A lot is made up of birds from a single house of poultry grown on a particular farm, but it may be as large as several houses of poultry.

Unloading & Hanging of Birds in overhead conveyor

Unloading of the birds from vehicle shall be done with due care. Throwing of coops must be avoided.

Birds shall be held with care and hanged by legs on the shackle of the processing line in a dimly lit room with blue light (avoid bright lighting). During the hanging process care shall be taken to avoid fluttering of poultry birds.

Stunning

Prior to slaughter poultry shall be made unconscious by using any suitable method of stunning (water bath electrical stunning, gas stunning etc.). It induces temporary loss of consciousness and minimizes the reaction of fear, anxiety, pain and distress to the birds.

Stunning equipment shall be properly maintained to confirm that poultry are unconscious prior to slaughter. Stunning efficiency is to be ensured in such a way that the recovery time of bird is maintained within120 seconds.

Slaughtering & Bleeding

Sufficient time shall be allowed to bleed out the poultry bird effectively. Minimum 150 seconds.

Slaughtering can be done by different methods of slaughter (like Halal, Jhatka, Mechanical etc.).After slaughtering, shall be allowed to bleed out the slaughtered birds before entering the scalder. No live bird shall enter scalder.

Blood collected in bleeding tank to be removed on regular intervals to avoid contamination. A qualified and trained veterinarian shall be appointed and be responsible for approving healthy birds for slaughter and to check that the birds are properly slaughtered.

Scalding & Defeathering

Scalding means passing the bird through hot water so as to loosen the feather follicle so that de-feathering of bird will be done effectively. Scalding shall be carried out at appropriate temperature depending upon size of the bird to loosen feather follicles. Scalding process efficiency is determined by the time and temperature combination and it will be vary as per machine manufacturer and speed of line. De-feathering means removal of loosed feather immediately after scalding. De-feathering is done through a mechanical de-feathering machine with rubber fingers. It can be done in multiple stages to have better quality. Care shall be taken to maintain the rubber fingers softness to get better de-feathering quality and avoid rupturing of skin.Feathers collected during de-feathering operations must be removed regularly or continuously.

Dressing of carcass

Dressing of carcass should only commence after ascertaining that the bird is dead.

Evisceration

Evisceration consists of removal of all internal organs from the slaughter birds. After evisceration carcass along with the viscera and edible offal's shall be subjected to post-examination by the veterinary doctor. The Evisceration process is to be carried out in such a way that the internal organs are ruptured minimally to avoid contamination.

Non-edible offal shall be removed regularly from the evisceration section to avoid contamination.

General requirements of Slaughter area:

1. The slaughtering area, equipment and implement must be clean, hygienic and sanitized.
2. All tools or equipment's used in slaughtering shall be made of stainless steel and

maintained clean and sharp.

3. A qualified and trained veterinarian shall be appointed and be responsible for approving healthy birds for slaughter and to check that the birds are properly slaughtered.
4. Non-edible offal shall be removed regularly from the evisceration section to avoid contamination.
5. Post mortem reports shall be prepared.

Post Mortem Examination

Post mortem examination means systematic examination of dressed poultry carcass and visceral organs by the veterinarian for evidence of any abnormal condition. Post mortem reports shall be prepared. The records shall be maintained as per the lot.

Deboning

Process of removal of bones and cartilages from whole chicken to get boneless meat.It can be done manually or semi-automatic or in automatic line. The temperature in rooms for deboning out and trimming should be controlled at appropriate temperature such a way that the hygiene standard is maintained. Care shall be taken to maintain the product temperature at or below 7 Degree Celsius. The carcass or shell shall be collected, packed and removed from the section at regular interval.

Raw marinated products:

Poultry meat with or without bones marinated with ingredients and with or without additives are categorised under"raw marinated products." It includes both whole pieces / cuts and comminuted products. Examples include Marinated Chicken Pieces, Marinated Chicken Tikka, Marinated Chicken Lollipop etc.

Formed/Coated Products:

These products are prepared by mixing of poultry meat with or without bones with ingredient(s) and/or permitted additive(s). They may or may not be subjected to different processes like marination, forming, pre-dusting, battering, breading, coating fixation / forming and fried in fryer etc. Marination can be achieved by simple mixing or tumbling or by injecting marination. Products may be raw, semi cooked, partially cooked or cooked. It includes whole pieces, cuts and comminuted products. Examples of such products include, coated / uncoated products, Chicken Nuggets, Chicken Patty, Coated bone-in products etc.

Canned Products

These products are "canned / retort pouch poultry products" which are heat treated processed poultry products in whole pieces or cuts or in comminuted form. These products are prepared by mixing of poultry meat with other ingredient(s) and permitted additive(s). The product may be smoked. The packing medium and other ingredients shall be of food grade quality.

These products shall be packed in hermetically sealed container and subjected to adequate heat treatment followed by rapid cooling to ensure that the product is self-stable and safe for consumption.

Primary Packing

Processed material is weighed and packed in standard packing material which should confirm FSSRs. (Packaging & Labelling).The food grade declaration/ certificate to be verified on COA during receiving of the packing material .Packing of chicken meat & chicken meat products can be done as per the customer requirement and applicable regulation specified in FSSRs. (Packaging & Labelling) & Legal metrology (Packaged Commodities).

Freezing

Freezing can be done either using blast freezer, Plate freezer or IQF. During Freezing core temperature of the product should be at or below – 18°C.

Metal Detection

All finished product shall be passed through metal detector.

Metal detector shall be calibrated/ verification at frequency appropriate to assure food safety.

Secondary Packing

Frozen meat / meat products after passing through metal detector shall be packed in suitable container. Secondary Packing material shall be secure to prevent spoilage and contamination during transit and storage.

Chilled Storage

Chilled Poultry meat and Poultry meat product shall be stored in the chiller at or below 4^0C.

Cold Storage

Frozen poultry meat and poultry meat product shall be stored in cold store at or below minus 18 degrees Celsius till dispatch.

Cold store temperature shall be maintained at or below minus 18 degrees Celsius except during defrosting cycle. FIFO / FMFO/FEFO method shall be followed in the cold storage for despatch of product.

Quality Evaluation

Finished products are tested in internal / external laboratory as per the sampling plan identified by the processing plant, for microbiological & applicable physio -chemical parameters as defined by FSSAI.

LOADING, DISPATCH, WAREHOUSING, TRANSPORTATION, RETAIL PRECAUTIONS RELATED TO FOOD SAFETY & QUALITY

The product temperature shall be maintained at or below minus 18 degree Celsius for frozen & at or below 4 degree Celsius for chilled products in any part of the cold chain, during storage, transport, distribution, and merchandising in retail stores.

Loading and dispatch of finished products

Dispatch vehicle shall be checked for presence of any contaminants, cleanliness, unacceptable odour and proper working of refrigeration system before loading. Loading should be done in shortest possible time. Dispatch vehicles shall be cleaned and sanitized using appropriate cleaning and sanitizing agents regularly to maintain the hygiene standard.

Warehousing

Stacking methods and height depend on several factors: resistance of the package, handling techniques and thermal state. Packaged and frozen meat is usually handled mechanically, combining forklift trucks with pallet.

Storage temperature of warehousing should be at or below minus 18 Degrees Celsius except during defrosting cycle in case of frozen product and at or below 4 degree Celsius in case of chilled product.

Transportation

All the transportation systems are expected to maintain the temperature of the processed meat and meat products within close limits to ensure its optimum safety and recommended shelf life. It is important that the processed meat and meat products is at the correct temperature before loading since the refrigeration systems used in most transport containers are not designed to extract heat from the product but to maintain the temperature of the product. In large containers used for long distance transportation, food temperature can be kept within recommended frozen temperature (at or below minus 18 degrees Celsius for frozen and at or below 4 degree Celsius for chilled products). Ensure proper air circulation is available to maintain product temperature during transportation.

Different modes of transportation:

a) **Air- freight:** This is used for highly perishable frozen food products. Although this provides a rapid method of serving distant markets, the main challenge faced is the product is mainly unprotected by refrigeration for much of its journey; due to the intermittent holding time. Standard containers with insulated linings and /or dry ice shall be used.
b) **Road/ Rail:** Refrigerated containers (for long distance) and Small Insulated / Refrigerated / Eutectic vans (for short distance) are used to supply food to local retail outlets or directly to the consumers. All vehicles shall have the temperature monitoring device.

Retail and display

During display; the temperature, temperature fluctuations and visual monitoring (like color of product, packaging intact, etc.) are the main parameters that determine the quality. Ensure that

products are stored in clean display cases which are covered at all times. See- through insulated lids are for consumer to look at the product at retail shops. Ensure products are stored at appropriate temperatures. Temperature differential or range should be kept at minimum. Adopt first-in-first-out (FIFO) method in the display of products for sale. Proper declaration on the products is needed & it should comply with requirements of FSSRs. (Packaging & Labelling).All containers should be cleaned and disinfected daily.

1. *Equipment & Containers*

- **Equipment and utensils** in contact with exposed meat and meat products should
  - have smooth impervious surface &non-absorbent
  - have resistant to corrosion,
  - made of material which is non-toxic,
  - Shall not transmit odour or taste,
  - free from pits and crevices,
  - capable of withstanding repeated exposure to normal cleaning and disinfection,
  - be easily cleaned and disinfected
- **Sanitary equipment:** Placing and location of all sanitary equipment should permit easy access and thorough cleaning

- **Containers for inedible material and waste** should be leak proof or disposable and where appropriate, able to be closed securely.
- **Refrigerated Spaces** should be equipped with temperature measurement and / or recording devices that are calibrated at regular interval.
- **Equipment Identification** - Equipment and utensils used for inedible material or waste should be so identified and should not be used for edible products. Also, containers holding hazardous substances shall be closed when not in use, stored separately and lockable to prevent malicious or accidental contamination of food.
- **Electrical Fittings -** shall be of such material and of such construction as to enable them to be kept clean. The implements shall be of metal or other cleanable and durable material resistant to corrosion.

- Knives, other tools and equipment's shall be clean and sanitized prior to use. Suitable and sufficient facilities shall be provided within the establishment / slaughter house for cleaning and sanitization of knives, other tools and equipment. The knives and scissors used should be of stainless steel.
- **Equipment, Utensils and Machinery** that come in direct contact with food shall be hygienically designed, constructed, located and, if necessary, installed to ensure that they can be adequately cleaned, sanitized and maintained to avoid contamination.

2. *Facilities & Utilities*

The facilities& Utilities are essential services that play a vital role to industry. Quality facilities and utilities provided like water, light, hygienic facilities etc. are the pre-requisite for an effective food safety.

Water Supply

- A constant and sufficient supply of clean potable water (cold and hot) should be made available in the slaughter and processing halls during working hours.
- Adequate supply and/or storage facilities shall be provided. Storage for distribution should be protected against contamination. Those shall be adequately designed, made of material, that is non-toxic and corrosion resistant and periodically cleaned and maintained. The records of the same shall be maintained.
- Potable water quality shall be as specified in the latest edition of BIS standard on drinking water (IS10500). Potable water shall be analysed at least semi-annually to confirm that it meets the requirements of this standard.
- Non potable water can be used for cleaning of those equipment's which does not come in contact with food, or food steam production. It can be used for firefighting, refrigeration equipment, washroomsetc.
- Non potable water pipes shall be clearly distinguished from those in use for potable water. Colour coding is recommended.

Ice and Steam

Ice should be made from potable water and should be manufactured, handled and stored so as to protect it from contamination.

- Steam used in contact directly with meat should be produced from potable water and contain no substances which may be hazardous to health or may contaminate the processed meat and meat product.

Drainage and Waste Disposal

Drainage system

- There shall be adequate and efficient drainage and plumbing systems.
- All drains and gutters shall be properly and permanently installed with traps and screens.
- The drainage system for blood shall either be underground for easy cleaning or a portable receptacle with Lid.

Waste disposal system

- An efficient effluent and waste disposal system shall be present.
- There should be efficient drainage and disposal of non-edible offal.
- Waste storage area should be constructed in such a manner as to avoid contamination of food, potable water supplies, equipment and building.
- All effluent lines (including sewer systems) should be large enough to carry peak loads.

Adequate facilities for the storage shall be provided. Storage space should be physically separated or segregated for –

- Raw material (like seasonings, spices, additives, ingredients etc)
- Packaging material
- Returned/rejected material
- Recalled material
- Allergens

- Semi processed material
- Final product
- Hazardous chemical (used in engineering)
- Cleaning & disinfection chemical
- Engineering tools
- Waste material (both bio degradable & non-biodegradable)

Storage areas shall be maintained at temperatures, wherever required:

- Freezer maintained at -18°C
- Refrigerators maintained at 4°C
- Room Temperature at 37°C
- Hot holding unit maintained at or above 60°C

Air Quality and Ventilation

- Ventilation should be provided to prevent excessive heat, steam condensation, dust and to remove contaminated air.
- The direction of the air flow always from clean area to unclean or dirty area.
- Ventilation openings should be provided with an insect screen or other protective enclosure of non-corrosive material & Screens should be easily removable for cleaning.

Lighting

- Adequate natural or artificial lighting should be provided throughout the slaughter house/ meat processing unit.
- All lightings should be well distributed.
- Where appropriate, the lighting should not alter colours.

Processing Areas	**Recommended Light Intensity(Lux)**
All Inspection areas	540 Lux
Work rooms	220 Lux
Other areas	110 Lux

1. *Allergen Management*

1. Cereals containing gluten; i.e., wheat, rye, barley, oats, spelt or their hybridized strains and products of these;
2. Crustacean and products of these;
3. Eggs and egg products;
4. Fish and fish products;
5. Soybeans and products of these;
6. Milk and milk products (lactose included);
7. Peanut, tree nuts and nut products; and

Sulphite in concentrations of 10 mg/kg or more.

5. *Packaging*

- The packaging design and materials shall provide protection for products in order to prevent contamination, damage and accommodate required labelling as laid down under the FSS Act & the Regulations there under. Only Food grade packaging materials as specified FSSR regulation shall be used.
- The food packaging materials shall be inspected before use to prevent using damaged, defective or contaminated packaging, which may lead to contamination of the product.
- The poultry slaughterhouses and processing units shall have effective procedures in place to confirm that contaminated, damaged or defective

reusable containers are properly cleaned and sanitized, repaired or replaced, as appropriate, before re-use.

- The packaging materials or gases where used, shall be non-toxic and shall not pose threat to the safety and suitability of processed product under the specified conditions of storage and use.Wrapping and packaging operations shall be carried out so as to avoid contamination of the products.

5. *Transportation of Meat and Meat Products*

- While loading in the refrigerated containers, the temperature in the container has to be brought to -12^{o}C (Precooling) so that there is no thawing of the frozen meat cartons while they are loaded. However, in case of chilled products, precooling temperature shall be at or below 4^{O}C
- The containers have to be clean and disinfected before loading.
- After loading it is sealed and taken to destination either by rail/road. The temperature should be maintained and monitored at or below -18^{O}C for frozen and at or below 4^{O}C for chilled/fresh products at all times.
- Conveyances and/or containers used for transporting shall be kept clean and maintained in good repair condition to protect meat from contamination and shall be designed and constructed to permit adequate cleaning and/or disinfection.
- Meat and meat products in conveyances and/or containers are to be so placed and protected as to minimize the risk of contamination.
- Unpacked Fresh / Chilled / Frozen meat shall not be transported with other food products to avoid cross contamination.
- Where conveyances and/or containers are used for transporting anything in addition to foodstuffs or for transporting different foods at the same time, there shall be, where necessary, effective separation of products to prevent cross-contamination.

- Where conveyances and/or containers are used for transportation anything other than foodstuffs or for transporting different foods, there shall be effective cleaning between loads to avoid risk of contamination.

5. *Quality Control*

- The Poultry slaughterhouses and processing units shall have a quality control programme in place to include inspection and testing of incoming, in-process and finished products.
- Adequate infrastructure including an in-house laboratory facility and / or engaging with an external laboratory facility, with qualified, trained and competent testing personnel shall be available for carrying out testing. Calibration of laboratory equipment's shall be done annually.
- Microbiological examination needs to be carried out periodically for air, water, personal hygiene (hand swabs) and food contact surfaces (knives, packaging tables, equipment etc) to ensure food safety in finished products.
- Ensure testing of relevant chemical and/or microbiological contaminants in food products in accordance with these regulations as frequently as required on the basis of historical data and risk assessment to ensure production and delivery of safe food through own or NABL accredited /FSSAI notified labs at least once in six months. It is recommended to retain the control samples, till the end of shelf life.
- Records of testing shall be maintained.

Questions:- 1)Expain the Transportation Measures for Meat and Meat Products.

3) Explain Allergen Management

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Chapter 5

SENSORY EVALUATION AND SENSORY ANALYSIS

1.1Introduction

The sensory quality of food products has been considered an important factor since the beginning of the food industrialization process due to its influence on the overall quality of the product. Sensory analysis is used to characterize and measure sensory attributes of products. Sensory Analysis is the description and scientific measurement of the attributes of a product perceived by the senses: sight, sound, smell, taste and touch. By understanding sensory data, one can offer food-product development guidelines as to which property should be emphasized when making product-development decisions. This decision process includes processing ingredient and economic considerations. Sensory analysis is a natural science. The measurements of sensory characteristics of foods should be taken carefully. When done properly, sensory information can provide great insight into the world. When measures are undertaken poorly they do more to mislead than to inform. Careful controls must be implemented and followed when conducting sensory analysis, including

(1) neutrality in the presentation of samples,

(2) elimination of response bias, and

(3) use of methods that require panelists to demonstrate their ability rather than relying upon self-reports.

Failure to adhere to any of these controls diminishes the value of the resulting sensory data. By contrast, determining appropriate controls and ensuring they are in place will result in reliable and useful information about foods which no instrument can measure i.e. their eating quality.

Definition

Sensory Evaluation has been defined as "A scientific discipline used to evoke, measure, analyze and interpret reactions to those properties of foods and materials as they are perceived by senses of sight, smell, taste, touch, and hearing." Four variables affect sensory evaluation: the food, the people and the testing environment and test methods used.

Importance

The role of sensory evaluation is to provide valid and reliable information to the research department, production and marketing in order for management to make sound business decisions about the perceived sensory properties of the product. Cost saving may be realized by correlating sensory properties with instrumental, physical or chemical analysis. Moreover, following points are equally important in sensory evaluation:

1 Man has well-developed like and dislikes for dairy products depending on their palatability.

2 Sensory evaluation will become paramount importance with increasing consumer awareness towards nutrition and quality.

3Sensory-evaluation assists in measuring the eating qualities of any food.

4 Optimal information can be obtained only through co-ordination of instrumental and sensory measurements.

5Where no signal appears our senses may still perceive an odour or taste.

6 Senses give us a total impression of quality.

Sensory evaluation provides unique information that has significant importance/value in the market place. Successfulness of sensory programme will depend on the involvement of individuals, the sensory professionals and their ability to make meaningful contribution to the decision making process.decision making process.

1.5.Applications

Sensory analysis gives answers to the following three questions

- What does the product taste like?
- What are its sensory characteristics?
- How does a change in production, packaging or storage affect sensory characteristics

Sensory evaluation can be applied in the following areas in dairy industry

- Companies can compare a competitor's product.
- Improve products by modifying or changing the ingredients.
- Check that the specification is being met.
- Monitor quality control by checking regular samples against specification.
- Detect differences between products from different runs or batches.
- Profile the characteristics of new products.
- Describe specific characteristics of the product.
- Demonstrate new products to marketing team.
- Promote new or reformulated products to consumers.

Advantages

- Helps manufacturers, scientists, food technologists etc. to gain a clear perception of what ordinary consumers may experience.

- Measures the overall impression of the product i.e. eating quality when consumed.
- Sensory panel testing can be much more rapid than most non-sensory methods.
- Uses more than one sense, making them more flexible instruments.
- Can be very sensitive and good at detecting minute differences in product characteristics.

Disadvantages

- Sensory panelists can become fatigued with the entire process of testing and assessing descriptive data.
- Assessors may be subject to biases e.g. from loss of interest or from distractions.
- To ensure precision in the analysis and interpretation of the descriptive data and for statistical analysis, several assessors may be required, making it an expensive proposition.
- The entire process of recruiting and training sensory panelists can be a time-consuming and costly process.
- It may not be easy to replace assessors quickly, as the incoming assessor will have to be given intensive training to develop requisite expertise of the job.
- The sensory panel method can be more expensive than some non-sensory methods.
- The panelists may not be good at quantifying perceptions.
- Interpretation of results may get problematic and be open to dispute.

Table 1.1 Intrinsic and extrinsic sensory attributes of food products

Intrinsic	Extrinsic

Appearance	Price
Color	Brand name and familiarity
Shape	Label (packaging design)
Size	Advertisement
Structure	Nutritional information
Aroma	Production information (environment, organic)
Taste	Origin (country)

SENSORY EVALUATION OF DAIRY PRODUCTS

Dairy product sensory evaluation includes the critical examination and interpretation of important sensory attributes of the given product.

Three different methods are available for tracing causes of sensory defects in dairy foods:

(1) chemical procedures;

(2) microbiological tests; and

(3) sensory evaluation. The simplest, most rapid and direct approach is sensory evaluation.

Correct diagnosis of the type and cause(s) of sensory defects is a prerequisite to application of remedial measures in production, processing and distribution stages.

Judging and grading dairy products normally involve assigning quality scores to products by one or two trained “experts”. Attributes scored include appearance, flavor, and texture, based on the presence or absence of predetermined defects.

Bureau of Indian Standards has specified guidelines for judging & grading of some dairy products. The sensory evaluation of dairy products has become an important research component in the development of new products and process.

The sensory attributes of food products can be either intrinsic or extrinsic. Intrinsic attributes are concrete product characteristics that can be perceived by a consumer and, in many situations, can

serve as a quality cue that can be observed, without actual consumption or use. It is related to the appearance, color, shape, size, and structure, all of them extremely important for milk products. Intrinsic attributes are always related to the physical aspects of the product. Extrinsic quality cues refer to product characteristics that are used to evaluate a product but are not physically part of it, such as price, brand, production and nutritional information packaging design, country of origin, store, and convenience.

ROLE OF PRIMARY SENSES IN JUDGING DAIRY PRODUCTS

The sensory properties of dairy products are mainly related to flavour, body and texture, colour and appearance. These properties of foods are perceived through human senses. The main senses involved in sensory perception are sight (eyes), smell (nose), taste (tongue), touch (skin) and sound (ear). Humans possess and utilize five primary senses for perceiving stimuli: sight, hearing, touch, taste and smell. Of these human senses, taste, smell and chemical/pain sense respond to chemical stimuli, with taste and smell considered to be the most primitive. Other human senses include temperature sensation (heat and cold), pain, visceral hunger, thirst, fatigue and balance.

Sight: The characteristics of a diary product that can be evaluated by sense of sight are: Neatness & cleanliness of package & finish, protection afforded by seal of pouch or bottle

closures. It has relatively low numerical rating on the scorecard. Sight as a sensory parameter is used to correlate defects in visible items with flavour.

Smell (Aroma): This sense plays paramount role in evaluation of quality of dairy products. The role of olfactory perception is greater in overall flavour than the taste. Milk and dairy products are smelled for aroma perception immediately after the opening of closure/ package and earlier than the taste.

Taste: It is a companion sense with aroma in establishing the overall flavour of dairy products. There are four fundamentals taste (Sweet, Sour, Salty and Bitter) which are of paramount importance in sensory evaluation of any food product. With very few exceptions, the food

product must be tasted. The role of taste is more complex, as tasting also involves tactual & olfactory sensations.

Touch: Tactual and mouth feel play an important role in examining the body and texture characteristics. Pressure between teeth determines the presence of undissolved salt in butter or of crystallized lactose in sweetened condensed milk. Fingertip and thumb may be used to substantiate findings of organs of mouth. Fingers play important role in examining body and1exture of butter and cheese. Ease and difficulty in chewing/rolling/dissolving the food is recorded by tongue and/or floor and roof of palate.

Sound: It is used sometimes in the judging of the dairy products. The evaluator can detect the presence of ice crystals while drawing a ice cream sample with spoon. The relative size and distribution of holes in Swiss cheese can be felt by the gentle tapping of the outside of the cheese.

Classification of Tastes

Sweet taste

Substances, which elicit the sweet sensation, are primarily organic compounds. Alcohol (glycerol), salts (lead acetate), sugars, complex aromatics (saccharine), organometallic compounds (cyclamates) aldehyde (cinnamic aldehyde) etc. taste sweet. Not all sugars are equally sweet; Fructose gives the most intensely sweet taste, followed by sucrose, galactose and lactose.

Sweetness appears to be associated with hydroxyl (-OH) radicals on the sugar molecules. Lower sweet taste of some sugars attributed to the crumpling of the molecule, putting -OH groups so close that they get attracted to each other by H bonds, therefore not free to elicit sweet tastes.

Sweetening agents used in food are toxic on long use and can be considered health hazardous.

Saccharine -300 times, sucramine -700 times, cyclamates -30 times sweeter than sugar.

Sweetness is particularly important in soft drinks, fruits and fruit juices, in honey and in many baked foods.

Sour taste

Sourness or the tart taste of acids, is .also important in fruits and fruit juices, and in fermented products. Lack of a certain amount of acidity results in flat & unpalatable taste in many foods. It is doubtful, if the acid taste has much protective value for man in food selection; even the most acid foods are not strong enough in acidity to be injurious to health.

The sour taste is associated with hydrogen ions supplied by acids like vinegar, those found in fruits, in acid salts. The intensity of sensation depends more on H ion concentration than the total acidity, but sourness and H-ion concentration do not run exactly parallel.

At equimolar concentration acetic acid tastes more acid than hydrochloric, although pH of the latter is lower, may be due to interactions of saliva and the acid compound.

Organic acids compared with inorganic acids at same pH will have a greater taste effect. Also, weak acids, which taste more acid than they should based on H ion concentration, may influence taste mechanisms other than the simple sour taste. Buffering action (of saliva) appears to play a role in determining the sourness of various acids.

Salty taste

Saltiness is much appreciated taste. It is due to ions of salts. Table salt is the most common salty taste in foods. Sodium chloride is said to be the only salty with pure salt sensation, even so, in dilute concentration it is frequently identified as sweet.

The taste of salt is dependent on the nature of both cation (Na+) and anion (CI-). As the molecular weight of either cation/anion/both increases the salts are likely to taste bitter. KCI and CaCl2 have a salty taste, but different from NaCI. Similar is the case is with Sodium Fluoride and Iodide.

The 'differences' may depend partially on other sensations -bitterness, feel, sweetness etc. The lead and beryllium salts of acetic acid have a sweet taste but are extremely toxic.

Bitter taste

The bitter taste is appreciated in beer, wines, and in some foods. It has little protective ! value to man in his selection of food, which is safe to eat. Bitter taste is widely distributed & can be attributed by variety of inorganic & organic compounds.

Alkaloids (basic N containing organic compounds) -caffeine, theobromine, nicotine, and quinine are bitter. Glycosides of Phenolic compounds 'Naringin' -in grape fruit, Inorganic Salts -CsCI, CsBr, KI, and MgSO4 -bitter in taste Amino acids -phenylalanine, leucine, valine, and histidine -bitter. Bitter peptides -partial enzyme hydrolysis of proteins -are formed during cheese ripening.

Although, bitter taste by itself is usually considered as unpleasant, it is a common component of taste of many foods usually in combination with sweet and sour. Quinine is often used as a standard for bitter taste.

Other aspects of taste

In addition to the individual tastes, there is important interrelationship between them.

- The sugar to acid ratio -important role in fruits.
- Alkaline taste -attributed to OH ions, an irritating effect on general nerves endings in the mouth.
- Astringency -not taste but aspect of flavor, Borax is known for its astringency.
- Coolness -Characteristic of menthol, a part of mint flavor complex.
- Hotness -associated with spices, also known as pungency, non-volatile amides are responsible for heat effects.
- Metallic taste -no receptor sites, but is real. It appears to be modality of common chemical sense like irritation & pain. It is generated by salts of metals like Hg, Ag, Fe, Cu, and tin. The lead salt of saccharin-intense sweet -gives metallic after taste. It is

frequently associated with oxidized products. 'Oct-1-en-3-one' -responsible for metallic flavor in dairy products.

- A drug 'gymneric acid' -renders taste bud insensitive to sweet & bitter, but no to salt and sour.
- A berry grown in Africa, known as 'miracle fruit' when eaten sour food (lemon) - tastes sweet. The active substance coats the taste buds.
- Salts reduces sourness of acids, certain acids increases saltiness.
- Salt on one side of tongue, cause distilled water on other side to taste sweet or insipid i (tasteless). .
- Salt on one side, sub threshold concentration of sucrose to the other -easily recognized as sweet/very sweet. A sugar solution on one side -enhances saltiness. A salt also sensitizes to salt.

Taste Threshold

Thousands of threshold are reported in the literature. The data are not always comparable, because of differences in technique, impurities/type of Chemical used, inadequate number of tests, insufficient statistical analysis of their validity, plus undetermined factors such as order presentation, temp., time, experience, physical condition, age, sex and area stimulated.

Taste -Interaction

Since foods contain mixture of substances, which elicit all four-taste sensations, the subject of taste interaction is of great interest to food technologist. In most of the cases, there is probably desensitizing effects i.e. an increase in threshold.

Salt reduces sourness of acids, sprinkling of salt on fruits increases the apparent sweetness of sucrose. A pinch of sugar may improve over salted soup. Sugar reduces bitterness of caffeine,

sourness of acid. At higher concentration, the effect of second taste is generally to reduce the sensitivity of frost. Not all the people react the same.

Taste -blindness

Individuals may exhibit varied responses to taste stimuli of certain chemicals e.g. 1/4th of population is said to be 'taste-blind' to PTC (Phenyl-theo-carbamide), which contain -N- C" group. Being blind to a certain taste should not cause undue concern for the novice evaluator, since other factors play important role in judging dairy products. Most expert judges possess no special taste acuity.

Factors Affecting Taste Threshold / Sensations

(1) Diseases: Disease and Accident may result into loss of, decreased or altered, temporary/permanent, and taste sensations. Irritating tongue of patient with X-rays or cobalt source reduced taste sensitivity of all tastes except sour. In case diabetes, sweet taste -in the absence of stimuli, bitter in the case of jaundice. Patients with adrenal insufficiency -increase sensitivity to all tastes.

(2) Effect of sleep and hunger: Lack of sleep, up to 72 hours, did not affect the thresholds to salt & sweet, but raised the sour threshold significantly. Sensitivity to 4 basic tastes -maximum at II :30 a.m., significant decrease for about 1 hr. after meal, followed by an increase in 3-4 hr. Little influence on preference. Fasting from breakfast until 4:30 p.m. -no effect.

(3) Age: New born to 40 days -no/little taste differentiation. Higher sweet threshold - 52 to 85 yr. group than 15 to 19 yr. A decrease in taste sensitivity after 60-yr. Age, may be because of degenerative changes in taste receptors, particularly for sweet & sour, no change for salt & bitter. Differential sensitivity -less in children 7-11 yr.

(4) Smoking: Smoking affect taste preferences via taste mechanism. No effect on threshold for sweet, sour, slat but for bitter was higher in smokers. Nicotine & other alkaloids plus smoke - fatigue the perception mechanism. No significant effects on receptors have also been reported.

(5) Other factors: Chronic alcoholism, excessive smoking, allergy, hay fever, badly infected germs, marked tooth decay did not affect the sensitivity to sucrose. Water unless purified is a factor. Practice is another factor-increased familiarity.

Related to threshold is the ability to distinguish intermediate concentrations. At lower concentration the solution chosen, was greater than half concentration, Quinine Sulphate was an exception.

(6) Effect of temperature on taste:

Increased temperature -increased response to sweet

-decreased response to salty & bitter

-unchanged sensitivity to acid

To study the effect of temperature one requires

- control of area stimulated

- the rate with which the liquid passes over tongue.

It is difficult to separate taste, temp. & pain effects. Moreover, temp. of receptor may be more important than temperature. of sapid substance. Fluids of extreme temperature. (especially extreme cold) cause temporary insensitivity. Optimum sensitivity to taste producing substance occurs at 30-40°C. The sapid substance should be neither so cold nor so warm as to distract attention from the taste reaction. For judging milk-a temp of about 60°F (15.5°C) is more preferred which is not cold enough to have distracting influence and not warm enough to volatative completely all the odors, that may be present. Further, volatilization may occur as the temperature. of the milk is brought upto the body temperature (98.6°F).

(7) Effect of taste medium: The intensity of the taste medium is greater in aqueous media than in paraffin oil/mineral oil. This is supposed to be due to: combined effects of viscosity and solubility of the compounds in oil and of the oil in saliva.

(8) Chemical configuration/structure and taste: The relationship between the chemical structure of a compound and a taste is more easily established than between structure and smell. All acids are sour, NaCI and other salts are salty, but as the constituent atoms get bigger, bitter taste develops. Taste responses are related to chemical specificity, therefore, ortho, meta or para positions of different groups in compound alter these tastes. Minor changes in the chemical structure may change the taste of a compound from sweet to bitter or tasteless. Stereo structure, optical relation (levo or dextro) etc. may also alter tastes, because these behave differently on taste receptors.

Classification of Odors

Just as the various taste reactions were resolved into four basic categories, attempts have been made by numerous investigators to classify odors:

1. A four modular classification : Any odorous substance has four components which include fragrant described as flowery or fruity) ; acid or sharp; burnt or tarry or scorched; and caprylic or goat like.

2. Six odor groupings : In diagrammatically arranged six fundamental odors in which interrelated or intermediate odors are shown as components of an olfactory prism. On a close examination of the prim , one can observe that a given odor can either be a fundamental odor by a occupying a corner when two odors are involved, they, would be located along an edge, or if three odors are involved, they would be located on a triangular surface.

3. Simplified six odor sel1sation to four odour grouping: With a range of intensity of stimuli for each of the four basic odors numbered to 0 to 3, they reproduced odors simply by mixing certain intensity of the basic odours. Within this format given aromatic substance may contain all

four fundamental odors, their relative degrees of stimulation determine the individuality oftl1at odor.

Most persons could differentiate between 2000-4000 odors, whereas highly trained persons could probably differentiate as many as 10000 different odors.

4. There are seven primary classes of odors: This include ethereal, camphoraceous, musky, floral, minty, pungent and putrid.

Certain perceived odors might be considered to be a composite or two or more primary odors, a dairy products judge should be alert to possible detection of individual components. Sense acuity of an individual may not involve but power & value of concentration, which is very important, can be materially improved.

Odor Thresholds

The apparent olfactory thresholds for the most powerful odors are about 10000 times lower than the lowest taste thresholds. Differential sensitivity to taste, appears to be finer than it is to odor. Typical thresholds are given in Table 8.1 Fatigue is also more rapid and permanent with smell than with taste, sight or hearing.

Factors affecting threshold

There are several factors which affecting the threshold. These are

1. Purity of compounds: purity is necessary for threshold tests.

2. External Variables: duration and rate of flow of inspired or injected air I reduction in olfactory acuity in the presence of noise. i -contrast between humid external and dry interior condition leads to increased sensitivity.

-methods of presentation of samples greatly influenced the results. -error of habituation.

3. Effect of Hunger and Chemicals: increase in sensitivity during morning and a rapid decrease after a meal. Alcohol and sugar decrease olfactory sensitivity.

4. Individual Variation: in order threshold not only a matter of definition and technique but also related to differences in the physiological state of the nose.

Techniques for Sensory Evaluation of Food Odors

Olfactometery

It is an air-diluents method consisting of a measured amount of odorous material sealed in a small, thin walled glass tube placed inside a larger container. The small tube was broken, and the subject opened the container and sniffed the contents. If the subject could detect the odor, the test was repeated with the same quantity of material in larger containers, until the odor was no longer recognizable.

Major errors associated with this technique-included adsorption of the test material on the glass, dilution when container is opened and difficulty in weighing volatile material.

A large number of similar technique developed, such as, using diluents air, compressed inert gas, mineral solvents, benzyl benzoate, glycerol or diethyl phthalate

a. Olfactometer

An instrument for controlled volume temperature humidity flow rate, presentation of odor stimuli, used for measuring threshold and other quantitative values.

b. Sniffing Method

Sniffing from beakers or bottle is the most widely used method of measuring odor intensity and quality. Although sniffing is the most simple and economical of all procedures. Certain limitations detract from its usefulness. The presence of non-ideal solutions at or near the threshold was a serious problem, suggesting that the procedure be used with caution when dilution of the odorous material is necessary. The method can be used for routine quality control

purposes, such as measuring odors in drinking water, but more precise studies of olfactory response require presentation of odors under highly controlled conditions.

Psychological Errors in Judgment

- The error of habituation: results from a tendency to continue to give the same response when a series of slowly increasing/decreasing stimulus is presented.
- The error of expectation: include the overly anxious observer to find a difference when none exists.
- A stimulus error: results when a subject knows that the test is being given in a certain way or when containers used or the procedure followed suggest differences and therefore cause him to find them when they do not exist.
- The Logical error: occurs when two characteristics of a food, which are logically associated in the minds of the observer, are rated the same.
- The error of Leniency: applies to ratings where bias in favour of some person or some object causes the observer to rate them higher than they should.
- Error of Central Tendency: arising in the tests involving judgment, rather hesitant to use the extreme values on a scale. This error probably also applies in sensory evaluation of unfamiliar foods.
- The Contrast error: may be noted, where expected or preferred method of evaluation is not followed. Foods may the be rated lower than with expected method; also, when a poor sample follows a good sample, the contrast error appears greater than when they re judged separately.
- The Proximity error: associated with judging scales, is attributed to the fact that adjacent traits tend to be rated similarly. Simultaneous scoring of color, texture, odor, taste &

acceptability on the same set of samples can give different scores from those obtained when each trait is judged individually.

- A Time error or positional bias: i.e. over selection of one sample on the basis of its order of presentation, has been demonstrated in paired tests.

- The Association error: is tendency to repeat previous impressions -a form of conditioned response.

Error of the First and Second kind :
Failure to detect a stimulus that is actually present is called and error of the First kind. Reporting a signal when no stimulus is present is called an error of the Second kind. These errors may be caused by expectation and can be influence by motivation. The most effective method of improving ratings, and thereby reducing psychological errors, is to train judges, carefully. Training that includes practice, followed by group discussion, has been recommended as being most effective.

Adaptation

When an exposure to a stimulus is prolonged, sensory response declines, i.e. adaptation occurs. This applies to direct sensory response as well as electrical activity. Complete Adaptation, i.e. no response, is possible but is certainly of little importance in the sensory examination of foods. Adaptation appears to be due to some special inhibition of the cell receptor membrane in the case of taste, rather than exhaustion of some receptive substance in the cell. Adaptation is relatively slow at higher concentration. Recovery from adaptation is rapid at first and slows thereafter.

Questions:- 1) Explain the Sensory Analysis Infrastructure Set Up requirement.

3) Different Methods in Sensory Analysis- Elaborate.

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Chapter 6

Quality enhancement models and Statistical quality control for Food Industry

The food industry has a number of Quality Assurance (QA) systems available like GMP (Good Manufacturing Practices), HACCP (Hazard Analysis. Critical Control Points), ISO (International Organisation for Standardisation) standards. These systems and their combinations are recommended for food quality and safety assurance. The agri-food production requires a specific approach to achieve the expected quality level. It is important to know to what extent the systems contribute to the total quality of the product and to balance the tools used for achieving the quality and safety objectives.

Introduction

Despite the huge efforts paid by the food safety authorities, specialists and industry, food safety still remains critical and often is coming into spotlights attracting media's attention with outbreaks that can bring a stack of multiple negative consequences. Such major events like BSE in 2000, dioxin or PCB crisis in 1999 and others questioned the effectiveness of the food quality assurance systems and food safety management applied and demonstrate that new tools are needed to complement the actual systems in place. When evaluating the negative consequences one have to take into account the medical costs incurred, the economical losses that can badly shake local small industries, and least but not last consumers` trust.

The safety paradigm is that although food is safer, consumers` attitude is dominated by high levels of uncertainty. In this changing climate we however, need to recognise the effort EU authorities make to restore consumers` trust and enforce new regulations and better communicate food safety related issues. An important feature of food industry is that producers, in order to cope with market needs and legal requirements, have to satisfy both safety and quality criteria for their products. Having multiple options in the form of different quality and/or management systems, food producers should decide the most appropriate one for its specific activity and should establish, document and implement effective systems for managing quality and safety (van der Speigel et al., 2003).

Among the available Quality Assurance (QA) systems there are at hand today systems such as: GMPs (Good Manufacturing Practices), GHPs (Good Hygiene Practices), GAPs (Good Agricultural Practices) or other prerequisite systems and HACCP (Hazard Analysis Critical

Control Points).

Management systems such as ISO 9000, or integrated management systems according to ISO 22000:2005 (Food safety management systems - Requirements for any organization in the food chain) are also accessible for producers

This paper discusses the most important theoretical systems and identifies several factors that limits or contribute to the successful implementation of quality, safety or integrated systems applied in the food industry.

Individual quality and/or safety management systems for food industry

- A quality management system (QMS) system can be defined as: a set of co- ordinated activities to direct and control an organization in order to continually improve the effectiveness and efficiency of it performance.

Food quality is a complex concept that can be assessed only in relation to food safety. To be considered safe for consumption, a food must meet: legislative requirements; technological criteria; hygiene requirements; transport and handling requirements; trading conditions and satisfy its intended use.

The relation between quality and safety is intricate and although safety cannot be viewed as a totally independent aspect from quality, recognising the complexity of both concepts brought the need of managing them separately. In fact the reasoning behind separating food safety from quality was the need to place the concept of safety first and above all the other quality aspects.

The result can be classified in quality assurance systems (QA) that includes the prerequisites (GMPs, GHPs, GAPs) and HACCP; quality management systems (QMS) that refers to ISO or TQM; and integrated systems (IS) such as ISO 22000.

The systems can be classified according to the extent of activities they cover, in:

- basic safety systems: prerequisites (GAPs, GMPs, GLPs, etc.);
- advanced safety systems such as HACCP;
- integrated food safety management – ISO 22000;
- basic quality management systems - ISO 9001;

-advanced quality management systems - ISO 9004.

A part of the quality assurance systems and prerequisite programs that are applied by the industry are presented bellow.

Good Manufacturing Practices - GMP. GMPs as defined by the Food and Drug Administration in 21 CFR part 110 are the minimum sanitary and processing requirements for food companies. The basic aim of GMP is concerned with the precautions needed to ensure adherence to all quality and safety basic requirements, like:

- elimination, prevention, minimisation of all product failures in the broadest sense;
- consistently yields safe, ensuring a certain quality uniformity.

Prerequisite programs provide the basic environmental and operating conditions that are necessary for the production of safe, wholesome food.

The Codex Alimentarius General Principles of Food Hygiene describe the basic conditions and practices expected for foods intended for international trade. In addition to the requirements specified in regulations, industry often adopts policies and procedures that are specific to their operations.

GMP guidelines are not prescriptive instructions on how to manufacture products. They are a series of general principles that must be followed during manufacturing.

When a company is setting up its quality program and manufacturing process, there may be many ways it can fulfill GMP requirements. It is the company's responsibility to determine the most effective and efficient quality process.

Hazard Analysis. Critical Control Points – HACCP.

HACCP is a preventative, proactive and systematic approach of food safety, which relies on the identification and control of the all the known associated health hazards in the food chain. The system based on seven principles was developed to control the biological, chemical, and physical hazards from the raw material production, through manufacturing, distribution and consumption of the finished product.

According to Codex Alimentarius (Alinorm 97/13A, Appendix III), the safety of foods is principally assured by control at the source, product design and process control and the

application of Good Hygienic Practices during production processing (including labelling), handling, distribution, storage, sale, preparation and use, in conjunction with the application of the HACCP system.

The production of safe food products requires that the HACCP system be built upon a solid foundation of prerequisite programs. While prerequisite programs may impact upon food safety, they also are concerned with ensuring that foods are wholesome and suitable for consumption. HACCP plans are narrower in scope, being limited to ensuring food is safe to consume (FDA, 1997).

ISO 9000 series of standards had a major revision in the year 2000 when three standards (9001, 9002, and 9003) were combined into one, called 9001. Design and development procedures are required only if a company is in fact engaged in the production and development of new products. ISO 9001 made a radical change in thinking by actually placing the concept of process management front and centre.

The process management refers to the monitoring and optimisation of a company's tasks and activities, instead of just relying on inspection of the final product. This standard also demanded involvement by upper management in order to integrate quality into the business system and prevent handing over the quality functions to junior administrators.

Another goal of the standard is to improve effectiveness via measuring process performance using statistical tools to assess the effectiveness of tasks and activities.

Expectations of continual process improvement and tracking customer satisfaction are made explicitly in standards` principles.

ISO 9004 goes beyond ISO 9001 and provides guidance on how one can continually improve its business' quality management system. This can benefit not only one`s customers but also: employees; owners; suppliers; society in general.

ISO 22000:2005 is a food safety management standard that is developed based on the ISO 9001 approach. The standard was especially developed to manage food safety. ISO 22000:2005 specifies requirements to enable an organization:

- to plan, implement, operate, maintain and update a food safety management system aimed at providing products that, according to their intended use, are safe for the consumer;
- to demonstrate compliance with food safety requirements;
- to evaluate and assess customer requirements and demonstrate conformity with those mutually agreed customer requirements that relate to food safety, in order to enhance customer satisfaction;
- to effectively communicate food safety issues to their suppliers, customers and relevant interested parties in the food chain;
- to ensure that the organization is consistent with the declaration of food safety policy;
- to demonstrate such conformity to relevant interested parties;
- to seek certification or registration of its food safety management system by an external organization, or make a self-assessment or self-declaration of conformity to ISO 22000:2005.

Total Quality Management – TQM is an integrative philosophy of management for continuously improving the quality of products and processes (Ahire, 1997).

TQM functions on the premise that the quality of products and processes is the responsibility of everyone who is involved with the production or the services offered by an organization (Rotaru et al., 2005).

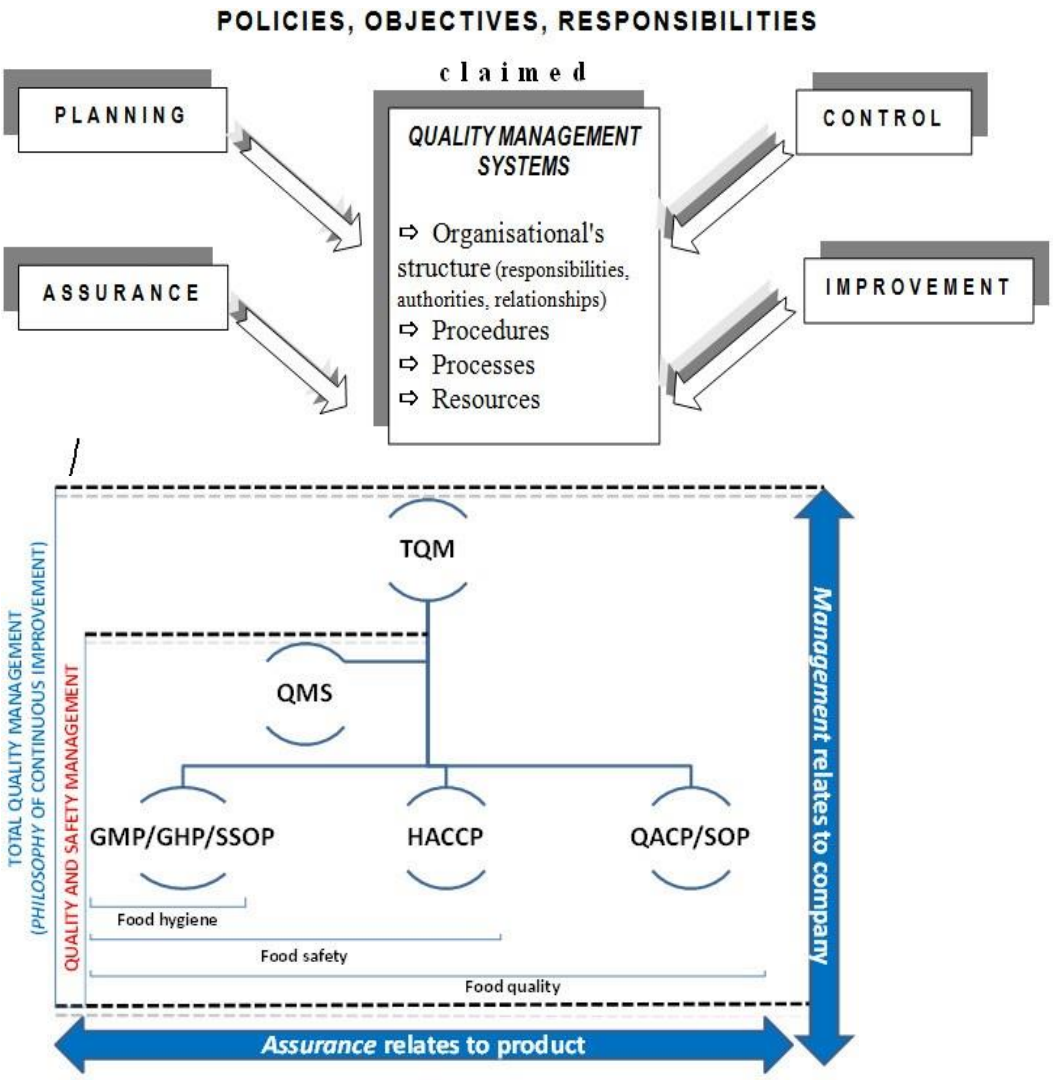
Integrated approaches for food industry - The agri-food production requires specific approaches to achieve the expected quality level. It is important to know to what extent the systems contribute to the total quality (van der Speigel et al., 2003).

The effective integration of the above mentioned individual systems will improve the performance of the organization. Efstratiadis and Arvanitoyannis (2000) mentioned that HACCP as a part of a quality system not only manages to provide safe food products, but also assure a better and more effective implementation of the entire quality system.

It is important to make distinction between the terms assurance and management. The term assurance relates to a product itself and involves all the safety assurance systems (GMP, GHP and HACCP) and the Quality Assurance Control Points (QACP), the later referring to quality assurance, not safety (Sikora and Strada, 2003). Maintenance and/or introduction of the all the other quality characteristics of the food (nutritional, sensory and convenience values) in quality assurance systems is not requested by law, albeit desirable by customers.

On the other hand, the term management corresponds to a company's overall organisation as regards the products' quality (including safety), and involves quality management systems -QMS (ISO-9000, ISO-14000, etc.) as well as TQM. Voluntarily implemented systems, known as quality assurance and management systems include ISO 22000, ISO 9000, ISO14000 and/or ISO 18000.

ISO 9001 can play an important role within TQM, by strengthening systems and procedures, but it is a small part of TQM activities. Thus, the QMS performance would be significantly improved with increasing the level of understanding of the relationship between all the quality and safety systems (Figure 1).To improve the performance of these systems, food manufactures should combine or integrate such systems as to assure that all the safety aspects of food and the necessary quality attributes are covered. For example, HACCP principles are often combined with ISO 9001 so that the technological and management issues regarding food safety and quality are achieved. Thus, ISO 9001 can be helpful for the application of HACCP.



Furthermore, food manufactures are obliged by legislation to apply HACCP principles, while the other systems are applied voluntarily in the food industry.In **Table 1,** an integrated model of the essential requirements for food industry is presented.

controlling activities, processes, procedures and resources according to the standards which constitute the basis for the quality and hygiene systems, including HACCP, ISO 9001 and 14000 series (Early, 1995).

The standard ISO 22000:2005 offers an alternative to food organizations which do not implement ISO 9001 and want to have an effective food safety management system.

Implementing QMS - Implementing a fully documented QMS will ensure that two important requirements will be met:

- ✓ customers' requirements – confidence in the ability of the organisation to deliver the desired product and service consistently meeting their needs and expectations.
- ✓ the organisation's requirements – both internally and externally, and at an optimum cost with an efficient use of the available resources – materials, working force, technology and information.

Table 1. Essential requirements for quality and safety assurance in the food industry

Features	**General requirements**
1. Quality management	Top management commitment; Plan and share responsibilities; Assign proper human and material resources; Ensure an effective quality system
2. Staff	Create an appropriate organizational framework; Describe the key positions; Train the workers; Develop behavioral and attitude competencies Supervise personal hygiene and health.
3. Production areas and equipment	Ensure proper facilities and equipment – constructions, installation; maintenance, environmental conditions, sanitizing, cleaning, validation of cleaning.
4. Documentation	Document, develop, approve, update, distribute, and archive documentation.

5. Processing	Validate the processes; Prevent cross-contamination during manufacture; Purchase good raw materials; Ensure the quality of the process, for intermediate, bulk or end products; Comply legal labeling requirements; Ensure good quality of the end products (quarantine, storage, handling, delivery); Track the products rejected recovered and returned (tracking and identification).
6. Quality control	Apply good practices in the laboratory; Apply sampling techniques; Validate the analytical method; Inspect the process; Maintain, check and calibrate the measuring and monitoring devices.
7. Regulations	Apply mandatory requirements; Follow contractual requirements.
8. Consumer complaints	Handle the complaints; Document the Withdrawals / Recalls; Analyze the decisions.
9. Self-inspection	Perform internal audit. Check compliance and corrective action
10. Supplier relationships	Identify and select key suppliers. Communicate clear and open. Share information and future plans. Establish joint development and improvement activities. Inspire, encourage and recognize improvements and achievements.

A QMS have four main components: quality planning, quality control, quality assurance and quality improvement (Figure 2):

When implementing an advanced/integrated food quality and safety management system, the lack of financial and human resources conflicting with high costs, the low personnel and time restrictions side by side with a general lack of knowledge and experience are important constraints. A brief analysis of the decisive factors that influence the application of advanced and/or integrated systems helps in understanding the relationship between certain specific elements such as: *internal* (staff involvement, communications, leadership), *external* (level of competition, relationships with suppliers, customers and authorities), *structural* (size, ownership structure) and the degree to which the *management practices* are applied (Figure 3). Only if all these elements are well addressed an organizations have the preparedness to implement an advanced management system.

The success of TQM approach is achieved if the system is treated as a strategic key business issue.

Additionally, we need to recognise that ISO and TQM focus more on the managerial aspects, whereas GMP and HACCP focus on the technological aspects (Hoogland et al., 1998). HACCP is the only quality assurance systems that consists of a plan with 14 steps, in contrast with the checklist of ISO. GMP includes guidelines and TQM uses awards or self-assessments (van der Speigel et al., 2003).

One of the key points to successful implementation of an advanced/integrated management system is to recognize the need for continuous improvement. Clause 8.5 ISO 9001 or 22000 urges a company to plan for corrective and preventive action, and continuous improvement.

Application of this principle guarantees the company's efficiency and competitiveness. In other words, a company that has been effectively implementing a QMS will make continuous improvements. Hence, the effort to meet the standards` requirements will bring the benefit of increasing the capability and the performance of the organisation.

Conclusions

Successful implementation of food quality and safety management systems is a necessity today.

In this paper, a brief analysis of the individual and integrated/advanced food quality and safety management systems was made, together with the identification and analysis of the factors that can influence the implementation process.

The effectiveness of the integrated system is based on the relationship between internal, external and structural factors. Besides these factors, food industry have to balance the quality assurance and safety management systems, select the proper ones according to its resources and needs and implement adequate tools for continuously measuring and evaluating the performance of the individual or advanced/integrated management systems.

QUALITY ENHANCEMENT MODELS

International Development of Food Safety Systems and Marketing of Processed Foods

1. *HACCP*

The HACCP system was introduced in the United States in 1971 by the Pillsbury Company in collaboration with the National Aeronautics and Space Administration (NASA) and the US Army Natick Research and Development Laboratories. These agencies had the initial responsibility for designing and manufacturing food products and hardware which were to provide 100 percent assurance that either the food products would not be contaminated with pathogens, bacteria or viruses which could cause illness or that the equipment would function with zero defects. The HACCP system has become the internationally recognized system for the management of food safety for all companies involved in the production, transformation, storage and distribution of food for human consumption. It has been adopted by the European Union (EU) for all food processors and the Codex Alimentarius Commission as the principal food safety system (EU Directive 93/43/EEC; Codex Alimentarius – Alinorm 93/131, 1993).

The HACCP concept involves the identification of specific hazards throughout the entire process involved in the production of a food product and focuses on the preventative measures for their control to assure the quality and safety of the food. This includes analysis of raw material sources and usage, processing equipment, operating practices, packaging and storage, together

with marketing and conditions for intended use. There is less reliance on the traditional system of end product testing and food safety is built into the product from conception through design and distribution.

1. *Hygiene Codes*

Hygiene codes work with a common HACCP system with predetermined Critical Control Points. Hygiene codes are basically, but not exclusively, established for the small- and medium-sized enterprises (SMEs) or even shops like butcheries and bakeries with limited manpower, where the Critical Control Points have been predetermined. A common HACCP system for a group of products or enterprises as mentioned above (branch) is applied to develop Hazard Analysis and Risk Assessment for that group community and to incorporate standard controls, preventive measures, and corrective actions into the hygiene code. This hygiene code can be applied directly by the operators of the group or branch.

Hygiene codes cover, in a systematic way, those elements which are laid down in the legislation to comply with basic matters on Hygiene and Good Manufacturing Practices and to provide the conditions to ensure the safety of food products.

Hygiene codes assist inspection bodies on their assignment to inspect the relevant items of the implemented system.

2. *BRC (British Retail Consortium)*

The BRC originated in the United Kingdom. Retailer branded products represent over 50 percent of all food sold in the UK. Under the terms of the Food Safety Act, 1990, retailers have an obligation to take all reasonable precautions and exercise all due diligence in the avoidance of failure, whether in the development, manufacture, distribution, advertising or sale of food products to the consumer.

That obligation, in the context of retailer branded products, includes the verification of technical performance at food production sites. Until recently, each retailer undertook this activity separately, verifying food production site performance against their individual, internally developed standards. In some instances, verification is undertaken by the retailer’s in-house technologists and in other instances by third party inspection bodies.

Technical inspection of supplying companies' production premises forms only part of the retailers due diligence system, and the acceptance of a company to supply, rests with the individual retailer. Major retailers, like AHOLD in the Netherlands and METRO in Germany are in favor of having BRC as an international standard.

The BRC has developed the Technical Standard (checklist) for those companies supplying retailer-branded food products. The Standard has been developed to assist retailers in their fulfilment of legal obligations and protection of the consumer, by providing a common basis for the inspection of companies supplying retailer-branded food products. It has encompassed the fundamental principles of the retailers' current standards and is intended to be incorporated into standards used by third party inspection bodies. It is not intended to replace the requirement of any legislation, where this legislation requires a higher standard for a specific industry sector. The Standard will be reviewed on a regular basis by the BRC membership and revised, where considered appropriate.

2. *EUREP GAP (Euro-Retailer Produce Working Group - Good Agricultural Practices)*

The objective of the EUREP, which is made up of leading European food-retailers, is to raise standards for the production of fresh fruit and vegetables. In November 1997 they agreed on the first draft protocol for GAP. This represented the first step towards integrated production. In September 1998 the EUREP initiated pilot trial projects to verify the implementation of EUREP GAP in the field. They were conducted together with advanced producers in Spain (MARTINAVARRO) and Italy (APO).

The prepared document (checklist) sets out a framework for GAP on farms, which defines essential elements for the development of best-practice for the global production of horticultural products (e.g., fruits, vegetables, potatoes, salads, cut flowers and nursery stock). It defines the minimum standard acceptable to the leading retail groups in Europe, however, standards for some individual retailers and those adopted by some growers may exceed those described. The document does not set out to provide prescriptive guidance on every method of agricultural production.

3. *SQF (Safe Quality Food)*

SQF 2000 is a HACCP quality code (system) designed in Australia specifically for companies in the agri-food industry. The code is aligned with the Codex Alimentarius

Commission Guidelines for the application of HACCP. SQF focuses on food safety and quality issues including GMP, SOPs (Standard Operating Procedures) and HACCP and is compatible with the ISO (International Standard Organization) 9000 standard. The code has been specifically developed for the food industry to include rural producers, processors, transport, storage, catering and hospitality sectors.

4. *EHEDG (European Hygienic Equipment Design Group)*

The EHEDG is a consortium of equipment manufacturers, food industries, research institutes and public health authorities, founded in 1989 with the aim to promote hygiene during the processing and packing of food products. European legislation requires that handling, preparation, processing, packaging, etc., of food is done hygienically, with hygienic machinery in hygienic premises (EC directives 98/37/EC and 93/43/EEC). How to comply with these requirements, however, is left to the industry. As food safety does not end at the borders of Europe, the EHEDG actively promotes global harmonization of guidelines and standards. The US-based organizations such as National Science Foundation (NSF) and 3-A (Sanitary Standards, Inc.) have agreed to cooperate in the development of EHEDG guidelines and in turn, EHEDG cooperates in the development of 3-A and NSF standards.

Quality Management Systems in Small and Medium Food Processing Enterprises

– Experience of South Africa

This paper identifies constraints, progress and status on an operational level of introducing HACCP in a fruit packinghouse and aims to present the exporter's role in this process.

The primarily activity of these packinghouses is the packaging of fresh fruit for export. In the light of the food safety requirements in the countries of destination, the South African packinghouses are now under pressure to implement HACCP. Should they fail to comply with these requirements, they lose access to their most lucrative export market, which will ultimately place the packinghouses and consequently the involved jobs at risk. For a fruit packinghouse the most pertinent system is HACCP, not only because food safety should be a basic standard in all food operations, rather than a competitive edge benefit, but also it will be the only mandatory

system in and for exporting to the EU. HACCP is a suitable system to ensure food safety in a packinghouse. It was developed for the food processing industry but it can be readily adapted to the operation in a packinghouse, even though some might consider packing not to be processing in the strict sense of the original definition.

Fruit is delivered from one or several farms for grading, sorting and packaging to a so- called packinghouse. Packinghouses are either owned by single large farms or by communal structures in which several farms participate. There are several projects under way that encourage ownership participation of employees and previously disadvantaged people by means of share plans and similar models. In order to maximize the return on investment some packinghouses will pack different types of fruit throughout the year. A typical example in South Africa is avocados and mangoes that are frequently packed in the same packinghouse. The packing, grading and sorting requirements are similar and allow for the reuse of machinery. The procedures in packinghouses are in fact quite similar for most fruit types, except for table grapes, in which the share of manual labor is far above average.

While resistance to change is a problem in the whole food industry, the fruit producers are particularly reluctant to break from their tradition. This is due partly to their unfamiliarity with the end-consumer who lives in a "different world". The European end-consumer's perhaps somewhat idealistic demand for healthy, biological, non-chemical, environment- friendly untreated food is poorly appreciated in these circles that must produce quantities of faultless fruit against dwindling margins. Another reason is the "foreign", western origin of the systems, including all food safety and quality management systems, which raises fears of foreign interference in people who look back on a long history of proudly defended independence.

Big companies will find resources and technical assistance relatively easily, while small businesses struggle against the lack of appropriate funds, experience and food safety priorities. Generally the cost of fruit production is on the increase, while the oversupply in the world lets prices for horticultural products decrease. Training centers, laboratories, research institutes and suppliers of packaging and chemicals are often not established in the grower's areas. A common misperception is that HACCP is the magic formula to right all wrongs – ranging from poor

personal hygiene, unsuitable facility design, and inadequate cleaning programs to ignorance and illiteracy – preferably overnight and at low or no cost.

The packinghouse is an integral link in the supply chain and thus the cooperation of other links in the chain is essential. Much support is needed from the supplying farm, as well as from the exporter. If the farm does not produce according to EUREP GAP guidelines, the delivered fruit must at all times be accompanied by a record of the production unit and a spray summary giving details of what chemicals have been used during production. More cooperation is needed in terms of the staff hygiene, transport and equipment.

To have a person from the exporter in the HACCP team of each packinghouse not only makes the team bigger, but also adds to input from the exporters' perspective. The team meetings take on a more formal manner, as this person is not part of the daily workforce. This person, being a member of many teams, can get an overview of the progress in the industry and can instill an element of competition to accelerate the process. Moreover, physical aids like signboards, examples of control sheets and training material can be distributed and financial incentives, such as free pre-inspections or covering certification costs, can be offered to increase motivation.

While some people may see prerequisites (PRs) as a new concept and think it makes HACCP more difficult, it is in fact the only way to keep the number of Critical Control Points (CCPs) low and the HACCP plan manageable. To keep the system as easy as possible, it is very important to ensure that everybody can understand it. This is particularly relevant in a packinghouse where most staff members have no higher education.

Since HACCP cannot be implemented over night, the motivation and focus can fade. It is therefore helpful to jointly develop a proper project plan with realistic, measurable milestones that are regularly monitored by the HACCP team. Even though a certification is not mandatory, it is advisable to certify the system once it is implemented. The final audit day will serve as a dead line and the display of the certificate in the office is a reminder to maintain the system.

Prior to 2001 no fruit packinghouse in South Africa was HACCP certified. Over the last two years, the combined efforts of packinghouses and exporters have been focused on getting the

PRs in place. As of today (almost) all PRs are in place, the actual HACCP implementation can be approached and thus a rapidly increasing number of HACCP accreditations can be expected in the near future.

South Africa has a national code of practice for the implementation of a HACCP system. A workgroup is drafting a document for fresh fruit and vegetables, which will become a local food safety regulation and will be legally enforceable.

Pressure from European clients and the EU directive mandating HACCP is the major driving force for the whole food processing industry in South Africa. Factories producing for export, including the fruit packinghouses, are ahead of other food processing sectors in terms of awareness, commitment and progress in implementing PRs.

There is little doubt that HACCP has brought numerous benefits to the food safety scenario. For the fresh fruit industry in South Africa it has lead to a better understanding of food safety amongst the packinghouse managers and owners, resulting in a general improvement of packing facilities and indicates that national regulations will be brought in line with the European food safety requirements.

GMP/GHP and HACCP Systems – Experience of Small and Medium Food Processing Enterprises in Poland

Modern systems of food health quality assurance are based on the concept of creating production conditions which guarantee optimal quality products. It is necessary to define quality characteristics and potential dangers as well as forecast the quality of a finished product in these systems, as opposed to the traditional systems which were based on controlling finished goods and eliminating products which did not meet defined requirements. Amongst Polish food companies implementation of quality management methods and systems and quality assurance is becoming more and more popular. In food processing and turnover some of the systems of food health quality assurance already are or soon will be obligatory. Thus, as of 28 February 2000 there was a binding Health Ministry regulation regarding sanitary conditions and hygienic rules for the production and turnover of food products, beverages and additional substances, as well as

the additional 22 November 2000 regulation of the Ministry of Health which introduces an obligation of implementing Good Hygienic Practice (GHP) and Good Manufacturing Practice (GMP) in food production and turnover.

There is still a Ministry of Health project being prepared with regards to a regulation concerning the scope and methods of internal quality control of food products, beverages, additional substances or other additions to food products and beverages as well as materials and products having contact with these articles, and the scope and methods of internal hygienic control. This regulation shall introduce an obligation of implementing the HACCP system.

The basic systems of health quality assurance used in food production are GMP, GHP and HACCP – the system which includes the area of food health quality assurance. It has to be strongly emphasized that the HACCP system is an independent food safety assurance system, specific for the food sector. Implementation of HACCP systems in production plants processing food should be preceded by implementing principles of Good Production Practice (GPP) and GHP. This should settle all the issues referring to plant hygiene and to basic food production conditions. It is essential that all the hygiene-related elements (i.e., applying relevant systems for a given hygienic production process, relevant washing and disinfecting agents) are consistent with sanitary requirements, efficient technical equipment and the efficient use of chemicals, water and time. GHP means performing all the required activities during the production and turnover of food products, and complying with conditions that assure the relevant health quality of the food products. GHP includes: maintenance of hygienic rooms, machines, production personnel, planned training courses and medical examinations as well as registration confirming performed and controlled cleaning and preventing activities (very often done by external services); washing, disinfecting, elimination of rodents; and other means used to maintain hygiene. Every food producing plant in Poland must have an instruction of GHP based on Polish and world regulations and adopted to the plant and production characteristics.

GMP includes the basic areas of a company's activity, the level of which determines whether the food produced meets the relevant quality. Food production should take advantage of GPP experiences. Elaborating GMP principles and following them are a basis for implementing other

quality assurance systems. The experience makes us believe that just one GHP/GMP system should be discussed and implemented. The requirements of these systems are connected, interwoven with and dependent on each other.

After elaborating and implementing GHP/GMP, a subsequent, logical step is to elaborate and implement the HACCP system. Special attention should be paid to all the potentially dangerous factors affecting the consumer's health in order to guarantee food health safety. These factors have to be defined and then preventative activities should be elaborated. If necessary, CCPs should also be identified to minimize or completely eliminate any dangers. The HACCP system consists of seven rules and is implemented in 12 stages. This system implements changes to previous habits, forces analysis of the production processes in the plant production areas, including areas which have production problems, and shifts the responsibility to the employees directly connected with the production. The presentation discusses basic rules of GMP, GHP and HACCP systems. Practical aspects of implementing the above mentioned systems are presented together with their advantages for food companies in Poland.

Implementing HACCP in SMEs – Concepts

vs. Consumer Participation, Business Culture and Policy Approach

Introducing any new concept or technology in small- and medium-sized enterprises (SMEs) require altogether a new approach, as they distinctly differ from their fortunate cousins, namely; larger enterprises, in terms of size, resources and access to knowledge. Since HACCP is an uncompromising, demanding and exacting quality assurance concept it is unfair to expect SMEs to implement it straight away without actually assessing their ability to do so. In addition SMEs may also be keen to ascertain tangible and immediate returns that accrue by investing in HACCP. If HACCP needs to be introduced and sustained in the long run in SMEs, especially in the developing countries, it is imperative to thoroughly understand the level of consumer participation, prevailing business culture and the policy support and direction.

All new and promising concepts including HACCP have a greater chance of adoption when the benefits are quantified and presented in monetary terms. As business basically revolves around money no amount of persuasion by harping upon social responsibility, statutory obligation and public health would succeed in convincing the SMEs to implement HACCP. This means HACCP campaigns with a judicious mix of technical and financial advantages can penetrate SMEs at a faster rate than the conventional ones. A coherent and proactive policy is perhaps the most critical factor that separates the success of HACCP from failure. The government's commitment sends the right signals to the food industry about the implementation of HACCP.

Export-focused policy is one of the main reasons for slow adoption of HACCP in SMEs. Since most of them are not involved in food exports directly, they have never felt the need and urgency to implement HACCP. Soft-pedaling by the policymakers has also not contributed to HACCP's cause. Emphasis on voluntary compliance has not paid rich dividends so far and it seems the time has come to look for hard options such as coming out with a definite time frame for compliance. Punitive action for defaulting units may also have the desirable effect in the food industry.

At present, in countries like India, 50 percent of HACCP implementation costs, subject to a maximum of one million rupees, are being offered as a grant for interested food enterprises irrespective of their size. Keeping in view the large number of food processing units operating at home, small and cottage level it is worthwhile to enhance this assistance to 75 percent. However this enhancement will be implemented with a provision of mandatory compliance in the specified time period. Involving banks and other developmental agencies in a big way to extend soft loans for HACCP implementation may also encourage many SMEs to come forward voluntarily.

The multiplicity of agencies and their conflicting interests have resulted in either confusion or lack of action. Since HACCP revolves around a wide spectrum of activities such as health, agriculture, food processing, trade, exports, etc., agencies responsible for these sectors are either claiming complete authority over HACCP or passing the entire buck to others resulting in slow progress of HACCP implementation. An exclusive agency to monitor the implementation of

HACCP in the food industry may yield better results rather than cobbling a loose mechanism by drawing people from different agencies. The success story of Thailand is an excellent example for developing countries in the region to follow in order to effectively implement HACCP. It has started working on HACCP since the early 1990s and emerged as one of the leading exporters of seafood to developed countries from the Asia- Pacific region.

Another area that requires immediate policy intervention is food legislation. Many developing countries, especially in the South Asian region, are still grappling with a legislative approach that is predominantly curative. Food legislation in these countries has yet to catch up with the latest developments, with modern quality and safety concepts such as GMP and HACCP missing from them. This situation is not conducive for promoting a preventive approach to food safety. Minimum requirements prescribed in many cases are below Codex standards and arrived at as a compromise for taking shelter under the prevailing manufacturing and technological capabilities. Needless to say proactive food legislation is essential for the success of HACCP and there is a need for immediate policy reorientation in this regard.

The policy of voluntary compliance without a specific time frame has not yielded desirable results so far in many countries of the region. Keeping in view the rise in food- borne diseases and the subsequent strain on budgetary resources to control them, it is prudent to make HACCP compliance mandatory for SMEs in a phased manner but within a specific time frame. This move, apart from contributing to the overall improvement of food safety and hygiene, helps harmonization with global standards, gradually resulting in trade benefits. This suggestion may sound a little bit harsh in the context of the fragile nature of SMEs operating in the food sector but in the overall interest of consumer health and the beckoning export opportunities, SMEs may have to take this bitter pill sooner or later.

Apart from providing funds for implementing HACCP in SMEs, there is also a need to create mass awareness through different media for the benefit of consumers. A well- informed and demanding consumer in turn would act as a catalyst for increasing the pace of HACCP adoption by the SMEs. Lack of awareness about HACCP and its impending benefits is impeding HACCP propagation and this could only be overcome with adequate budget allocation for innovative

publicity campaigns. The ultimate aim of this strategy is to make the food industry use HACCP as a trump card in their marketing campaigns. Hence mass publicity shall form an integral part of any HACCP policy in the developing countries for its success among SMEs.

Recognition and rewards act as great stimuli for entrepreneurs to strive for excellence. Instituting national level awards for promoting and implementing HACCP in an exemplary manner may provide the much-needed momentum for HACCP campaigns in developing countries. Already some member countries like India are implementing similar schemes for promoting productivity in industry, agriculture and service sectors with considerable success. Similar efforts specifically targeting HACCP in SMEs may yield tangible benefits. If launching exclusive recognition schemes is not possible for some reason, HACCP implementation should find a prominent place in the performance appraisal of SMEs operating in the food sector.

Shortage of adequate trained personnel to assist SMEs is also hindering the progress of HACCP implementation in many countries. There is a need to formulate a policy to encourage SMEs to train their personnel in various aspects of HACCP. In addition, institutions involved in producing food technologists and food engineers have to include HACCP in their curricula to meet the shortage of personnel. Engagement of foreign consultants should also be encouraged to keep pace with the latest developments in the west on a selective basis. Since these consultants come with a price tag and usually beyond the reach of SMEs, it is necessary to convince the concerned governments to extend these services under bilateral assistance programs. Attracting international agencies like UNIDO, WHO and FAO in a big way may also help the cause of SMEs in expediting the implementation of HACCP.

Policies can succeed only when they are made after a thorough understanding of the basic realities and as such a reliable database about various aspects of HACCP implementation at national level is essential. Unfortunately enough attention has not been paid towards this issue so far and it is time to concentrate on developing national as well as regional HACCP databases, with emphasis on SMEs. Organizations like APO which have a tradition of conducting periodic surveys on important topics in the member countries can play a leading role in this regard. This

will help not only in conducting objective comparative analysis but also in duplicating success stories among different countries of the region.

To conclude, it is important to note that HACCP policies formulated without proper understanding of business culture and the level of consumer awareness are bound to encounter roadblocks sooner or later. Before launching large-scale HACCP campaigns it is necessary to prepare SMEs mentally by explaining the inevitability of HACCP adoption not only for growth but also for survival. A business plan that justifies the investment on HACCP in clear monetary terms is the best way to convince SMEs to adopt HACCP. Exerting pressure through consumers is another way of increasing the pace of HACCP implementation among SMEs. A dual HACCP approach emphasizing exports may not succeed in the long run, especially in the open market era.

HACCP – Food Certification

The SPS (Sanitary and Phyto-sanitary) Agreement under the WTO Agreement makes it mandatory for all countries to maintain measures to ensure that food is safe for consumers and to prevent the spread of pests and disease among animals and plants. The HACCP system is a food safety management system, recognized by the Codex Alimentarius Commission, which is the internationally recognized standard for world food trade under the WTO Agreement.

The HACCP system, which is a preventive food safety management system, has shifted emphasis from resource-intensive end-product inspection and testing to that of prevention or control of hazards at all stages of food production. Since the focus is on food safety, the intent is to institute preventive mechanisms in the system.

The HACCP system is a proactive food safety management system, with focuses on prevention. It encompasses the key elements of good product management, good hygiene conditions and good manufacturing practices and calls for: a) critical examination of raw materials, processes and products; b) hygienic conditions from origin till it reaches the customer; c) identifying stages/processes where hazards could occur; d) instituting and maintaining controls at identified

stages/processes; e) documenting HACCP process and keeping records; and f) ensuring that the system continues to work effectively.

An evaluation or audit of a company's HACCP system is necessary to ensure that it is being implemented effectively and is suitable to achieve the objectives. An audit is defined as a systematic and independent examination to determine where the activities and related results comply with the planned objective. An audit is an effective evaluation of a company's quality and safety management system. It brings out whether the documented system has adequate evidence to demonstrate the effectiveness of its implementation.

The audit paves the way for continuous improvement. The purpose of the audit is:

a) establishing adequacy and suitability of the system; b) determining effectiveness of the system; c) providing an opportunity for system analysis; d) aiding problem solving;

e) facilitating decision-making; f) aiding employee involvement; g) helping to establish capability of process and equipment; h) ensuring compliance with legal and statutory requirements; and i) providing aid for communications and facilitating training.

The Bureau of Indian Standards (BIS), the officially recognized certification body in India, besides offering product certification also offers system certification schemes to the industry. These include: 1) Quality System Certification (against IS/ISO 9000);

2) Environmental Management System Certification (IS/ISO 14000), and 3) HACCP

STATISTICAL QUALITY CONTROL FOR FOOD INDUSTRY

1. Introduction

Increasing costumer demand for safe food has lead food industry to build up food safety and quality systems. The food safety and quality are affected by insufficiency on administration, supplier, production technologies, working environment, human resources and control activities.

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Hazard analyzes and critical control points (HACCP) is a system that identifies, evaluates and controls hazards which are significant for food safety. It is a structured, systematic approach for the control of food safety throughout the commodity system, from the farm to the plate. It requires a good understanding of the relationship between cause and effect in order to be more pro-active and it is a key element in Total Quality Management (TQM). The HACCP system has 7 elements called the HACCP principles and pre-requisite programs that must be in place for the system to operate effectively. HACCP is focused in two main steps, namely; (1) Hazard analysis and critical control points (CCPs) determination and (2) HACCP plan for the food processing. First step includes hazards identification, hazard assessment, preventive measure establishment, CCPs determination and their critical limits. The following step is to carry out HACCP plan preparation; monitoring system, corrective actions, verification system and related record system on each CCP.

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Statistical tools are an effective way for improving process quality and safety. A large number of managers have achieved the benefits from statistical process control (SPC) implementation. SPC includes flow charts, pareto analysis, histograms, cause-and-effect or Ishikawa diagrams, scatter diagrams, and control charts. Control charts enable the monitoring of key variables during production and they give warning when the process is out-of-control. The best-known charts are the X and s charts that show the temporal variability of the average and standard deviation of the sample subgroups. SPC tools are, particularly control charts, for trend analysis, monitoring and evaluating the critical control points (CCPs) statistically, obtaining advance warning on the status of a critical control point and not just a “Pass/Fail” classification and measuring process outputs and identifying if they vary within statistically defined upper and lower control limits. Use of these tools is discussed by considering traditional sucuk (sausage) process. Sucuk, is a

term used for a fermented dry meat product, is a very popular meat product in Turkey and countries located in Balkans, Middle East and Caucasus. Similar type products are also known in most Middle East countries and in European countries. This meat product has been chosen because of its liability to deteriorate easily.

Assuring HACCP effectiveness for food safety relies on application of many prerequisite programs. In addition, some processes (Documentation and record process, internal audit process, etc) applied with ISO 9000-Quality Management System (QMS) standard are used with the HACCP system. ISO 22000-Food Safety Management System (FSMS) standard is being introduced as organizing all of these requirements; moreover it is desired to be used as a single standard in the world. These management systems require statistical tools to have an effective implementation.

2. Food safety and quality systems

Food safety is a scientific discipline handling, preparation, and storage of food in ways that prevent food borne illness. HACCP is a management system in which food safety is addressed through the analysis and control of biological, chemical and physical hazards from raw material to the end product. ISO 22000 concentrates exclusively on food safety and will instruct food producers how they can build up the food safety system itself. Food quality is the quality characteristics of food that is acceptable to consumers. The ISO 9000:2000 includes all management, production, distribution, and product design and service activities.

2.1 TQM and ISO 9000-Quality management system standard

Total Quality Management (TQM) is a comprehensive and structured approach to organizational management that seeks to improve the quality of products and services through ongoing refinements in response to continuous feedback. TQM covers to meet customer requirements, to improve teams, to reduce product and service costs and to provide continuous improvement. TQM techniques have demonstrated an ability to significantly increase productivity and improve

profitability. Total Quality Management (TQM) is a comprehensive philosophy of living and working in organizations that emphasizes the relentless pursuit of continuous improvement (Chase & Aquilano, 1995). The principles of TQM and other management systems are summarized in Table 1.

The basic principles for the Total Quality Management (TQM) philosophy of doing business are to satisfy the customer, satisfy the supplier, and continuously improve the business processes. Organizations depend on their customers and therefore should understand current and future customer needs, should met customer requirements and strive to exceed customer expectations. Nearly every organized activity can be looked upon as a process. This process is supported by on organization consisting of people and their relations, resources and tools. Continuous improvement is an integral part of a total quality management system. Common tool to achieve to continuous improvement could be the plan-do-check-act (PDCA) cycle, often called the Deming Wheel, which conveys the sequential and continual of the continuous improvement process.

ISO 9000:2000 is in fact families of standards developed to assist organizations implement and operate effective quality management systems (QMS). ISO 9000:2000 consisted of quality systems that focused on documenting all quality assurance and improvement processes in a company (ISO, 1999). Although the ISO 9000:2000 was originally developed for the manufacturing sector, it had been applied to many service organizations and was gaining some acceptance in the food industry.

TQM	ISO 9000:2000-QMS	HACCP	ISO 22000-FSMS
□ Focus on customer □ Leadership	□ Customer focus □ Leadership □ Involvement of	□Hazard analysis □Critical control	□Customer focus □Leadership and team work

Let □ everybody be committed □ Approaching of process □ Focus on system management □ Continuous development □ Reality approaching □ Cooperation with suppliers	people □ Process approach □ System approach to management □ Continual improvement □ Factual approach to decision making □ Mutually beneficial supplier relationships	points (CCPs) □Critical limits □Monitoring procedures □Corrective actions □Verification procedures □Documentation procedures	□Involvement of people □Process approach and food safety □System approach to management □Continual improvement □Factual approach to decision making □Mutually beneficial supplier relationships □Legislation, regulations □Science and experience

Table 1. The Principles of TQM, ISO 9000:2000-QMS, ISO 22000-FSMS and HACCP

The ISO 9000:2000 standard describes a basic set of 8 elements by which quality management system can be developed and implemented. Table 2. represents the structure of ISO 9000:2000-QMS Standard.

2.2 HACCP and ISO 22000-Food safety management system standard

For the food industry, the HACCP program is currently recognized as the best approach to control food safety. Although concerns such as quality and economic adulteration are not included in the HACCP system, the implementation of an HACCP system means greater control over production process, which results in improvements in both the quality and safety of food. The HACCP system has 7 elements called the HACCP principles (Table 1.) and pre-requisite programs (Table 2.) that must be in place for the system to operate effectively (FAO, 1998; Codex, 2003).

The food processing industry has long used HACCP programs to make their products safer. Application of HACCP systems in many different manufacturing processes has led to more efficient prevention of adverse health effects associated with the consumption or use of the products. In addition, HACCP focused on the elimination of food-related health hazards. Companies involved in HACCP attempted to identify all critical points at which health hazards could be introduced into food and control those points to eliminate the associate risk (Mortimore & Wallace, 1998).

	Strategic	Operational	Support
ISO 9000:2000 -QMS	QP.1 Market Research and Customer Relation QP.2 Internal Communications QP.3 Document and record Control QP.4 Planning QP.5 Resources Management	QP.6 Product Design QP.7 Food Manufacturing	QP.8 Purchasing QP.9 Internal Audit QP.10 Data Analysis QP.11 Maintenance of measurement's and process equipments QP.12 Calibration of measurement's equipment

ISO 22000-2005 FSMS	PR.1 Construction and lay-out of buildings and associated utilities PR.2 Lay-out of premises, including workspace accessibility for and employee facilities PR.3 The suitability of equipment and its cleaning, maintenance and preventative maintenance	PR.4 Supplies of air, water, energy and other utilities PR.5 Supporting services, including waste and PR.7 Pest control sewage disposal PR.6 Cleaning and sanitizing PR.8 Personnel hygiene PR.9 Measures for the prevention of cross contamination	PR.10 Management of purchased materials (e.g. raw materials, ingredients, chemicals and packaging), and supplies

QP: Quality Process, PR: Pre-requisite

Table 2. Some quality processes and prerequisite programs

HACCP is a system that identifies, evaluates and controls hazards which are significant for food safety (FAO, 1998). It is a structured, systematic approach for the control of food safety throughout the commodity system, from the farm to the plate.

ISO 22000-2005 FSMS aims to harmonize the requirements for food safety management in food and food related business (ISO, 2005). ISO 22000-2005 FSMS assists the food manufacturers in the use of HACCP principles. Main elements in ISO 22000:2005 FSMS are compatible with ISO 9000:2000 QMS. Both models consist of 5 major elements. For the proposed-integrated models,

the principle aim is to provide simplicity and applicability. A common documentation system is provided by the integration.

HACCP system had been required operational applications such as GMP, GHP, and SSOP before ISO 22000-FSMS Standard had been published. ISO 22000-FSMS Standard has included and organized the definition and detailed contents of these applications. Prerequisite programs, in this study, are classified as strategic, operational, and supportive programs (Table 2). ISO 22000-FSMS and ISO 9000-QMS have the same framework properties. The standards have built on customer focus, continuous improvement, and process approach.

2.3 Continuous improvement

Continuous improvement is a management philosophy that approaches the challenge of product and process improvement. Specifically, continuous improvement seeks continual improvement of machinery, materials, labor utilization, product quality and safety, and production methods through application of suggestions and ideas of team members (Chase & Aquilano, 1995).

ISO 9000:2000 Quality Management System and ISO 22000:2005 Food Safety Management System are based on the process model which includes the continuous improvements from suppliers to the customer chain. In both models the influence of Deming's cycle can be seen (Table 3.). In ISO 9000:2000-QMS and ISO 22000:2005 a far greater emphasis is placed on the use of measurement and analysis of results, feeding into the review and improvement process. The continued auditing and verification of HACCP system demand more attention than the initial development of a HACCP plan. Food companies sometimes focus on the process control portion of HACCP without documenting the product design. Important process in HACCP system verification includes the initial validation of HACCP plan and its periodic revalidation. HACCP is brought to a standard structure with ISO 22000:2005 which has similarities with ISO 9000:2000 QMS. Moreover, integration of standards will provide simplicity in practicing of them.

2.3.1 Management responsibility

In both models top managements make/decide quality and safety policies. After this step, objectives to reach quality and safety policies should be determined. The customer requirements have to be included in this determination. Food quality and food safety management system planning is then followed. Planning will include strategies, resources and cost estimation.

2.3.2 Resource management

The required resources such as human resources, infrastructures, equipments, and work environment have to be organized. Infrastructure covers the hygienic and sanitary design of equipment and buildings. Required continuing education for employees has to be planned and supplied.

Deming Wheel (PDCA Cycle)	Quality and safety improvement steps	ISO 9000-QMS	ISO 22000-FSMS
	Theme		
Plan (P): The plan phase of the cycle is an improvement area and a specific problem with it to be identified. In this phase, objectives and strategies are developed and necessary sources are determined.	1. Selection	5.3. Quality Policy	5.2. Food Safety Policy
	2. Current situation review and analysis	5.4. Quality planning	5.3. FSMS planning
	3. Preventive action planning	5.4. Quality planning	5.3. FSMS planning

Do (D): The do phase of the cycle deals with implementing the changes according to the plan.	4. Action	7. Product/Service Realization 7.5. Production & Service Provision	7. Realization of safe product 7.9. Operation of FSMS
Check (C): The check phase deals with evaluating data collected during implementation.	5. Analysis	8. Measurement, Analysis, and Improvement	8.2. Monitoring and measuring
Act (A): During the act phase, the improvement is codified as the new standard procedure; necessary revisions are applied and replicated in similar processes throughout the organization.	6. Standardizatio n of the countermeasures	7.5. Production and Service Provision	8.4. Validation of control measure combinations
	7. Identification of remaining problems	8.3. Control of Nonconforming product	8.3. FSMS verification
	8. Evaluation of whole plans and procedures	8.5. Improvement 5.6. Management review	8.5. Improvement 5.6. Management review

Table 3. PDCA cycle with ISO 9000-QMS and ISO 22000-FSMS

2.3.3 Product/service realization

Following steps have to be studied in safe product and service realization;

- Planning of safe product and service
- Implementation of pre requisite programs

- Hazard and risk analysis
- Design (Safe product and/or service, HACCP plan, Operational procedures)
- Realization of purchasing after evaluating of supplier
- Realization of safe products and service by customer requirements

2.3.4 Measurement, verification, validation and improvement

Data obtained from suppliers, customer satisfaction, product quality and safety, process trends, critical control points, pre-requisite programs and quality-safety system have to be analyzed. Quality and safety systems are usually analyzed and verified through internal audits (Sperber, 1998). After that, outputs coming from auditing are validated. In both systems, the control of non confirmative products (in terms of quality and safety aspects) is required. Preventive and corrective actions provide us to get improvements.Management starts the review the data obtained through the former stages. Then, re-planning and validation are conducted.

2.4 Process management

Process is a collection of related, structured activities that produce a specific service or product from inputs given for particular customers. All of these activities are connected to each other with logic relations of processes. They provide the results by using sources of a organization to attain the goals. Process management between functional units of the institution within the hierarchical structure of production is a simple management system that provides work flows. In addition it is an effective management system in which responsibilities of employees are

considered, inputs and outputs are clearly stated, performance criteria and the size of success are being measured, and continuous improvements are provided (Juran & Gryna, 1998).

ISO 9000:2000-Quality Management System standard requires process management activities, resource management, product / service implementation and identification of processes during monitoring. Documentation required by these processes vary according to the organizational structure, however, the documents should be prepared in accordance with ISO 9000:2000-Quality Management System standard, the necessity, their validities must be approved and implemented.

Chapter 7

FOOD QUALITY MANAGEMENT SYSTEMS

1.1 Quality

The Oxford American Dictionary defines quality as “a degree or level of excellence.” According to Garvin - Quality is an unusually slippery concept, easy to visualize and yet exasperatingly difficult to define. The word ‘quality’ normally conveys notions of nebulous factors that are not readily measured or tied down. Quality conveys a positive connotation to whatever it is applied

The standard of something as measured against other things of a similar kind; the degree of excellence of something.

Concept of quality – historical background

The concept of a quality as we think of it now first emerged from the Industrial Revolution. Previously goods had been made from start to finish by the same person or team of people, with handcrafting and tweaking the product to meet 'quality criteria'.

Quality, as a profession and the managerial process associated with the quality function, was introduced during the second half of the 20th century and has evolved since then. Over this period, few other disciplines have seen as many changes as the quality profession.

Quality Control (QC)

Quality control (QC) is implemented as a means of fulfilling quality requirements, reviewing all factors involved in production. The business confirms that the good or service produced meets organizational goals, often using tools such as operational auditing and inspection. QC is focused on process output

- Procedures used in each assay to assure a test run is valid and results are reliable
- A system for verifying and maintaining a desired level of quality in an individual test or process
- A generic term that refers to the monitoring and assessment of laboratory testing processes to identify problems and maintain performance
- The operational techniques and activities used to fulfil requirements for quality

Quality Assurance (QA)

Quality assurance is implemented as a means of providing enough confidence that business requirements and goals (as outlined in quality planning) for a product and/or service will be fulfilled. This error prevention is done through systematic measurement, comparison with a standard, and monitoring of processes

- A part of quality management focused on providing confidence that quality requirements will be fulfilled
- A formal and systematic exercise in identifying problems in medical care delivery, designing activities to overcome the problems, and carrying out follow-up monitoring to ensure that no new problems have been introduced and that corrective steps have been effective.

- A broad spectrum of evaluation activities aimed at ensuring compliance with minimum quality standards
- All actions taken to establish, protect, and improve the quality of health care

Quality Improvement (QI)

Quality improvement is implemented as a means of providing mechanisms for the evaluation and improvement of processes, etc. in the light of their efficiency, effectiveness, and flexibility. This may be done with noticeably significant changes or incrementally via continual improvement

- A formal approach to the analysis of performance and systematic efforts to improve it.
- Systematic and continuous actions that lead to measurable improvement in health care services and the health status of targeted patient groups.
- Defining standards of care, reassessing those standards periodically, and continuously improving the medical systems that support those standards.
- A set of techniques for continuous study and improvement of the processes of delivering health care services and products to meet the needs and expectations of the customers of those services and products. It has three basic elements: customer knowledge, a focus on processes of health care delivery, and statistical approaches that aim to reduce variations in those processes.

Quality Management (QM)

Quality management ensures that an organization, product or service is consistent. It has four main components: quality planning, quality assurance, quality control and quality improvement. Quality management is focused not only on product and service quality, but also on the means to achieve it. Quality management, therefore, uses quality assurance and control of processes as well as products to achieve more consistent quality. What a customer wants and is willing to pay for it determines quality. It is written or unwritten commitment to a known or unknown consumer in the market. Thus, quality can be defined as fitness for intended use or, in other words, how well the product performs its intended function

- The application of a quality management system in managing a process to achieve maximum customer satisfaction at the lowest overall cost to the organization while continuing to improve the process

- Management activities and functions involved in determination of quality policy and its implementation through means such as quality planning and quality assurance (including quality control)
- Quality management is the act of overseeing all activities and tasks needed to maintain a desired level of excellence. This includes the determination of a quality policy, creating and implementing quality planning and assurance, and quality control and quality improvement
- All activities of the overall management function that determine quality policy objectives and responsibilities; and implement them by means such as quality planning, quality processes, quality control, quality assessment, and quality improvement within the quality system.

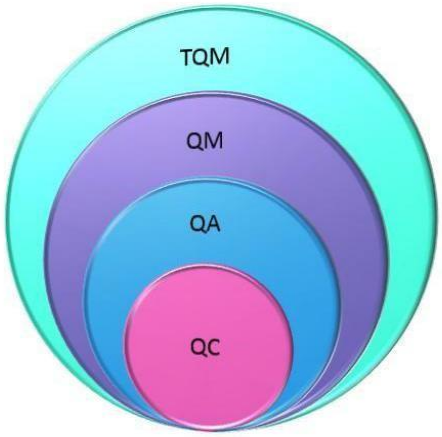
Quality Management System (QMS)

- Management system to direct and control an organization with regard to quality
- A formalized system that documents the structure, responsibilities and procedures required to achieve effective quality management. A QMS helps coordinate and direct an organization's activities to meet customer and regulatory requirements and improve its effectiveness and efficiency on a continuous basis
- The organizational resources, processes and procedures to implement quality management, which is broader than both quality assurance (QA) and quality control (QC). Besides QA, the laboratory quality management system also includes management of equipment, supplies and inventories, management of capital, finances and budgeting, and providing training and continuous support of staff and customer service
- The organizational structure, resources, processes, and procedures needed to implement quality management

Total Quality Management (TQM)

- A management approach to long-term success through customer satisfaction
- A management philosophy that seeks to integrate all organizational functions (finance, production, customer service, etc.) to focus on meeting customer needs and organizational objectives
- A business philosophy that the long-term success of a company comes from customer satisfaction. TQM requires that all stakeholders in a business work together to improve processes, products, services and the culture of the company itself

Quality planning - Quality planning is



implemented as a means of "developing the products, systems, and processes needed to meet or exceed customer expectations." This includes defining who the customers are, determining their needs, and developing the tools (systems, processes, etc.) needed to meet those needs.

Food quality

Food quality is the quality characteristics of food that is acceptable to consumers. This includes external factors as appearance, texture, and flavour; factors such as federal grade standards and internal. Food quality in the United States is enforced by the Food Safety Act 1990. Public analysts carry out scientific analysis on the samples to determine whether the quality is of sufficient standard. Food quality is an important food manufacturing requirement, because food consumers are susceptible to any form of contamination that may occur during the

manufacturing process. Many consumers also rely on manufacturing and processing standards, particularly to know what ingredients are present, due to dietary, nutritional requirements, or medical conditions. Besides ingredient quality, there are also sanitation requirements. It is important to ensure that the food processing environment is as clean as possible in order to produce the safest possible food for the consumer. As the matter of fact is that it depends on individual as their quality standards may vary from person to person.

1.3 Quality & Quality Management

Food quality is the quality characteristics of food that is acceptable to consumers. This includes external factors as appearance (size, shape, colour, gloss, and consistency), texture, and flavour; factors such as federal grade standards (e.g. of eggs) and internal (chemical, physical, microbial). Food quality in the United States is enforced by the Food Safety Act 1990. Members of the public complain to trading standards professionals, who submit complaint samples and also samples used to routinely monitor the food marketplace to public analysts. Public analysts carry out scientific analysis on the samples to determine whether the quality is of sufficient standard.Food quality is an important food manufacturing requirement, because food consumers are susceptible to any form of contamination that may occur during the manufacturing process. Many consumers also rely on manufacturing and processing standards, particularly to know what ingredients are present, due to dietary, nutritional requirements (kosher, halal, vegetarian), or medical conditions (e.g., diabetes, or allergies).

Raw Material Control

Raw materials are the basic ingredients used to create food products. These could be fruit and vegetables that are farmed and harvested; cows, chickens, pigs and sheep that are farmed for their meat, eggs and dairy products and various other items. Naturally, raw material control is directly related to process control as raw ingredients will need to meet certain guidelines before reaching processing phases.

Process Control

This principle relates to the process of food manufacturing. Ultimately, preventative measures are used alongside corrective measures – preventative strategies can only resolve a certain number of quality issues due to outside factors such as environment, storage and other such conditions. Many manufacturers work according to the Hazard Analysis Critical Control Point (HACCP) system as a result of this unpredictability. This system focuses on food safety as well as spoilage and other potential food risks. Total Quality Management (TQM) and ISO 9000 standards also relate to manufacturing processes and quality guidelines.

Finished Product Inspection

The third principle focuses on the final product – the packaged food that is then sold to consumers and suppliers. There are many forms of testing done at different stages – visual observation, physical tests and chemical tests are just some examples. Microbiological testing is very effective for determining health and sanitation controls, with a stringent monitoring process that incorporates records, data collection and the analysis of trends. External inspectors are also used alongside internal testers. Systems are designed for immediate corrective action when any products have raised red flags at any stage of the inspection, to reduce safety and hazard risks.Quality management plays a vital role within the food industry, across many different stages of sourcing, processing and packaging. In addition to basic laws and regulations on nutritive value, quality levels also incorporate factors such as shelf-life, raw materials, taste, texture, use of preservatives and many other indicators too.Not surprisingly, this makes it all the more important for food manufacturers to adhere to an efficient quality management system (QMS) in order to achieve standardisation and meet the demands of consumers and authorities.When it comes to food quality, the definition can vary considerably in its use – some may use the term to define high end products such as caviar, while others may use the term in reference to basic quality of everyday items such as bread. In terms of quality control and management however, the term is used universally to ensure that all food products are processed according to strict guidelines. Businesses may choose to obtain external recognition or accreditation of their FS & QMS for a number of reasons.

- Gain independent confirmation that the systems operated comply with industry standards and are sufficiently robust.
- Customer assurance.
- Serve as a continuous improvement initiative.
- Gain a competitive advantage and access to new markets.
- Demonstrate control and legal ‘due diligence’.

Benefit from related impacts of the improvement in general site efficiency. Gaining accreditation of a recognised quality standard typically starts with the selection of the appropriate ‘scheme/standard’ for the manufacturing operation. Such standards include:

- Global G.A.P;
- IFS (International Featured Standards);
- BRC (British Retail Consortium);
- ISO 9001 Food quality management standard (International Organization for Standardization);
- ISO22000 FSMS-Food Safety Management System;
- Food Safety System Certification (FSSC) 22000.

Defining technical and quality standards, for further information with regard to the selection of appropriate food industry standards and certification schemes.After the appropriate standard has been selected by the organisation, the standard will often contain hundreds of clauses requiring the business to operate extensive systems and procedures to assure ongoing and consistent control, all of which will have to be met before the site can achieve full approval/accreditation according to the standard. Therefore, a process cycle of gap analysis, procedure implementation and review can continue up to the point where the business feels sufficiently confident that all requirements of the chosen standard are met. At this point, the business should seek to secure the services of an accredited/authorised independent third-party audit body to assess the operation against the requirements of the standard. Once the audit has been completed, and any nonconformances raised dealt with appropriately (and within the timescales required), then the operation can be awarded certification or approval against the selected standard.

Accreditation will often be on a graded basis and usually will be for a fixed period, after which another audit will be required to ensure that the operation continues to meet the requirements of the standard, including incorporating any updates or additions to the standard since the last site assessment.

Food fraud is a significant and growing problem, driven by globalization, economic opportunity, and the low probability and severity of punishment. Although food fraud is economically motivated, it may result in serious health consequences. Therefore, emerging food fraud issues are described in this chapter, including the usage of food fraud databases. Analytical verification of food fraud and food authentication is needed to support proper food safety management systems. However, due to time and money constraints, only a restricted number of samples can be analysed in a laboratory. For analysis outside the laboratory, rapid, non-destructive, nontargeted methods are needed. This can be either handheld equipment for food safety inspectors or in-line equipment for the food manufacturers.

1.4 Quality Control in the Food Industry– Defect Identification

Quality control (QC) is a set of activities for ensuring quality in products by identifying defects in the actual products produced. It's a reactive process and aims to identify (and correct) defects in finished products.

QC can be achieved by identifying and eliminating sources of quality problems to ensure customer's requirements are continually met. It involves the inspection aspect of quality management and is typically the responsibility of a specific team tasked with testing products for defects.Quality management is the act of overseeing all activities and tasks needed to maintain a desired level of excellence. This includes the determination of a quality policy, creating and implementing quality planning and assurance, and quality control and quality improvement. It is also referred to as total quality management (TQM).

Specialisations

Within the master's programme you can choose one of the following Specialisations to meet your personal interests.

- Quality Control and Assurance
- Quality and Food Logistics
- User-oriented Food Quality
- Quality Management and Entrepreneurship

Master's Food Quality Management

The Food Quality Management Master of Science study programme offers an integrated approach to the study and assessment of quality processes in the agri-food chain through an exclusively developed techno-managerial approach. The whole supply chain is studied from the primary sector to the final consumer. Food, flowers and cattle are also discussed. This two-year MSc gives you the chance to analyse problems using both the social and life sciences. This allows you a higher level of approach on the topics of food quality, quality management, quality design, quality control, quality improvement, quality assurance, quality policy and business strategy.

Importance of Quality Control

We have identified a few reasons why brands dealing in food items must not ignore quality control:

Reduced production cost SE banner Square

By undertaking effective inspection and control in the production processes and operations, companies in the food industry can reduce their production costs considerably. Wastages and poor product quality further increase production costs. Quality control keeps tabs on the production of inferior products and wastages thereby bringing down the cost of production significantly.

Better goodwill

By producing goods of better quality and satisfying customer's needs, quality control gives a boost to the goodwill of the company in the minds of people. This consequently results in a good brand reputation and positive word-of-mouth on both offline and online channels. A reputed concern can easily raise finances from the market. Furthermore, when a company has enhanced goodwill, the chances of its survival in the highly competitive market are also high.

Facilitates Pricing

By employing quality control measures, food industry companies can ensure that uniform products of the same quality are produced. This greatly facilitates the problem of price fixation for food products. This also eliminates the worry of constantly changing the prices of commodities.

Increase sales

Quality control ensures the production of good quality products which is immensely helpful in attracting more customers to the product thereby increasing sales. It is significantly beneficial in maintaining the existing demand and also creating new demand for the company's products. Also, the rise in the use of social media has made it more essential for brands to be on their toes. Any negative comment or review by a customer could affect the brand image.

Improved techniques of production

Quality control ensures that commodities are produced at reasonable rates and the desired standards. By supplying technical and engineering data for the product and manufacturing processes, better methods and designs of production are contact Unsure by quality control.

Higher employee morale

An effective quality control system is greatly useful in increasing the morale of employees. When employees start to feel that they are working in a concern producing good and higher quality products their willingness and motivation to work towards the company's objectives tend

to increase. Also, these employees are more likely to keep up with the company's standards of quality control in their operations.

1.5 Quality Management System

A Quality Management System (QMS) is defined as a formalized system that documents processes, procedures, and responsibilities for achieving quality policies and objectives. A QMS helps coordinate and direct an organization's activities to meet customer and regulatory requirements and improve its effectiveness and efficiency on a continuous basis.

Quality management serves many purposes: -

- Improving processes
- Reducing waste
- Lowering costs
- Facilitating and identifying training opportunities
- Engaging staff
- Setting organization wide direction Requirements of quality management system: -

1. Design
2. Deploy
3. Build
4. Control
5. Measure
6. Review
7. Improve

1. **Design and Build**: -

The design and build portions serve to develop the structure of a QMS, its processes, and plans for implementation. Senior management should oversee this portion to ensure the needs of the organization and the needs of its customers are a driving force behind the systems development.

2. Deploy: -

Deployment is best served in a granular fashion by breaking each process down into subprocesses and educating staff on documentation, education, training tools, and metrics. Company intranets are increasingly being used to assist in the deployment of quality management systems.

3. Control and Measure: -

Control and measurement are two areas of establishing a QMS that are largely accomplished through routine, systematic audits of the quality management system. The specifics vary greatly from organization to organization depending on size, potential risk, and environmental impact.

4. Review and Improve: -

Review and improve detail how the results of an audit are handled. The goals are to determine the effectiveness and efficiency of each process toward its objectives, to communicate these findings to the employees, and to develop new best practices and processes based on the data collected during the audit.

These eight quality management principles form the basis of the Quality Management System standards within the ISO 9000 family.

Requirement of Quality Management System

Design and Build

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Quality management systems serve many purposes, including:

- Improving processes

- Reducing waste
- Lowering costs
- Facilitating and identifying training opportunities
- Engaging staff
- Setting organization-wide direction

QMS Certification

QMS Certification Services are responsible for auditing and certifying thousands of organisations in a range of industries, across the world. By building a strong reputation for the highest quality service, market leading pricing and simplified client process, QMS are Australia's most trusted accredited third-party International Certification Body.QMS was formed with customer service and value in mind and these aims have been embodied into every internal and external process.Our certification services are designed with a customer-first focus, to help us create and deliver value through everything we do. We strive to be proactive in enhancing the quality of our offerings, so we can proudly lead the market in certification services. Our teams are comprised of experienced professionals that have previously been involved in the development of quality management systems, either as auditors, auditees or trainers. This experience allows us to understand every aspect of management system and how to deliver optimal results consistently.

QUALITY CONTROL TOOLS

INTRODUCTION

There are seven basic quality tools, which can assist an organization for problem solving and process improvements. The first guru who proposed seven basic tools was Dr. Kaoru Ishikawa in 1968, by publishing a book entitled "Gemba no QC Shuho" that was concerned managing quality through techniques and practices for Japanese firms. It was intended to be applied for "self-study, training of employees by foremen or in QC reading groups in Japan. It is in this book that the seven basic quality control tools were first proposed. valuable resource when applying the seven basic tools (Omachonu and Ross, 2004). These seven basic quality control tools, which

introduced by Dr. Ishikawa, are : 1) Check sheets; 2) Graphs (Trend Analysis); 3) Histograms; 4) Pareto charts; 5) Cause-and-effect diagrams; 6) Scatter diagrams; 7) Control charts. Figure 1 indicates the relationships among these seven tools and their utilizations for the identification and analysis of improvement of quality (Kerzner, 2009).

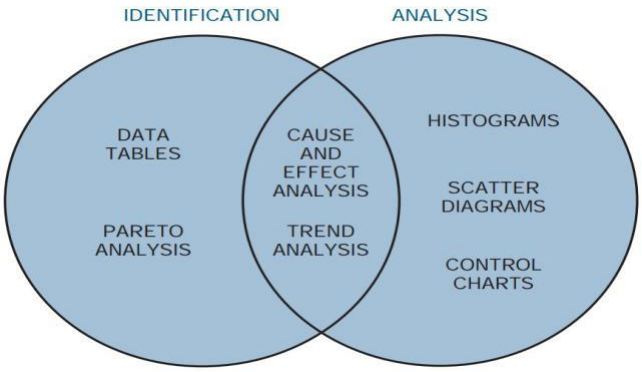

Figure 1: The seven quality control tools (Kerzner, 2009).

Check Sheet

Check sheets are simple forms with certain formats that can aid the user to record data in an firm systematically. Data are “collected and tabulated” on the check sheet to record the frequency of specific events during a data collection period. They prepare a “consistent, effective, and economical approach” that can be applied in the auditing of quality assurance for reviwing and to follow the steps in a particular process. Also, they help the user to arrange the data for the utilization later (Montgomery, 2009; Omachonu and Ross, 2004). The main advantages of check sheets are to be very easily to apply and understand, and it can make a clear picture of the situation and condition of the organization. They are efficient and powerful tools to identify frequently problems, but they dont have effective ability to analyze the quality problem into the workplace. The chech sheets are in several, three major types are such as Defect-location check sheets; tally check sheets, and; defect-cause check sheets (Kerzner, 2009). Figure 2 is depicted a tally check sheet that cn be used for collecting data during production process.

Telephone Interruptions

Reason	Day					
	Mon	Tues	Wed	Thurs	Fri	Total
Wrong number	𝍸	||	|	𝍸	𝍸 ||	20
Info request	||	||	||	||	||	10
Boss	𝍸	||	𝍸 ||	|	||||	19
Total	12	6	10	8	13	49

Figure 2: Check sheet (Tally) for telephone interruptions

Histogram

Histogram is very useful tool to describe a sense of the frequency distribution of observed values of a variable. It is a type of bar chart that visualizes both attribute and variable data of a product or process, also assists users to show the distribution of data and the amount of variation within a process. It displays the different measures of central tendency (mean, mode, and average). It should be designed properly for those working into the operation process can easily utilize and understand them. Also, a histogram can be applied to investigate and identify the underlying distribution of the variable being explored (Omachonu and Ross, 2004; Forbes and Ahmed, 2011). Figure 3 illustrates a histogram of the frequency of defects in a manufacturing process.

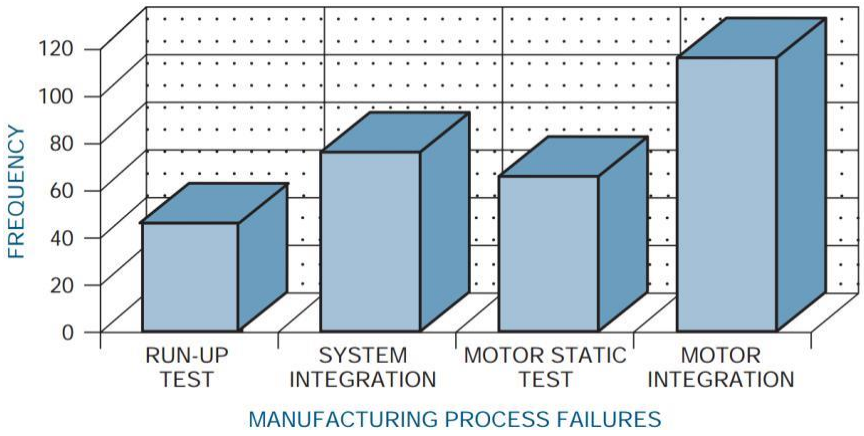

Figure 3: Histogram for variables

Pareto Analysis

It introduced by an Italian economist, named Vilfredo Pareto, who worked with income and other unequal distributions in 19th century, he noticed that 80% of the wealth was owned by only 20% of the population. later, Pareto principle was developed by Juran in 1950. A Pareto chart is a special type of histogram that can easily be apply to find and prioritize quality problems, conditions, or their causes of in the organization (Juran and Godfrey, 1998).. On the other hand, it is a type of bar chart that shows the relative importance of variables, prioritized in descending order from left to right side of the chart. The aim of Pareto chart is to figure out the different kind of "nonconformity" from data figures, maintenance data, repair data, parts scrap rates, or other sources. Also, Pareto chart can generate a mean for investigating concerning quality improvement, and improving efficiency, "material waste, energy conservation, safety issues, cost reductions", etc., as Figure 4 demonstrated concerning Pareto chart, it can able to improve the production before and after changes (Montgomery, 2009; Kerzner, 2009; Omachonu and Ross, 2004).

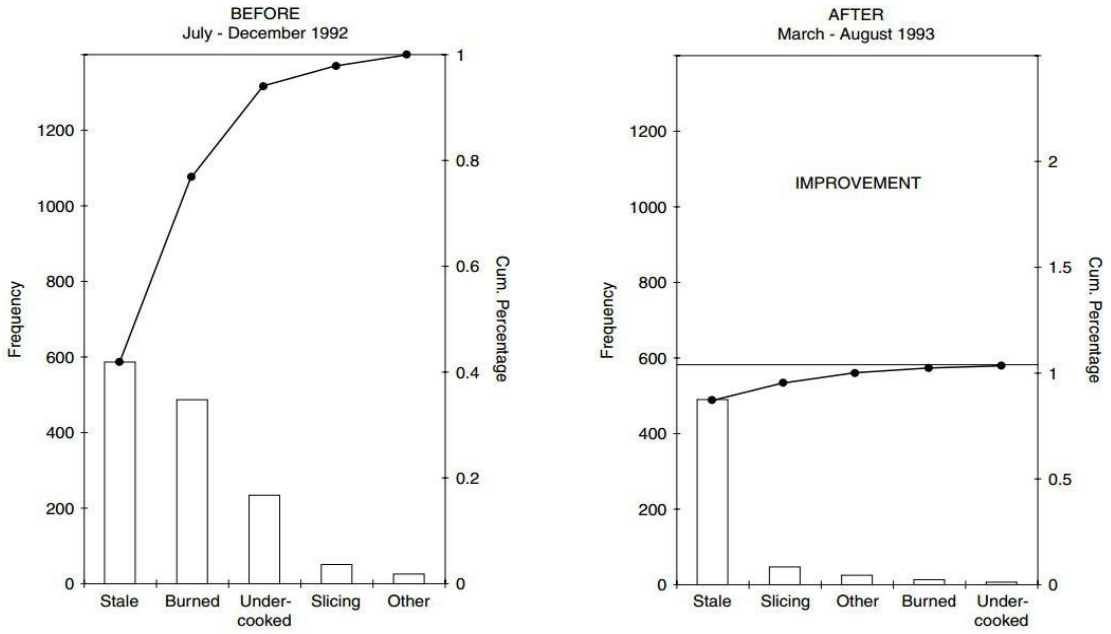

Figure 4: Pareto Charts

Fishbone Diagram

Kaoru Ishikawa is considered by many researchers to be the founder and first promoter of the 'Fishbone' diagram (or Cause-and-Effect Diagram) for root cause analysis and the concept of Quality Control (QC) circles . Cause and effect diagram was developed by Dr. Kaoru Ishikawa in 1943. It has also two other names that are Ishikawa diagram and fishbone because the shape of the diagram looks like the skeleton of a fish to identify quality problems based on their degree of importance (Neyestani, 2017). The cause and effect diagram is a problem-solving tool that investigates and analizes systematically all the potential or real causes that result in a single effect. On the other hand, it is an efficient tool that equips the organization's management to explore for the possible causes of a problem (Juran and Godfrey, 1998). This diagram can provide the problem-solving efforts by "gathering and organizing the possible causes, reaching a common understanding of the problem, exposing gaps in existing knowledge, ranking the most probable causes, and studying each cause" (Omachonu and Ross, 2004). The generic categories of the cause and effect diagram are usually six elements (causes) such as environment, materials, machine, measurement, man, and method, as indicated in Figure 5. Furthermore, "potential causes" can be indicated by arrows entering the main cause arrow (Neyestani, 2017).

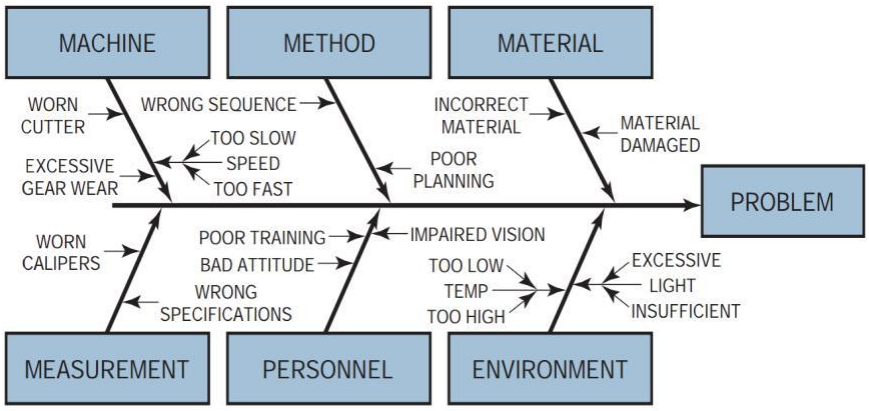

Figure 5: The cause and effect diagram (Fishbone Diagram)

Scatter Diagram

Scatter diagram is a powerful tool to draw the distribution of information in two dimensions, which helps to detect and analyze a pattern relationships between two quality and compliance variables (as an independent variable and a dependent variable), and understanding if there is a

relationship between them, so what kind of the relationship is (Weak or strong and positive or negative). The shape of the scatter diagram often shows the degree and direction of relationship between two variables, and the correlation may reveale the causes of a problem. Scatter diagrams are very useful in regression modeling (Montgomery, 2009; Oakland, 2003). The scatter diagram can indicate that there is which one of these following correlation between two variables: a) Positive correlation; b) Negative correlation, and c) No correlation, as demonstrated in Figure 6.

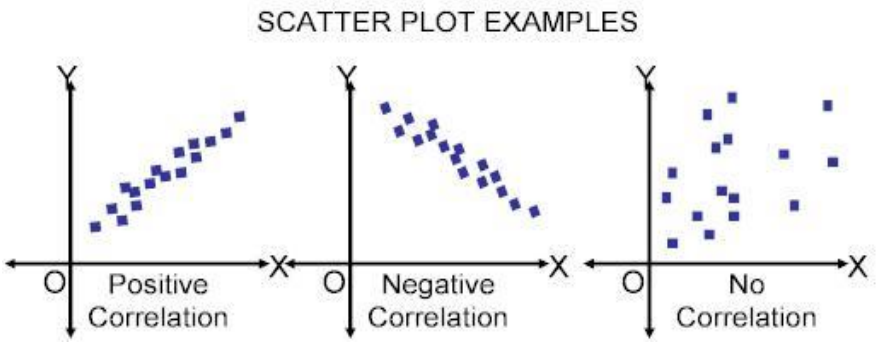

Figure 6: Scatter Diagrams

Flowchart

Flowchart presents a diagrammatic picture that indicats a series of symbols to describe the sequence of steps exist in an operation or process. On the other hand, a flowchart visualize a picture including the inputs, activities, decision points, and outputs for using and understanding easily concerning the overall objective through process. This chart as a problem solving tool can apply methodically to detect and analyze the areas or points of process may have had potential problems by "documenting" and explaining an operation, so it is very useful to find and improve quality into process (Forbes and Ahmed, 2011), as shown in Figure 7.

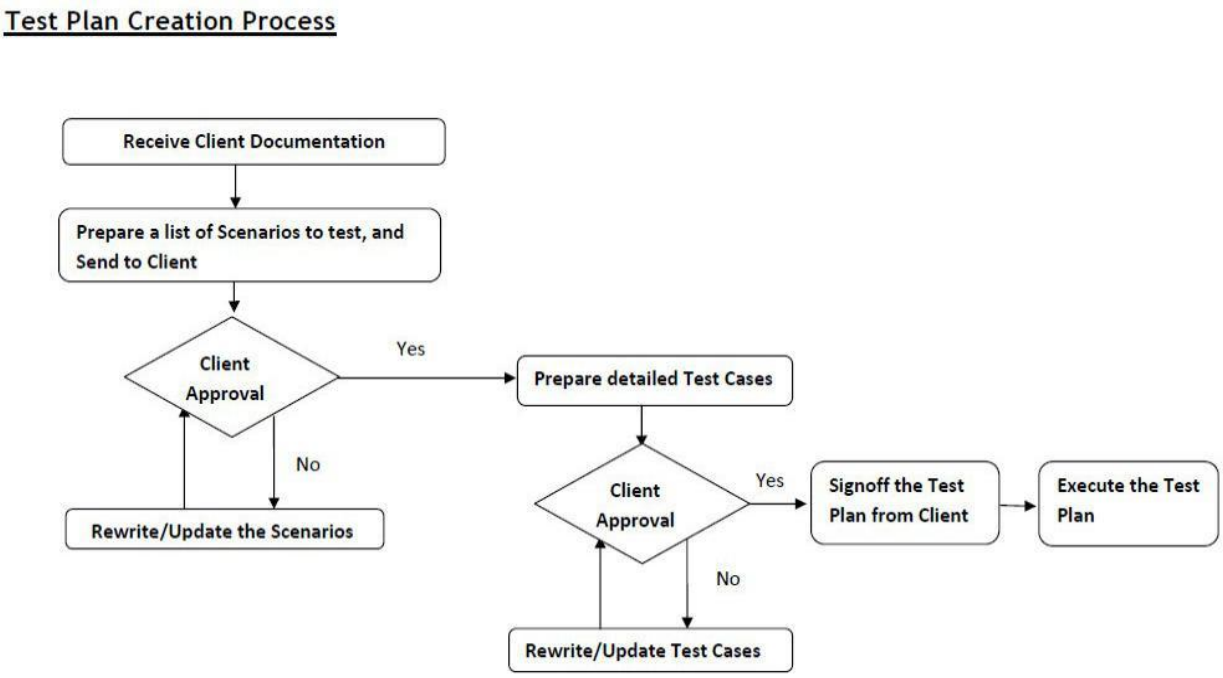

Figure 7: Flow chart of review process

Control Chart

Control chart or Shewhart control chart was introduced and developed by Walter A. Shewhart in the 1920s at the Bell Telephone Laboratories, and is likely the most "technically sophisticated" for quality management (Montgomery, 2009). Control charts is a special form of "run chart that it illustrates the amount and nature of variation in the process over time". Also, it can draw and describe what has been happning in the process. Therefore, it is very important to apply control chart, becaust it can observe and moniter process to study process that is in "statistical control" (No problem with quality) accordant to the samplings or samplings are betwwen UCL and LCL (upper control limit (UCL) and the lower control limit (LCL)). "statistical control" is not between UCL and LCL, so it means the process is out of control, then control can be applied to finde causes of quality problem, as shown in Figure 8 that A point is in control and B point is out of control. In addition, this chart can be utilized for estimating "the parameters" and " reducing the variability" in a process (Omachonu and Ross, 2004). The main aim of control chart is to

prevent the defects in process. Itt is very essentialiy for different businesses and industries, the reason is that unsatisfactories products or services are more costed than spending expenses of prevention by some tools like controlcharts (Juran and Godfrey, 1998). A Control Chart is presented in the following Figure.

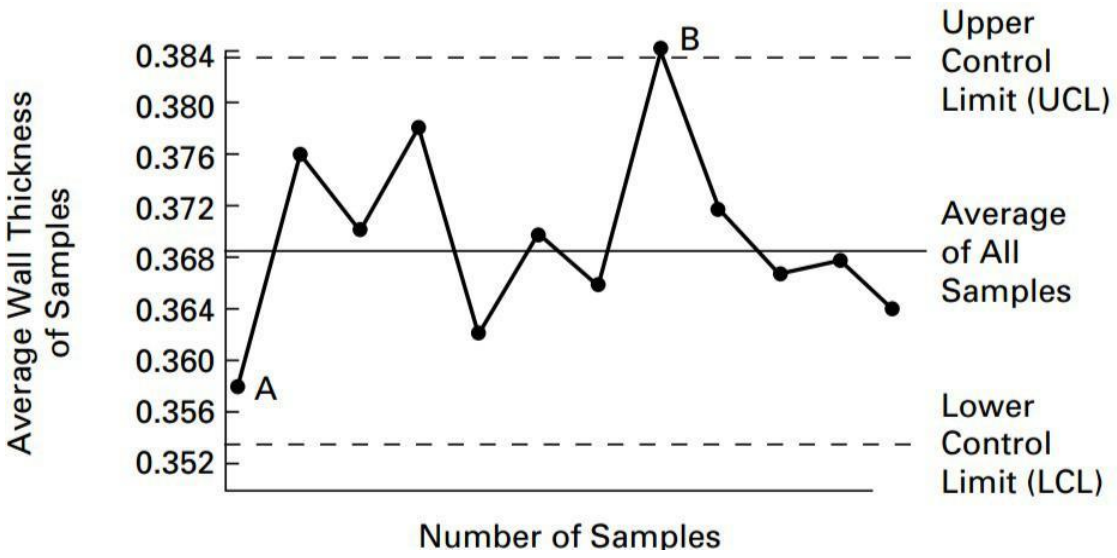

Figure 8: The Shewhart control chart

CONCLUSION

This study identified that is very essential to apply all seven QC tools for troubleshooting issues within production processes in the organizations. Doubtlessly, all of the aforementioned quality tools should be considered and used by management for identifying and solving quality problems during producing the products and services. Thus, the production processes can be affected and improved by multiple factors of these statistical QC tools. Also, Mirko et al. (2009) designed and developed an effective layout for using these QC in the organizations based on the performance of them, in order to apply appropriately these quality tools for solving quality problems and quality improvement, as demonstrated in Figure 9. Accordingly, the following Figure interprets

how the 7 QC should be employed from firs step to end of production processes for identifying the problems of quality performance and controlling them.

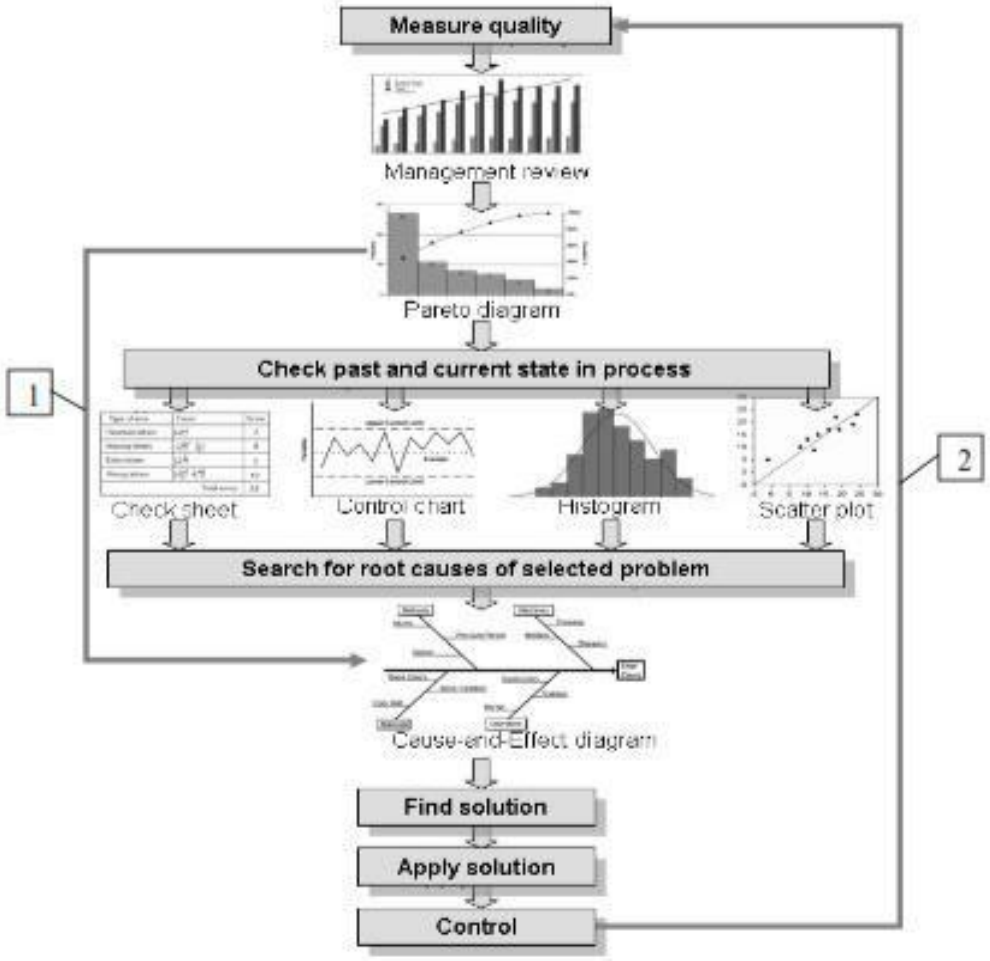

Figure 9: An appropriate layout for using 7QC tools with the aim of improving extremely quality performance

Questions:-

1) Enlist Different Quality assessment Models.
2) What are the 7 QC Tools?

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Chapter 8

Indian Food Laws and Regulations

United Nations Food Safety Resolutions and Other Actions In 2002, the United Nations in cooperation with consumer organizations drafted and eventually adopted guidelines for consumer protection that urges governments to "give priority to areas of essential concern for the health of the consumer, such as food, water, and pharmaceuticals. . . . Governments should maintain, develop or improve food safety measures, including, inter alia, safety criteria, food standards and dietary requirements and effective monitoring, inspection and evaluation mechanisms." These international resolutions attest to the growing urgency of food safety. As food is increasingly traded globally, food safety has become a global public health issue. Dialogue between the United Nations' specialized agencies and groups representing consumers' interests is vital to improving national programs and protecting all consumers. Valuable contributions have been made by the longstanding involvement of international consumer organizations like Consumers International and the growing involvement of the International Association of Consumer Food Organizations in the work of the Codex Alimentarius Commission and its subsidiary bodies that deal with health and safety issues. Looking closely on the above positions on international food standards governance, we find that there are mainly three sites of contestations; the first is the CODEX itself, wherein the international norms and guidelines are being formulated; the second one is the WTO, wherein CODEX non-conforming national regimes can be legally challenged through the dispute settlement process; and the third one (and also perhaps the most dynamic and most interesting) has been the bilateral trade agreements between the two largest trade blocks (viz. the USA and the EU) and the developing countries (Chowdhury and Kumar,2008) .

Intergovernmental Standards: Emergence of the Codex Alimentarius Standards The intergovernmental body for the development of internationally recognized standards for food is the Codex Alimentarius Commission (CAC). The Codex Alimentarius Commission (Codex) was established in 1962 in Rome, Italy as an intergovernmental agency of the United Nations under the Food and Agriculture Organization and the World Health Organization (WHO). Currently the Codex Alimentarius Commission has 188 Codex Members - 187 Member Countries and 1 Member Organization (EU); 234 Codex Observers - 54 IGOs, 164 NGOs, 16 UN. The voting members (one State, one vote) for the development of the Codex standards are the national agencies, departments or ministers that regulate the production of food, rather than the national

standard organizations that vote for the development of ISO standards. Membership of the Commission is open to all Member Nations and Associate Members of FAO and WHO which are interested in international food standards. Regional economic integration organizations that are members of either FAO or WHO can also become members and special rules apply.6 The Codex Alimentarius Commission develops science-based standards taking into account the scientific advice provided by FAO/WHO expert bodies and ad hoc consultations and meetings. Codex committees, when developing standards, apply risk analysis and rely on the independent scientific advice from those FAO/WHO expert committees. Risk analysis is fundamental to the scientific basis of Codex food safety standards. Risk analysis within Codex is a structured, systematic process that examines the potential adverse health effect consequential to a hazard or condition of a food, and develops options for mitigating that risk. This also includes interactive communication among all interested parties involved in the process. Within Codex Alimentarius Commission and its procedures, the responsibility for providing advice on risk management lies with the Commission and its subsidiary bodies (risk managers), while the responsibility for risk assessment lies primarily with the joint FAO/WHO expert bodies and consultations (risk assessors). The three independent international risk assessment FAO/WHO expert committees are: Joint FAO/ WHO Expert Committee on Food Additives (JECFA): performs toxicological evaluation for food additives, contaminants, naturally occurring toxicants and residues of veterinary drugs in food. India is a Codex member since 1964. The National Codex Contact point is the Food Safety Standards Authority of India7 with its head office at New Delhi. It coordinates and promotes Codex activities in India in association with the National Codex Committee and facilitates India's input to the work of Codex through an established consultation process. The FSSAI has appointed the Shadow Committees of the NCC on subject matters corresponding to the Codex Committees to assist the NCC in the study or consideration of technical matters. Officers in the rank of Joint Secretary or above in the concerned Department/Ministry / Food Authority who handle the subject at the policy level and also serve as the members of the NCC may be nominated as the Chairpersons of these Shadow Committees. Specialized experts in the relevant field may be nominated as members of these Shadow Committees. Historical Background of Regulatory Framework for Foods in India Till the advent of 21st century, a number of different laws governed the food processing sector in India. The

prevailing laws/regulations adopted by the Government to verify the quality of food and drugs prescribe varied standards regarding food additives, contaminants, food colours, preservatives and labeling. In order to rationalize the multiplicity of food laws, a Food Safety Standards Authority of India(FSSAI) was recently set up to suggest legislative and other changes to formulate a modern, integrated food law, which would be a single reference point in relation to the regulation of food products.

The Food Safety and Standards Authority of India (FSSAI)

The FSSAI has been established under Food Safety and Standards Act, 2006 which consolidates various acts & orders that have hitherto handled food related issues in various Ministries and Departments. FSSAI has been created for laying down science based standards for articles of food and to regulate their manufacture, storage, distribution, sale and import to ensure availability of safe and wholesome food for human consumption.8 Amongst the Government agencies, the Food Safety and Standards Authority of India (FSSAI) is the regulatory body responsible for food safety and quality issues across the country. Food Safety and Standards Act, 2006 consolidates various acts and orders that have hitherto handled food related issues in various Ministries and it is in turn implemented through the food control authorities in respective states. Thus, in Gujarat state, it is the Food and Drug Control Administration, Gandhinagar. With the mandate of laying down science based standards for food, FSSAI proposes to support research projects and related innovative R&D proposals pertaining to food safety and quality control by extending financial assistance to various institutions/Universities and recognized R&D laboratories. The Head Office of FSSAI is in New Delhi and it falls under the purview of Ministry of Health & Family Welfare. The Regional offices are located in four major zones, i.e., Northern, Western, Southern and Eastern. A former Senior official9 , based in Delhi, informed that “the Food Safety and Standards Act was enacted in the year 2006, to consolidate the multiple laws relating to food and to establish the Food Safety and Standards Authority of India for laying down science based standards for articles of food and to regulate their manufacture, storage distribution, sale and import, to ensure availability of safe and wholesome food for consumers. It provides for legal powers and specifies offences in relation to public health and consumers’ interest; and allows shifting from regulatory regime to self-compliance through Food

Safety Management system." He further stated that "the Food Safety & Standards Authority of India is the principal Government Authority responsible for preparing specific regulations under the Act". Ministry of Health & Family Welfare, Government of India is the Administrative Ministry for the implementation of FSSAI. The Chairperson and Chief Executive Officer of Food Safety and Standards Authority of India (FSSAI) are appointed by Government of India. The Chairperson is in the rank of Secretary to Government of India.

IMPLEMENTATION OF FOOD SAFETY LAWS

The existing levels of implementation of food laws vary from state to state, depending on the priorities attached to them, the resources made available and the leadership provided. The contribution of the State Governments and the local bodies will be critical to the effective implementation of the food laws in the country. The primary role assigned to local bodies is licensing as well as monitoring of foods as per the FSSAI regulations. A very senior official10 informed that "FSSAI is mandated to streamline the procedures for licensing and registration. Currently each state has its own procedure for licensing and registration, and this prevents comparison and coordination between states." However he desired that a common platform and format for such licensing and registration should be developed by FSSAI. Such a portal should be IT enabled so that it can be easily accessed by the regulator for prompt response. In this regard, the researcher requested for interviews with the Food Safety Commissioner, Gujarat State. The request was directed to two senior Food Safety Officers based at Food and Drug Control Authority (FDCA), Gandhinagar. In depth interview was conducted on 26th February 2015. The queries were based on the Interview schedule (Annexure -3). The responses received were basically sourced from within the FSSAI Act and Regulations, 2011. The food safety officers were forthcoming about the shortage of staff and extreme work load and other such limitations. They informed about the annual schedule of sampling and testing of food products accordingly in the respective jurisdictions. One of them revealed that "a number of complaints received by us are actually found to be cases of personal rivalries or other such petty issues. Genuine complaints are far less in number than such false ones". Thus, interestingly though, they need to take extra precaution with respect to sampling and enquiry for that matter.

FOOD SAFETY AND STANDARDS REGULATIONS The Food Safety and Standards Regulations, 2011 were notified in the Gazette of India dated 1st Aug 2011 and came in force after 5th Aug 2011. The important regulations are regarding --food product standards and food additives; prohibition and restriction on sales; contaminants, toxins and residues; laboratory and sampling analysis. The Food Safety and Standards Authority of India has specified — Food Safety and Standards (Food Products Standards and Food Additives) Regulations, 2011. These regulations specify the requirements for various food articles. Ex-Chairperson20warned that product approval by a team of officers is no guarantee of food safety. The food item has to be manufactured safely in line with the standards and this can only be ensured by insisting that industry follow verifiable process standards on a day to day basis get certified by accredited agencies and be subject to risk-based inspections. Even an advanced country like the US is able to inspect only 1% of the total food produced in the country. What other countries have done is to lay down easily understood safety standards and guidance documents for ensuring compliance. They intervened only when malfeasance was detected.

COMPARISON AGAINST CODEX ALIMENTARIUS When we compared these FSSA standards against the International Codex Standards, it is observed that in case of Codex, Standards belonging to a common subject group have been grouped and are available in separate editions of the Codex Alimentarius.21 The complete list of standards (including text) adopted by Codex Alimentarius Commission is also available on line. The standards may include Guidelines (GL), Maximum Residue Limit (MRL), Standards (STAN), Recommended Code of Practice (RCP) and/ or General Principles. Codex has made available online database -Codex General Standard for Food Additives (CGSFA), Veterinary Drug Residue in Foods and Pesticide Residues in Food and Feed. The Codex Alimentarius or "Food Code" was established by FAO and the World Health Organization in 1963 to develop harmonized international food standards, which protect consumer health and promote fair practices in food trade. Thus most of the standards here serve as guidelines or baselines for working up the national standards for domestic and/ or trade purposes. Indian regulations on foods have been devised with the approach and objectives that suit the nation’s interests and ideology. Thus when compared both Codex and FSSAI are principally committed to formulate Science based standards. Codex International, as previously discussed is an intergovernmental body and India is a member.

Codex Alimentarius establishes guidelines for quality, safety, nutrition and other important aspects of foods. It can act as a blue print, to be suitably modified to a country's needs and conditions. Many of the Indian regulations are modeled on the fundamental guidelines given by the Codex. This is perceived as an act of avoiding duplication of research activities over already established standards and saves on time technical, human & financial resources.

Questions:- 1)State the food safety Laws in India.

2) Write a Short note on FSSAI

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Chapter 9

Codex Alimentarius and WTO

The Codex Alimentarius Commission The Codex Alimentarius Commission was established in 1962 as a joint effort of the U.N. World Health Organization and the U.N. Food and Agricultural Organization. Its current membership is over 160 countries. Its official mandate is to implement the Joint FAO/WHO Food Standards Programme, among the aims of which are: —

- To protect the health of consumers and to ensure fair practices in the food trade;
- To promote coordination of all food standards work undertaken by international governmental and non-governmental organizations;
- To determine priorities and initiate and guide the preparation of draft standards through and with the aid of appropriate organizations;
- To finalize standards.

The major work of the Commission is to compile the Codex Alimentarius, a 13- volume tome of internationally accepted voluntary food safety standards. Codex standards address the hygienic and nutritional quality of food (including microbiological norms), food additives, pesticide residues, contaminants, labelling and presentation, and methods of analysis and sampling. The Codex also includes provisions of an advisory nature: codes of practice, guidelines and other recommended measures. The Commission, served by a six-person Secretariat based in Rome at FAO, meets every two years to adopt new standards, guidelines and recommendations, and to assign new work to its Committees. Over two hundred non-governmental organizations have observer status with the Commission. Most of these are industry representative groups, but there are a handful of public interest groups as well. The Committees of the Codex do the work of preparing proposed draft standards. Codex produces two types of standards: commodity standards, applicable to specific commodities (for example, processed fruits and vegetables, or fish and fisheries products); and general standards, which are crosscutting and applicable to all types of food, such as food labelling, food additives and food hygiene. For this latter type of standard there are nine ―general subject‖ or ―horizontal‖ Committees, each hosted by a member country responsible for administration, chairing and financial support. The Food Labelling Committee is hosted by Canada, for example, and France hosts the Committee on General Principles. For product-specific standards there are 16 ―commodity‖ or ―vertical‖ Committees, again hosted by member countries. There may be as many as 20 Committee

meetings in one year. There are also five regional Committees working on regional standards, and three ad hoc intergovernmental task forces with Committee-like responsibilities. The Committees submit proposed draft standards to the Commission for its consideration. The Commission then decides whether to adopt them as draft standards. Draft standards go through a consultation procedure with member countries and interested international organizations, involving specified steps (ranging from 5 – 8, depending on the circumstances) and usually lasting several years. If the process is successful, the draft standard becomes a Codex standard and is added to the Codex Alimentarius. Even after adoption, Codex standards are voluntary, though most countries choose to accept most standards. The Codex takes great pains to focus its work on a foundation of scientific inquiry. ―The food standards, guidelines and other recommendations of Codex Alimentarius shall be based on the principle of sound scientific analysis and evidence, involving a thorough review of all relevant information, in order that the standards assure the quality and safety of the food supply. Codex members rely on outside help in this regard. There are two standing expert groups that feed the Codex process: the Joint FAO/WHO Expert Committee on Food Additives and the Joint FAO/WHO Meeting on Pesticide Residues, established in 1955 and 1963 respectively. On standards not related to these two areas, Codex convenes expert consultations on an ad hoc basis. Both the expert groups and the consultations make recommendations to Committees on proposed draft standards. The Problem of Uncertainty Despite its expert mechanisms, the Codex increasingly faces a critical problem: scientific uncertainty. This basic problem is not new; mankind has been making policy decisions under uncertainty in one form or another for as long as we have existed. Since nothing can be definitely proven by science – we merely operate on the hypothesis that best fits the facts at any given time ―any standard setting or regulatory body makes such decisions on a regular basis. There are at least four trends that are aggravating the problem for Codex:

1. Growth of new technologies

2. Increasing environmental degradation, and public concern

3. Explosive growth in world trade

Growth of new technologies. The last decade has seen enormous growth in new technologies and products of interest to standard setters, particularly in the biotechnology and chemicals sectors. The speed of that growth has been such that we have not been able to assess the human health and environmental implications of a number of the new innovations on which we now rely. Of the 70,000 chemicals in commercial use in the United States in 1995, only 2% had been fully tested for human health effects, with 70% not tested for health effects of any kind. And testing on synergistic effects – the effects of more than one chemical encountered in combination – are almost non-existent. Neither have the food products of biotechnology begun to be rigorously tested, particularly in the US where they are assumed to be substantially equivalent to the unmodified varieties. The result is a widening gap between the progress of innovation and the progress of assessment. The larger the gap, the larger the degree of uncertainty with which the regulatory and standard-setting bodies will have to deal in discharging their responsibilities. Increasing environmental degradation: The most recent UNEP survey of the global environment confirms that on almost every indicator of environmental quality we have made little progress in slowing the continuing degradation of the natural environment. This has led to increasing public concern about both the state of the environment and human health implications. These trends translate into increased demands on standard-setters and regulators to protect the public interest. But the environment is, in most of its manifestations, too complex for science to yield certainties as the basis for regulation or standard setting. Climate change is an excellent example: despite the diligent efforts and years of work by what may be the largest collective scientific effort in human history, including but not confined to the 200 member Intergovernmental Panel on Climate Change, we still have no hope of fully understanding the complexities of the interactions of the atmosphere, the oceans and greenhouse gases. This type of complexity is the rule, rather than the exception, in ecosystems. An increasingly urgent need for action in the area of the environment, then, forces regulators and standard setters to increasingly deal with uncertainty. Explosive growth in world trade: Since 1950, the gross world product has increased by a factor of five, while world trade in that time has increased by a factor of fourteen. So internationally traded goods constitute a larger and larger portion of our economies. In a globalized world, the importance of national level standards is intensified. In the context of sustainable development, those whose PPM-based standards are lower than others are suspected of creating pollution

havens to attract investments, and those whose standards are higher are suspected of using standards as a strategic barrier to trade, unfairly protecting domestic producers. As trade volumes grow, the commercial implications of any standards decision become that much greater. The WTO's SPS Agreement: The World Trade Organization was created in 1995, taking under its umbrella the various agreements existing around the General Agreement on Tariffs and Trade, and various new agreements resulting from the Uruguay Round of multilateral negotiations. One of these new agreements was the Agreement on Sanitary and Phytosanitary Measures (SPS). In this agreement, Codex was named as one of five recognized bodies for setting international standards. With the stroke of a pen, in an agreement not of its own making, the Codex was thus fundamentally changed. The SPS Agreement places a number of restrictions on domestic standards to protect human, plant and animal life and health. The measures in question should not be more trade-restrictive than necessary to achieve their objectives, nor should they be applied so as to create arbitrarily different treatment for comparable situations, either domestically or between countries. They should not be applied in such a way as to create disguised barriers to trade and, with limited exceptions for interim measures, must be based on scientific principles and not maintained without sufficient scientific evidence. This is a tough list of requirements, but the SPS Agreement allows that it can be completely avoided by countries that follow international standards – in this case, Codex standards.11 For this reason, the language in the SPS completely changed the character of the Codex. The Commission was originally designed to act as a consensus shop on voluntary standards, which would serve as guidelines to those in need of technical assistance. Its standards were thought by many to be a useful floor,12 but the WTO language in effect made Codex standards more like a ceiling, beyond which onerous requirements are in effect. Such standards cannot be called fully voluntary, nor are they fully mandatory, falling into an area in between which looks like voluntarism under duress. The instant effect was to transform standard setting in the Codex into a highly charged political exercise; all countries knew that the standards they were debating might subsequently be the subject of WTO dispute settlement, and acted accordingly. It would be a mistake for those in other standard setting bodies to think that this particular driving factor only applies to the Codex. It will undoubtedly manifest itself in other contexts as well. For example, it is likely that some governments in the process of greening their procurement practices will

simply rely on existing regimes, such as national level ecolabel schemes or ISO 14001, instead of establishing their own standard, certification and verification practices. 13 Such standards would, in that case, no longer be completely voluntary – they would become government-mandated conditions of sale for a substantial portion of the markets in question. They would be voluntarism under duress. In summary, the basic problem of uncertainty has been aggravated for Codex, first by the advent of new technologies and the rise of environmental concern, which ensure that the Commission will deal increasingly with uncertain science, and second by the language of the SPS and the explosion of international trade, which raise the stakes in any such dealings.

Questions:-1) What is the role and purpose of Establishment of Codex Alimentarius.

2) Explain the roles and functions of WTO?

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Chapter 10

FOOD AND AGRICULTURE ORGANISATION

The Food and Agriculture Organisation (FAO) is a specialized agency of the United Nations that leads international efforts to defeat hunger. Food and Agriculture Organisation (FAO)

The FAO is a specialized agency of the United Nations.

- Established in 1945, the Food and Agriculture Organisation (FAO) has its headquarters in Rome, Italy.
- It was founded with a goal to provide food security for everyone and assure that people will have access to high-quality food in sufficient quantities to achieve a healthy lifestyle.
- Every year, the FAO publishes a number of major 'State of the World' reports related to food, agriculture, forestry, fisheries and natural resources.

FAO Members

The FAO has 197 member countries, which includes the European Union as well. It conducts biennial conferences. The FAO Council is the executive arm of the governing body. The members elect the Council which is composed of 49 members.

FAO Council

The FAO Council was established in 1947 at the FAO Conference that replaced the original "Executive Committee of FAO". This was in accordance with the recommendation of the Preparatory Commission of FAO on World Food Proposals.

Note: The Council, within the limits of the powers, acts as the Conference's executive organ between sessions.

Role and Functions of Food & Agriculture Organisation (FAO)

Food and Agriculture Organisation (FAO) is a global organisation and its functions can be listed as follows:

- Helping Governments and Development Agencies coordinate their activities which are targeted to develop and improve agriculture, fisheries, forestry and other water and land resources.
- Conducting research and providing technical assistance to various projects related to improving agricultural output and development.
- Conducting training and educational programs and also collecting and analyzing agricultural data to improve yield and production.
- The FAO also brings out a number of publications/reports, some of which are, the State of the World, the Global Report on Food Crises, the State of Food and Agriculture, the State of the World's Forests, etc. Other functions include dealing with matters related to Food and Agriculture around the world. It also executes current and prospective activities of the Organisation including its Programme of Work and Budget, administrative matters and financial management of the Organisation and constitutional matters.

FAO and India

The Food and Agricultural Organisation of the United Nations has enjoyed a valuable partnership with India since it began operations in 1945. It continues to play a major role in India's progress in the areas of crops, livestock, fisheries, food security, and the management of natural resources. FAO began its operations in India in 1948. It has an office in New Delhi. The nodal ministry for FAO in India is the Ministry of Agriculture.

- The main objective of the Indian Government is to double the income of farmers by increasing efficiency and ensuring equity in a sustainable manner.
- The NITI Aayog is the country's premier policy-making institution that is expected to bolster the economic growth of the country. Its various policies and agendas represent the encircling framework for the Agricultural Sector.

Priority Areas	
Sustainable and improved agricultural productivity and increased farm incomes	Stronger food and nutrition security systems
Effective natural resource management, community development and assistance in transboundary cooperation to the global public good	Enhanced social inclusion, improved skills and employment opportunity in the agriculture sector

The FAO Council also approved India's membership to the **Executive Board of the United Nations World Food Program (WFP) for 2020 and 2021**.

FAO's mandate, written into the Preamble of the FAO Constitution, consists of four functions: information gathering and dissemination, formulation of policy recommendations, provision of technical assistance, and assistance to governments with FAO-related obligations. These functions serve the following goals:

- Help eliminate hunger, food insecurity, and malnutrition
- Make agriculture more productive and sustainable
- Reduce rural poverty
- Ensure inclusive and efficient agricultural and food systems
- Protect livelihoods from disasters

About one in nine people suffer from chronic hunger, most of them in the developing world, and as many as one in three people are currently affected by micronutrient deficiency, so-called "hidden hunger." Despite some progress, achieving the target of halving hunger from its 1990 level by 2015 remains uncertain. Indeed, global food demand is projected to increase 70% by 2050. Issues such as climate change; higher energy and fuel prices; surging demand for meat , fish, eggs and dairy products; and continued rapid population growth combine to make reducing hunger a complex global challenge. These challenges highlight the importance of an international architecture to

(i) monitor the performance of global food and agricultural systems,

(ii) ensure that countries can provide food security for their populations, and

(iii) promote cooperation among nations in solving problems related to food and agriculture systems.

What sets the FAO apart from similar international agencies is its ability to provide what experts call 'global public goods'. These are goods which are available to all; consumption by one person does not diminish the supply for another, and no one can be barred from consuming the good. The kinds of global public goods that the FAO provides include (but are not limited to) basic research, global analysis, statistics, and advocacy on food policy and agricultural development. The FAO uses its wide network of experts, including agricultural experts, nutritionists, economists and social scientists, to provide these essential services. This information allows ministers and national and international leaders to plan for the future and design policies that meet the needs of rural and food insecure people. The other Rome-Based Agencies (WFP and IFAD) primarily provide resources such as direct food aid (WFP) and loans and grants (IFAD) rather than public goods. The FAO is comprised of 194 member-states, as well as the European Union, Faroe Islands and Tokelau. The FAO has eight departments: Agriculture and Consumer Protection; Economic and Social Development; Fisheries and Aquaculture; Forestry; Corporate Services, Human Resources and Finance; Natural Resources Management and Environment; and Technical Cooperation. Three entities comprise the top-level of FAO's governance structure: the Conference, Council, and Director-General. The FAO Conference is the plenary body of member states, which meets every two years to review FAO's work, approve a "Programme of Work and Budget" for each biennium, elect the Council and Director-General when their terms expire, and take other decisions as appropriate. Each member state receives one vote in the Conference, and most decisions are made by simple majority, while constitutional changes require a two-thirds majority. In most matters, the Conference approves the proposals presented to it unanimously, although in past years, contentious negotiations over the level of the budget have taken place. The Council fulfills the role of an "executive board," with responsibility for operational and management policies. Forty-nine member countries sit on the Council, with each of 7 regional groups entitled to an agreed number of seats. In practice, the Council makes many of the final decisions on new organizational policies before they are

presented to the Conference for endorsement. Prior to consideration by the Council, many new proposals or reports go before the smaller Programme and Finance Committees or the appropriate technical committee (e.g., Committee on Fisheries). The Director General is the head of the FAO Secretariat and its senior management team. The Office of the Director-General is responsible for preparing a budget, strategic plans, and other proposals for approval by the governing bodies, as well as having final responsibility for the day-to-day management of the organization. Like other UN specialized agencies, the FAO is funded by assessed (obligatory) and voluntary contributions by member states. Member states' assessed contributions are established at the biennial FAO conference. The regular budget for 2014-2015 is USD 1 billion, and voluntary contributions, which support technical and emergency assistance to governments, are expected to approach USD 1.4 billion. The IEE was a comprehensive assessment of the FAO, described by the team that conducted it as "probably the largest and most ambitious evaluation ever attempted of a global intergovernmental organization". It culminated in a report published in 2007. The IEE recommended far-reaching reforms, including the development of a Strategic Framework, investments in governance, a change of the institutional culture, a reform of the organization's administrative and management systems, and a far-reaching restructuring to increase effectiveness and efficiency in both headquarters and the field. The IEE characterized the situation at the time as a make-or-break moment for FAO; if meaningful reforms did not take place to address the organization's weaknesses, the decline in funding and capacity could threaten FAO's future relevance. On the other hand, it was agreed that FAO exists to address a very real need, and the IEE considered that a substantial overhaul could ultimately reverse its decline. Following the publication of the IEE report, a comprehensive reform process was approved by members, resulting in a reform process. In 2008, FAO agreed to implement an "Immediate Plan of Action of FAO Renewal" (IPA) which included more than 270 reform actions, including the introduction of ResultsBased Management, decentralization and human resources management reforms. Although a few elements of the IPA are still being implemented, they are expected to be completed by the end of 2013, and the IPA is now officially considered complete.

Questions:- 1) Explain the role of Food and Agriculture Organisation

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Chapter 11

HACCP AND ITS APPLICATIONS

Introduction Traditionally, the Hazard Analysis and Critical Control Point (HACCP) methodology has been considered to be a food safety management system. It aims to prevent known hazards and to reduce the risks that they will occur at specific points in the food chain. The same principles are also increasingly being applied, in other industries, such as the car industry, aviation and the chemical industry. This text provides general guidance on the use of the HACCP system to ensure the quality of pharmaceuticals, while recognizing that the details of its application may vary depending on the circumstances (see Appendix 1). It does not provide detailed information on major hazards. Hazards affecting quality are controlled to a certain extent through the validation of critical operations and processes in the manufacture of finished pharmaceutical products in accordance with Good Manufacturing Practices (GMP). However, GMP do not cover the safety of the personnel engaged in manufacture, while both aspects are covered by HACCP. Procedures, including GMP, address operational conditions and provide the basis for HACCP.

HACCP is a systematic method for the identification, assessment and control of safety hazards. Such hazards are defined as biological, chemical, or physical agents or operations that are reasonably likely to cause illness or injury if not controlled. In the manufacture of pharmaceuticals,1 these may include the manufacture of certain antibiotics, hormones, cytotoxic substances or other highly active pharmaceuticals, together with operations such as fluidbed drying, granulation is an example of hazard unit operations. The use of inflammable solvents (solutions) and certain laboratory operations may also constitute hazards. The following elements of the HACCP methodology are integral parts of the validation master file: — development of a flow diagram of the process; — verification of the flow diagram on site. In addition, HACCP will extend this concept to include an analysis of the critical quality variables as well as the assessment of hazards affecting the safety of workers and environmental pollution hazards directly related to the process (in particular in open systems) concerned. GMP for pharmaceutical products require the validation of critical processes as well as of changes in the manufacturing process which may affect the quality of the final product. Experience shows that most manufacturing processes contain steps that are “critical” from the point of view of variations in

final product quality. HACCP should not be confused with validation since its approach is broader; it thereby helps to identify matters on which validation should concentrate. It is science-based and systematic, and identifies specific hazards and measures for their control, as well as providing information on environmental protection and labour safety. HACCP is a tool to assess hazards and establish, control systems that focus on prevention rather than relying on corrective action based on endproduct testing.

All HACCP systems are capable of accommodating changes, such as advances in equipment design and processing procedures or technological developments. HACCP should not replace GMP; however, its application may be used as a first step towards GMP. In countries where appropriate regulations exist and are enforced, compliance with GMP (including validation), drug regulatory activities and inspections provide good assurance that risks are largely controlled. In countries where control is less effective, however, patients may be put at risk through the production of drugs of inadequate quality. The assessment of individual risks related to specific pro-ducts and starting materials, and the recognition of hazards at specific stages of production or distribution should permit regulatory authorities to improve drug control by increasing the effectiveness of their activities within the limits of the available resources. The present guidelines are aimed at assisting industry to develop and implement effective HACCP plans covering activities such as research and development, sourcing of materials, manufacturing, packaging, testing and distribution. Links with other programmes In each stage of the manufacture and supply of pharmaceuticals, the necessary conditions should be provided and met to protect the pharmaceuticals concerned. This has traditionally been accomplished through the application of Good Clinical Practice (GCP), Good Laboratory Practice (GLP), GMP and other guidelines, which are considered to be essential to the development and implementation of effective HACCP plans. HACCP plans are focused on hazards, the overall objective being to ensure that pharmaceuticals are safe for use. The existence and effectiveness of GCP, GLP and GMP should be assessed when drawing up HACCP plans. 3. Definitions The following definitions apply to the terms as used in these guidelines. They may have different meanings in other contexts. control (verb) The taking of all necessary actions to ensure and maintain compliance with the criteria established in the HACCP plan. control (noun) The state wherein correct procedures are being followed and criteria are being met. control measure Any

action and activity that can be used to prevent or eliminate a pharmaceutical quality hazard or reduce it to an acceptable level. corrective action Any action to be taken when the results of monitoring at the CCP (see below) indicate a loss of control. critical control point (CCP) A step at which control can be applied and is essential to prevent or eliminate a pharmaceutical quality hazard or reduce it to an acceptable level. critical limit A criterion which separates acceptability from unacceptability. deviation Failure to meet a critical limit. flow diagram A systematic representation of the sequence of steps or operations used in the production, control and distribution of a particular pharmaceutical. HACCP plan. A document prepared in accordance with the principles of HACCP to ensure the control of hazards which are significant for pharmaceutical quality in the production and supply chain. hazard Any circumstance in the production, control and distribution of a pharmaceutical which can cause an adverse health effect. hazard analysis The process of collecting and evaluating information on hazards which should be addressed in the HACCP plan. monitor The act of conducting a planned sequence of observations or measurements of control parameters to assess whether a CCP is under control. pharmaceuticals All products related to pharmacy, including starting materials (active pharmaceutical ingredients and excipients), finished dosage forms, and biological and other specific products. validation The collection and evaluation of data, beginning at the process development stage and continuing through the production phase, which ensure that the manufacturing processes — including equipment, buildings, personnel and materials — are capable of achieving the intended results on a consistent and continuous basis. Validation is the establishment of documented evidence that a system does what it is supposed to do. verification The application of methods, procedures, tests and other evaluations, in addition to monitoring, to determine compliance with the HACCP plan.

Principles The HACCP system is based on seven principles

Some stages are linked to specific principles while others serve as an introduction to the concept. The seven principles are:

1. Conduct a hazard analysis.

2. Determine the critical control points (CCPs).

3. Establish target levels and critical limit(s).

4. Establish a system to monitor the CCPs.

5. Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control.

6. Establish procedures to verify that the HACCP system is working effectively.

7. Establish documentation concerning all procedures and keep records appropriate to these principles and their application.

Guidelines for the application of the HACCP system The following guidelines will be found useful in applying the HACCP system:

• Before HACCP is applied to any sector, that sector should be operating in accordance with the principles of good practices and the relevant legislation.

• Management commitment is necessary if an effective HACCP system is to be implemented.

• HACCP should be applied to each specific operation separately.

• CCPs identified in any given example in any reference document (including GMP guidelines) may not be the only ones identified for a specific application or may be of a different nature.

• The HACCP application should be reviewed and necessary changes made when any modification is made in the product or process, or in any step.

• It is important, when applying HACCP, to take into account the nature and size of the operation.

• There should be a HACCP plan. The format of such plans may vary, but they should preferably be specific to a particular product, process or operation. Generic HACCP plans can serve as useful guides in the development of product and process HACCP plans; however, it is essential

that the unique conditions within each facility are considered during the development of all components of the HACCP plan.

Training and education As HACCP is a relatively new concept in the pharmaceutical industry, training of personnel in industry, government and universities in 104 HACCP principles and applications is essential for its effective implementation. In developing specific training to support a HACCP plan, working instructions and procedures should be drawn up which define the tasks of the operating personnel to be stationed at each critical control point. Specific training should be provided in the tasks of employees monitoring each CCP. Cooperation between producers, traders and responsible authorities is of vital importance. Opportunities should be provided for the joint training of industrial staff and the control authorities to encourage and maintain a continuous dialogue and create a climate of understanding in the practical application of HACCP. The success of a HACCP system depends on educating and training management and employees in the importance of their role in producing safe pharmaceuticals. Information should also be provided on the control of hazards at all stages of production and supply. Employees must understand what HACCP is, learn the skills necessary to make it function properly, and must also be given the materials and equipment necessary to control the CCPs.

Application The application of HACCP principles consists of the following 12 stages, as identified in the logic sequence for application of HACCP.

Assemble a HACCP team The pharmaceutical manufacturer should assure that product-specific knowledge and expertise are available for the development of an effective HACCP plan. This may be best accomplished by assembling a multidisciplinary team. Team members should therefore represent all the relevant disciplines, such as research and development, production, quality control, quality assurance, microbiology, engineering and distribution or others as applicable. Team members should have specific knowledge and expertise regarding the product and process. Where such expertise is not available on site, expert advice should be obtained from other sources. Team members should be able to:

(a) conduct a hazard analysis;

(b) identify potential hazards;

(c) identify hazards which should be controlled;

(d) recommend controls and critical limits;

(e) devise procedures for monitoring and verification;

(f) recommend appropriate corrective action where deviations occur;

(g) verify the HACCP plan.

The scope of the HACCP plan should be defined. The scope should describe the segment of the process involved and the classes of hazards to be addressed should be identified. Describe the product and process A full description of the product and the process should be drawn up, including relevant quality information such as the composition, physical/chemical properties, structure, pH, temperatures, method of cleaning, bactericidal/bacteriostatic treatments (e.g. heat-treatment), drying, screening, mixing, blending, packaging, and the storage conditions. The method of distribution and transport should also be described, especially where products are thermolabile. Identify the intended use The intended use should be based on the expected uses of the product by the end user or consumer. In specific cases, vulnerable population groups, e.g. geriatric patients, infants and immunocompromised patients, may have to be considered.

Construct a flow diagram The flow diagram should be constructed by the HACCP team, and should cover all operations and decisions in a process. When applying HACCP to a given operation, the steps preceding and following that operation should also be considered. A block-type diagram may be sufficiently descriptive.

On-site confirmation of flow diagram The HACCP team should confirm the processing operation against the flow diagram during all stages and hours of operation. Amendments to the flow diagram may be made where appropriate, and should be documented.

List all potential hazards associated with each step, conduct a hazard analysis, and consider any measures to control identified hazards (Principle 1)

When hazard analysis is conducted, safety concerns must be distinguished from quality concerns. 106 The HACCP team should list all the hazards that may be reasonably expected to occur at each step from production, testing and distribution up to the point of use. It should then conduct a hazard analysis to identify for the HACCP plan which hazards are of such a nature that their elimination or reduction to acceptable levels is essential. A thorough hazard analysis is required to ensure an effective control point. A two-stage hazard analysis is recommended. During the first stage, the team should review the materials, activities, equipment, storage, distribution and intended use of the product. A list of the potential hazards (biological, chemical and physical) which may be introduced, increased or controlled in each step should be drawn up. In the hazard analysis, the following should be included wherever possible: — the probable occurrence of hazards and the severity of their adverse health effects; — the qualitative and/or quantitative evaluation of the presence of hazards; — the survival or multiplication of microorganisms of concern; — the production or persistence in drugs of toxins, chemicals or physical agents; — the conditions leading to the above. During the second stage, a hazard evaluation should be conducted, i.e. the severity of the potential hazards and the probability of their occurrence should be estimated. The team should then decide which potential hazards should be addressed in the HACCP plan, and what control measures, if any, exist that can be applied for each hazard. More than one control measure may be required to control a specific hazard(s) and more than one hazard may be controlled by a specified control measure. Potential hazards in relation to at least the following should be considered: — materials and ingredients; — physical characteristics and composition of the product; — processing procedures; — microbial limits, where applicable; — premises; — equipment; — packaging; — sanitation and hygiene; — personnel; — risk of explosions; — mix-ups.

Determine critical control points (Principle 2)

A CCP in the HACCP system can be more easily determined by the use of a decision-tree, which facilitates a logical approach. The way that a decision-tree is used will depend on the operation

concerned, e.g. production, packing, reprocessing, storage, distribution. Training in the use of decision-trees should be given. If a hazard has been identified at a step where control is necessary for safety, and no control measure exists at that step, or any other, the product or process should be modified at that step, or at an earlier or later stage, to include such a control measure.

Establish critical limits for each CCP (Principle 3)

Critical limits must be specified and verified, if possible, for each critical control point. More than one critical limit may sometimes be elaborated at a particular step. The criteria used often include measurements of temperature, time, moisture level, pH, and sensory parameters, such as visual appearance and texture. Critical limits should be scientifically based.

Establish a monitoring system for each CCP (Principle 4)

Monitoring is the scheduled measurement or observation of a CCP relative to its critical limits. Monitoring should be recorded. The monitoring procedures used must be able to detect loss of control at the CCP, and this information should ideally be available in time to make adjustments to ensure control of the process and prevent violations of the critical limits. Where possible, process adjustments should be made when monitoring results indicate a trend towards loss of control at a CCP. These adjustments should be made before a deviation occurs. Data derived from monitoring must be evaluated by a designated person with the knowledge and authority to carry out corrective actions when indicated. If monitoring is not continuous, the amount or frequency of monitoring must be sufficient to guarantee that the CCP is under control. Most monitoring procedures for CCPs will need to be done rapidly because they relate to on-line processes and there will not be time for lengthy analytical testing. For this reason, physical and chemical measurements are often preferred to microbiological tests because they can be done rapidly and can often indicate the microbiological control of the product. The personnel conducting the monitoring of CCPs and control measures should be engaged in production (e.g. line supervisors, maintenance staff) and, where appropriate, staff from quality control. They should be trained in monitoring procedures. Where continuous monitoring is possible, a reliable monitoring procedure and frequency should be identified. Statistically designed data collection

or sampling systems should then be used. All records and documents associated with monitoring CCPs must be signed and dated by the person(s) carrying out the monitoring and by a responsible reviewing official(s) of the company.

Establish corrective actions (Principle 5)

Specific corrective actions should be developed for each CCP in the HACCP system in order to deal with deviations when they occur. These actions should ensure that the CCP is brought under control. Corrective actions should include at least the following: (a) determination and correction of the cause of non-compliance; (b) determination of the disposition of the non-compliant product; (c) recording of the corrective actions that have been taken. Specific corrective actions should be developed in advance for each CCP and included in the HACCP plan. As a minimum, this plan should specify what is to be done when a deviation occurs, who is responsible for implementing the corrective actions, and that a record will be kept and maintained of the actions taken. Individuals who have a thorough understanding of the process, product and HACCP plan should be assigned the responsibility for the oversight of corrective actions. As appropriate, experts may be consulted to review the information available and to assist in determining the disposition of noncompliant product. Actions taken must also include the proper disposition of the affected product. Deviation and product disposition procedures must be documented in the HACCP records.

Establish verification procedures (Principle 6)

Procedures should be established for verification.

Verification and auditing methods, procedures and tests, including random sampling and analysis, can be used to determine whether the HACCP system is working correctly. The frequency of verification should be sufficient to confirm the proper functioning of the HACCP system. Examples of verification activities include: — review of the HACCP system and its records; — review of deviations and product dispositions; — confirmation that CCPs are kept under control. Initial verification of the HACCP plan is necessary to determine whether it is scientifically and technically sound, that all hazards have been identified, and that, if the HACCP

plan is properly implemented, these hazards will be effectively controlled. Information reviewed to verify the HACCP plan should include: (a) expert advice and scientific studies; (b) in-plant observations, measurements and evaluations. For example, verification of the moist heat sterilization process for sterile injectables should include the scientific justification of the heating times, pressure and temperatures needed to obtain an appropriate destruction of pathogenic microorganisms (i.e. enteric pathogens) and studies to confirm that the sterilization conditions ensure that the whole load is kept at the required temperature for the time required. Subsequent verifications should be performed and documented by a HACCP team or an independent expert, as needed. For example, verifications may be conducted when there is an unexplained system failure, a significant change in product, process or packaging occurs, or new hazards are recognized. In addition, a periodic comprehensive evaluation of the HACCP system by an unbiased, independent third party is useful. This should include a technical evaluation of the hazard analysis and each element of the HACCP plan as well as an on-site review of all flow diagrams and appropriate records of the operation of the plan. Such a comprehensive verification is independent of other verification procedures and must be performed in order to ensure that the HACCP plan is resulting in the control of the hazards. If the results of the comprehensive verification identify deficiencies, the HACCP team should modify the HACCP plan as necessary. Individuals doing verification should have appropriate technical expertise to perform this function.

Where possible, verification should include actions to confirm the efficacy of all elements of the HACCP plan.

Establish documentation and record keeping (Principle 7)

Efficient and accurate documentation and record keeping are essential to the application of a HACCP system and should be appropriate to the nature and size of the operation. Examples of activities for which documentation is required include: — hazard analysis; — CCP determination; — HACCP plan; — critical limit determination. Examples of activities for which records are required include: — CCP monitoring activities; — process steps; — associated

hazards; — critical limits; — verification procedures and schedule; — deviations; — associated corrective actions; — modifications to the HACCP system.

Questions:- 1) Enlist and Explain the 7 Principles of HACCP.

2)Explain in brief The Food Safety Management Systems.

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