FSN 421 – FOOD SAFETY AND QUALITY CONTROL FOR HORTICULTURAL PRODUCTS (1+1)

Unit – I Introduction – Food safety and quality control

Definitions – food safety and quality. General principles of food safety and quality. Hazards – physical, chemical and biological. Food borne diseases. Food additives – types – usage, permissible limits. Food toxins – causes and effects.

Unit – II Quality evaluation of horticultural produce

Quality attributes – size, shape, color, viscosity, texture, taste and flavor. Principle and methods for subjective and objective evaluation of foods. Microbial examination of foods. Insect contaminants and pesticide residues in horticultural produce. Quality of organic produce.

Unit – III National food laws and standards

Standards for food packaging and labeling – Prevention of Food Adulteration Act (PFA), FSSAI, Bureau of Indian Standards (BIS), Agricultural Grading and Marketing (AGMARK) and APEDA.

Unit – IV International standards and organizations

Food and Drug Administration Act (FDA), International organization for Standards (ISO) and it's implication, Generally recognized as safe (GRAS), European Council (EU), Codex Alimentarius Commission (CAC), Total Quality Management (TQM), Good Manufacturing Practices (GMP), Good Agricultural Practices (GAP) and Good Hygienic Practices (GHP), Hazard Analysis Critical Control Point (HACCP)

Unit – V Quality control measures in industrial and marketing centres

Quality control system in storage, Quality control aspects in food industries, importance of Quality control in marketing of horticultural products – domestic and export markets. Role of government agencies in export market – International standards for export and quarantine requirements for export of horticultural produce.

Unit – I: Introduction – Food safety and quality control

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Introduction

Food is a major determinant of health, nutritional status and productivity of the population. It is therefore, essential that the food we consume is wholesome and safe. Unsafe food can lead to a large number of food-borne diseases.

Unsafe food costs India as high as $15 billion annually, even though it has almost halved from $28 billion estimated last year (2018), a recent World Bank report says underlining the "unnecessarily high" economic burden caused by food borne diseases.

Acknowledging India's efforts in last few years to streamline food safety regulations, the report said India, along with few other countries, has demonstrated that better health and commercial outcomes are possible with the joint involvement of public agencies, businesses and consumers in food safety.

Of late, Food Safety and Standards Authority of India (FSSAI) has taken a series of measures including stringent packaging and labelling norms, regulation of restaurant and street food as well as inspections and sampling of food products to ensure quality of food in India.

Food-borne illness can not only result in mortality but can damage trade and tourism, lead to loss of earnings, unemployment and litigation and thus can impede economic growth and therefore food safety and quality have gained worldwide significance.

Definitions

Food safety	Assurance that food will not cause any harm to the consumers.
Toxicity	Capacity of a substance to produce harm or injury of any kind under any conditions.
Hazards	Hazard is the relative probability that harm or injury will result when substance is not used in the prescribed manner and quantity.
Food infection / food poisoning	It results from ingestion of live pathogenic organisms which multiply in the body and cause disease. Salmonella is a classic example.
Food intoxication	Some bacteria produce harmful toxins which are present in food even if pathogen has been killed. Organisms produce toxins when the food has not been hot or cold enough.
Contamination	It is the presence of harmful or objectionable foreign substances in food such as chemicals, micro organisms, dilutants before / during or after processing or storage.
Adulteration	It is intentional or accidental addition of impure or cheap or unnecessary ingredients to cheat, cheapen or falsify a preparation, that will alter the properties and composition and diminish the quality of the food
Food quality	Food quality refers to attributes that influence a product value to consumers. This includes both negative attributes such as spoilage, contamination, adulteration, food safety hazards as well as positive attributes such as color, flavor, texture

General principles of food safety and quality

Quality of fresh horticultural commodities is a combination of characteristics, attributes and properties that give the commodity value to humans for food (fruits and vegetables) and enjoyment (ornamentals).

Quality of produce encompasses sensory properties (appearance, texture, taste and aroma), nutritive values, chemical constituents, mechanical properties, functional properties and defects.

The word "quality" is used in various ways in reference to fresh horticultural produce. The quality of fresh fruits and vegetables may be explained in terms of the following:

For producers of horticultural crops "good quality" produce (fruits, vegetables or flowers) should give high yield with good appearance, disease resistance, insect resistance, good transport quality and bring higher profit.

To receivers and market distributors, appearance quality is most important and also the firmness and long storage quality.

Consumers consider good quality fruits, vegetables or flowers to be those that have good fresh market quality i.e., good appearance, good color, firm or tender (good and optimum texture), good flavor and nutritive value.

Although, consumers buy on the basis of appearance and feel, their satisfaction and repeat purchase are dependent upon good edible quality in case of fruits and vegetables.

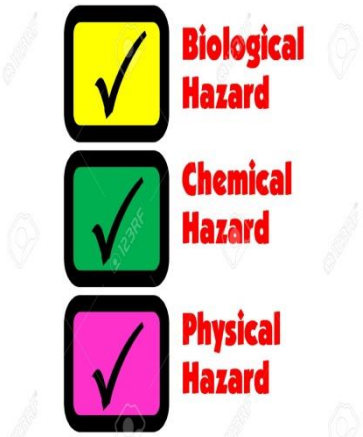
The components that are used to evaluate the quality of the commodities in specifications for grade and standard, selection in breeding

programme and evaluation of responses to various environmental factors and post harvest treatments are listed below.

Quality components of fresh fruits and vegetables

Main factors	Components
Appearance	Size, dimension, weight, volume, shape and form, smoothness, compactness, uniformity in color, intensity gloss, nature of surface wax. Defects: external, internal (morphological, physical and mechanical, physiological, pathological and entomological)
Texture	Firmness, hardness or softness, crispness, succulence, juiciness, mealiness, grittiness, fibrousness, toughness
Flavor (taste and smell)	Sweetness, sourness(acidity), astringency, bitterness, aroma, off odor, off flavor
Nutritive value	Contents of carbohydrates, proteins, lipids, vitamins, minerals, fibre, water, antioxidants etc.
Safety	Naturally occurring toxicants, contaminants (chemical residues, heavy metals) mycotoxins, microbial contamination

There is no universal set of quality standards for any given commodity. Each country has its own criteria depending on local circumstances. Different standards may apply for produce for home consumption and for export. Generally only the better/higher quality produce is exported, because of longer time it has to survive before consumption and to excel in the international market competition.

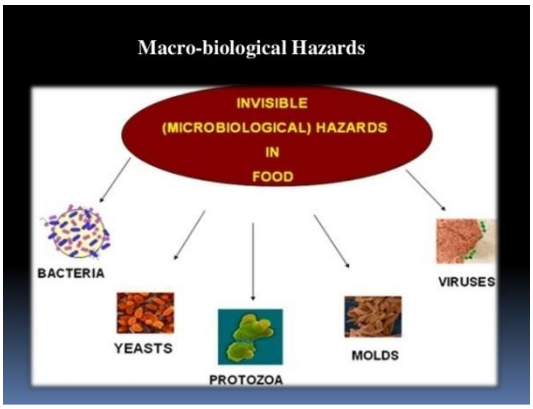


Hazards

The Codex Alimentarius Food Hygiene Committee defined a food hazard as: "A biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect".

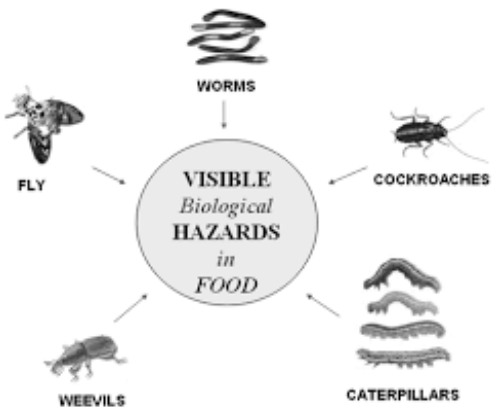
It is generally recognized that food safety hazards are of three types. These are biological, chemical and physical in nature.

Biological hazards



Biological hazards are micro-organisms and their toxic metabolites which can cause illness when transmitted to humans through food. A great variety of micro-organisms are found in nature. Some can grow on food causing spoilage, others constitute a hazard to man through illness caused either by food infections or food intoxications.

In most cases micro-organisms use our food supply as a source for their own nutrients for their own growth. By increasing in number, utilizing nutrients, producing enzymatic changes and contributing off flavors by means of breakdown of a product or syntheses of new compounds they spoil our food.



It is only when the micro-organisms involved are pathogenic, their association with our food supply becomes critical and assumes importance with respect to food safety. Many of our food support the growth of pathogenic micro-organisms or at least serve as vectors for them. Micro-organisms that can constitute food safety hazards include bacteria, yeast and moulds, viruses and parasites.

Chemical hazards

Chemical hazard is any chemical introduced into the food systems, which may cause illness or injury to the individual using the product. Toxic chemicals such as residues of pesticides, cleaning agents can also find their way into the food and make us fall sick. A few examples of chemical hazards are:

- **Agricultural chemicals:** These are used to enhance the livestock production and include insecticides, fungicides and fertilizers in crop production and pesticides, antibiotics and growth hormones in livestock production.
- **Pollution:** However there is another class of chemical hazards that enters the food chain at the primary production step on account of pollution. These include toxic metals such as mercury, lead, arsenic and cadmium discharged into the sea by industry progressively accumulates in marine life along the food chain.
- **Processing plant / Facility chemicals:** Inappropriate design of manufacturing equipment and selection of chemicals used for operating machines and their maintenance increases the risk of contamination of the food. Chemical residues left on vessels and food contact surfaces due to improper cleaning operations contaminate the food products.
- **Naturally occurring toxicants:** Some foods contain naturally occurring toxins. A very good examples are mycotoxin – aflatoxins in grains and processed foods.

- **Food chemicals:** Food additives such as smoke, alcohol, vinegar, oil and spices have been used for thousands of years to preserve food, enhance flavor and improve maintain food consistency. However, changes in the distribution of food and the increase in processed food products, has seen an increase in use of food additives. It is estimated that more than 2500 different chemicals are currently being used after having undergone extensive toxicological screening for imparting flavors, protecting and preserving the food from microbiological deterioration, to impart a functional characteristic, as a processing aid, or even for improving appearance. At established levels, these materials are not toxic or dangerous. But lack of proper controls can result in violation of prescribed levels and may result in illness for consumers.

- **Food Allergen:** Protein derived from milk, egg, fish, tree nuts, wheat, peanuts and soyabeans.

Physical hazards

Physical hazard is defined as any physical materials not normally found in a food, which may cause illness or injury to the individuals using the food product. Physical contaminants like pebbles, chips of glass, piece of metal wire all have the potential to injure us when consumed along with food.

Physical hazards include a variety of materials often referred to as extraneous materials or foreign objects emanating from various sources and having a potential to inflict injuries. Some examples are listed below and Health and safety problems from these sources commonly occur and can be dangerous to our health and safety.

Material	Source	Injury potential
Glass	Bottles, jars, light fixtures, glassware, gauge covers etc.	Cuts, bleeding, may require surgery for removal.
Wood	Fields, pallets, boxes, buildings.	Cuts, infection, choking, may require surgery for removal.
Stones	Fields, buildings.	Choking, broken teeth.
Metal	Machinery, fields, wire, employees	Cuts, infection, may require surgery for removal.
Insects	Fields, plant, post process entry.	Illness, trauma, choking.

Food borne diseases

The term food-borne diseases, including food-borne intoxications and food-borne infections, covers illnesses acquired through consumption of contaminated food, and are also frequently referred to as food poisoning.

Food-borne disease outbreaks are defined as the occurrence of 2 or more cases of a similar illness resulting from ingestion of a common food or when observed number of cases of a particular disease exceeds the expected number.

Classification of food-borne illnesses

Food-borne illness is typically caused by microorganisms or their toxins, and most often manifests with gastro-intestinal symptoms, which can vary in severity and duration. In addition to food-borne pathogens (bacteria, viruses and parasites), food-borne disease may also be caused by contaminants like heavy metals, chemicals, pesticides and toxic substances present naturally in food like toxic mushrooms, plants, fish or shellfish.

- **Food-borne infections:** caused by consuming foods or liquids contaminated with bacteria, viruses or parasites. These pathogens cause infection by:
    - Invading and multiplying in the lining of the intestines and/or other tissues.
    - Invading and multiplying in the intestinal tract and releasing a toxin (bacteria only)

- **Food-borne intoxications:** caused by consuming foods or beverages already contaminated with a toxin. Sources of toxins are as follows:
    - Certain bacteria (pre formed toxins)
    - Poisonous chemicals
    - Natural toxins found in animals, plants and fungi

	Infections	**Intoxications**
Cause	Bacteria / viruses / parasites	Toxin
Mechanism	Invade and/or multiply within the lining of the intestines	No invasion or multiplication
Incubation period	Hours to days	Minutes to hours
Symptoms	Diarrhea, nausea, vomiting, abdominal cramps, fever	Diarrhea, nausea, vomiting, double vision, weakness, respiratory failure, numbness, sensory and motor dysfunction.
Transmission	Can spread from person to person via the faeco-oral route	Not communicable
Factors related to food contamination	Inadequate cooking, cross contamination, poor personal hygiene, bare hand contact	Inadequate cooking, improper holding temperatures

Chemical food poisoning

Toxic compounds like lectins and glycoalkaloids are naturally present in some vegetables like potatoes and legumes. Other toxic compounds like pesticides, heavy metals and toxins of fungal or bacterial origin could also contaminate food during manufacture, storage or transportation.

Mycotoxins of importance in India include aflatoxins, fumonisins, trichothecenes, ergot alkaloids and ochratoxins. Inorganic forms of arsenic predominate in rice and spices, and are a real threat to human health.

Food-borne transmission of pathogens and toxins

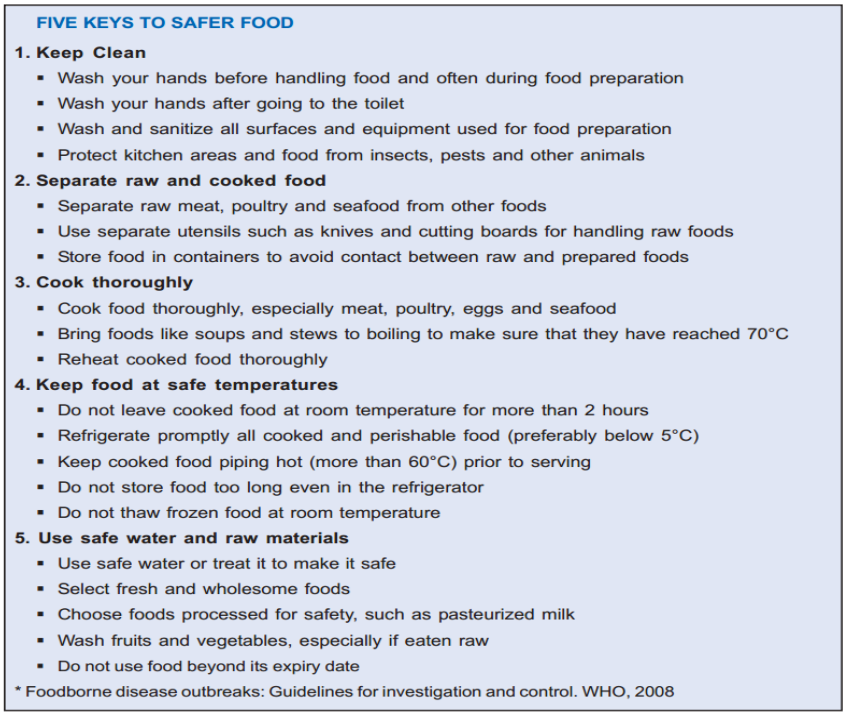
Food may become contaminated during production and processing or during food preparation and handling.

Foods, such as fruits and vegetables, may be contaminated if washed or irrigated with water that is contaminated with pathogens from animal or

human faeces. Animals naturally harbour many food-borne bacteria in their intestines that can cause illness in humans, but often do not cause illness in the animals.

- **Infected individuals** - Most food-borne pathogens are shed in the faeces of infected persons and these pathogens may be transferred to others through food via the faecal-oral route. Bacteria present in infected lesions and normal nasal flora may also be transmitted from an infected food-handler to ready-to-eat foods.
- **Cross-contamination** – Pathogens naturally present in one food may be transferred to other foods during food preparation if same cooking equipment and utensils are used without washing and disinfecting in between, especially in case of ready-to-eat foods.
- **Inadequate cooking temperature** – With insufficient cooking bacteria can multiply and produce toxins within the food. Many bacterial toxins are heat stable and may not be destroyed by cooking.
- **Improper storage** - Food held or stored at warm (10-50^{o}C) temperature allows multiplication of pathogens and is an important cause of food-borne outbreaks.

Prevention



FIVE KEYS TO SAFER FOOD

1. Keep Clean
- Wash your hands before handling food and often during food preparation
- Wash your hands after going to the toilet
- Wash and sanitize all surfaces and equipment used for food preparation
- Protect kitchen areas and food from insects, pests and other animals

2. Separate raw and cooked food
- Separate raw meat, poultry and seafood from other foods
- Use separate utensils such as knives and cutting boards for handling raw foods
- Store food in containers to avoid contact between raw and prepared foods

3. Cook thoroughly
- Cook food thoroughly, especially meat, poultry, eggs and seafood
- Bring foods like soups and stews to boiling to make sure that they have reached 70°C
- Reheat cooked food thoroughly

4. Keep food at safe temperatures
- Do not leave cooked food at room temperature for more than 2 hours
- Refrigerate promptly all cooked and perishable food (preferably below 5°C)
- Keep cooked food piping hot (more than 60°C) prior to serving
- Do not store food too long even in the refrigerator
- Do not thaw frozen food at room temperature

5. Use safe water and raw materials
- Use safe water or treat it to make it safe
- Select fresh and wholesome foods
- Choose foods processed for safety, such as pasteurized milk
- Wash fruits and vegetables, especially if eaten raw
- Do not use food beyond its expiry date

* Foodborne disease outbreaks: Guidelines for investigation and control. WHO, 2008

Food Additives

Introduction

An additive means any substance, which is not a normal constituent of the food material, and its purposeful addition is aimed for technological, organoleptic and nutritional reasons.

Food additive is defined as a substance or mixture of substances other than the basic food stuff, which is present in food as a result of any aspect of production, processing, storage and packaging.

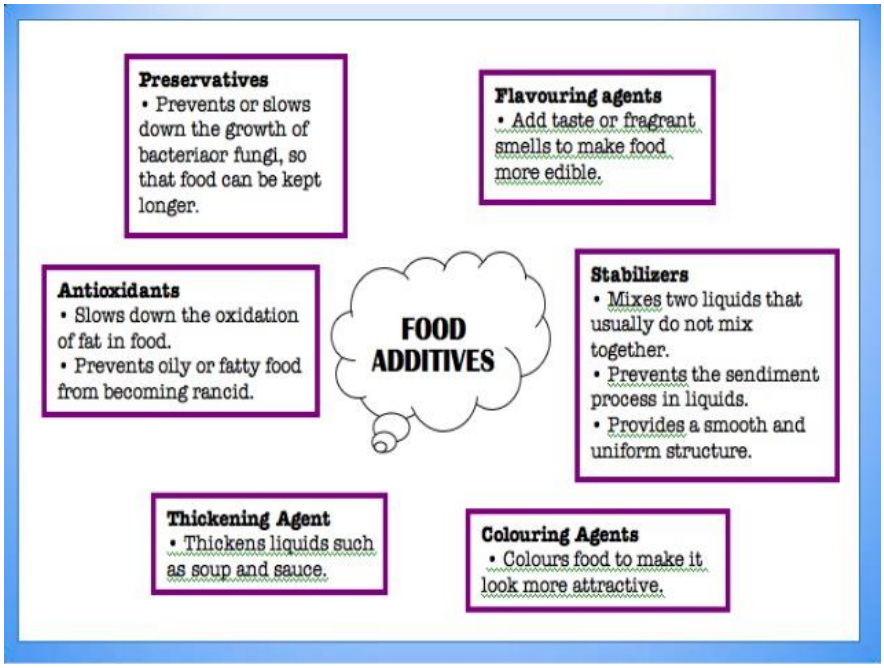
Uses of food additives

The uses of food additives are justified when it serves at least one of the following purposes.

- Maintenance of nutritional quality.
- Enhancement of keeping quality or storage stability with reduction in food losses.
- Making the food additives and acceptable to the consumer and at the same time not leading to deception and
- As essential aids in food processing.

Classification of food additives

The following classes of food additives are allowed in various foods



Preservatives: The preservatives are classified into 2 classes-class I, which is not restricted in any food unless otherwise provided in the Rules, and Class II, which are restricted to a specified group of foods in concentrations not exceeding limits prescribed for each.

Class I preservatives	Class II preservatives
Common salt, sugar, dextrose/glucose syrup, wood smoke, spices, vinegar or acetic acid, and honey	Benzoic acid & its salts, sulphurous acid & its salts, nitrites & nitrates, sorbic acid & its salts.

Antioxidants: Antioxidants are defined by the United States (U.S.) Food and Drug Administration, as the agent that prevents rancidity or discoloration caused due to oxidation.

The prominent effects of oxidation include the development of rancid off-flavor by fats, oils and lipid containing foods, possibility of toxic oxidation products; discolouration of pigments, loss of product flavor or odour, changes in texture and the loss of nutritional value from the destruction of vitamin (A, D and E) and essential fatty acids (e.g. Linoleic acid).

Aldehyde and ketones, which are generated from the chain reactions, are responsible for the off-flavor and odors. A number of factors such as oxygen, light, heat, heavy metal, pigments, alkaline condition and degree of unsaturation catalyze oxidation.

BHA is more effective in suppressing oxidation, occurring in animal fats than in vegetable oils. It is useful in protecting the flavor and color of essential oils. It is the most effective in controlling the oxidation of short – chain fatty acids such as those contained in coconut and palm kernel oil which are used in cereal and confectionary products.

Tocopherol: The best known of the natural oxidants are Tocopherol, present in plant tissues. The tocopherols have been found to be effective antioxidants in a number of products, including bacon, baked goods, butter fat, lard, margarine, rape seed oil, safflower oil, and sunflower seed oil. Because of their heat liability, tocopherols usually lost during refining, deodorizing and processing operations.

Emulsifying agents: The emulsifying agents used in the food production are amphophilic substances; their structure involves both hydrophilic and hydrophobic (or lipophilic) functions, whereby they are able to stabilize a system which is naturally unstable in oil or water. Monoglycerides are the most widely used emulsifying agent.

Clarifying agents: Chill haze is common problem in beer, wine and many fruit juices and oxidation deterioration are long-standing problems. Specific enzymes have been utilized to partially hydrolyze high molecular weight products. However, excessive enzymatic activity can adversely affect the desirable properties such as foam formation in beer.

The important clarifying agents that have selective affinity for tannins, proanthocyanidins and other polyphenols include protein and certain systemic resins, such as polyamides and polyvinylpyrrolidone (PVP). Gelatin is commonly used to clarify beverages.

Flour bleaching agents and bread improvers: It is an usual practice to employ chemical treatment to mature flour and improve its baking qualities. Flour bleaching involves primarily the oxidation of carotenoid pigments. One commonly used flour bleaching agents benzoyl peroxide exhibits a bleaching or decolorizing action but does not influence its baking properties.

Materials that act both as bleaching and improving agents include chlorine gas, chlorine dioxide nitrosyl chloride (NOCL) and oxides of nitrogen (nitrogen dioxide and nitrogen tetraoxide).

Food Colorants: Generally, artificial colors are added to improve the appearance of preserved food products. Color added to foods are classified as

- **Natural colors:** Ex. carotenoid, annatto, paprika and saffron; anthocyanin from grape skin and beet root, caramel, chlorophyll and tumeric etc.
- **Nature identical synthetic colors**: synthesized in laboratories.

- **Artificial colors:** Coal tar is available in wide range of colors. Ex. Indigocarmine.
- **Inorganic colors:** PFA prohibits use of inorganic colors except titanium dioxide, which is permitted in chewing gums (maximum limit 1%).

Flavoring agents and flavor enhancers: Flavoring agents are those substance, naturally occurring or synthetic, which are responsible for the characteristic flavors of almost all the foods in our diet. Spices, herbs, plant extracts (root, leaves, stem, flower) and essential oils are widely used flavoring agents of natural origin. Since the preparation of extracts and essential oils is very costly synthetic ones are replacing natural flavoring substances.

Esters, aldehides, ketones, alcohols and ethers having characteristic fruity odors can be easily synthesized and readily replace natural aromatic substances. Some examples of these are amyl acetate (banana), methyl anthranilate (grape) and ethyl butyrate (pineapple). Generally, mixing a number of different synthetic substances can reproduce natural flavors.

Flavor enhancers do not posses any flavor themselves but they intensify the flavors of other substances through a synergistic effect. The best known, most widely used and somewhat controversial flavor enhancer is monosodium glutamate (MSG), the sodium salt of the naturally occurring glutamic acid, an amino acid extracted from seaweeds and soybean. Ribonucleotides (5-nucleotides) extracted from yeast possess ten times the flavor-enhancing property of MSG.

Nutrient supplements: When foods are processed or stored there may be loss of some nutrients. In order to restore this loss or to provide more nutritional value than what nature may have provided nutrient supplements are added. These are mainly vitamins and minerals, vitamin D (added to milk), vitamin B, iron and calcium (to cereal products), iodine (to salt), vitamin A (to margarine), vitamin C (to fruit-juices and fruit-flavored desserts).

Non-nutritive and low calories sweeteners: The current trend is to look for intensive sweeteners that can be used as sucrose substitute without any toxicological hazards. Present sucrose alternatives viz., saccharine (300 times as sweet as sucrose), cyclamate, aspartame and acesulfame-k fall short of expectations in one way or other in delivering the complete sucrose taste experience.

Anticaking agents: Several conditioning agents are used to maintain free flowing characteristics of granular and powdered forms of foods that are hygroscopic in nature. These materials, functions by readily absorbing excess moisture, by coating particles to impart a degree of water repellency and/or by providing an insoluble particulate diluent. Calcium silicate is used to prevent caking in baking powder and in table salts (up to 2%).

Other anticaking agents include sodium silicon aluminate tri-calcium phosphate, magnesium silicate and magnesium carbonate. Microcrystalline cellusose powders are used to prevent grated or shredded cheese from clumping. Anticaking agents are either metabolized (starch, strearates) or exhibit no toxic actions at levels employed in food applications

Antibiotics: Nisin, is a polypeptide antibiotic produced by streptococci is now permitted to prevent potential outgrowth of clostridium botulinum in high-moisture processed cheese products. It is active against Gram-positive organism and is extensively used in parts of the world for prevention of spoilage of dairy products, such as processed cheese and condensed milk.

Antimicrobial agents: Sulphur dioxide and its derivatives have been extensively used in foods as a food preservative. It acts both as an antioxidant, and reducing agent and prevents enzymatic and non-enzymatic reactions, leading to microbial stability. However, more recently, there has been growing concern against the use of sulphite as they have several reactions to asthmatics. The frequently used sulphiting agents are the sodium and potassium metabisulphite because they exhibit good stability towards antioxidation in the solid phase.

Nitrite and nitrate salts: Nitrates and nitrites have a significance role from the technological and hygiene point of view. They allow the stabilization of color after cooking, impart good flavor and the maintenance of the color of lean meat without this treatment meat would be green brown. The use of nitrates and nitrites in the food industry is now subject to strict control. The lethal dose for man is of order of one gram. These two salts are inhibitors of toxic bacteria, particularly those involved in botulism, that is why they are considered to be preservatives from a legal point of view. Under the code of federal regulations nitrites are permitted as preservatives in cured meat and meat products including poultry at level not to exceed 2000 ppm.

FOOD TOXINS

Introduction

Occurrence of toxins in food and feed represents undoubtedly an important food safety issue which is of growing concern of both scientists and regulators.

Considering the current terminology, several approaches are applied for classification of natural toxins. The narrow definition specifies natural toxins as food constituents endogenously produced by food organisms and capable to give rise to adverse effects when the food organism or product thereof is consumed. The broader definition of natural toxins includes also toxic compounds originating from a contamination of the food.

Sources of natural toxins

- Microorganisms producing toxic metabolites may contaminate food (or raw material used for its production).
- Mycotoxins such as aflatoxins, ochratoxin A, trichothecenes, zearalenone, fumonisins and patulin produced by toxicogenic species of *Aspergillus*, *Penicillium* , *Fusarium* and other genera of fungi are of greatest concern both in terms of toxicity and worldwide occurrence.

- Once contaminating food crop and/or animal products, their removal by common food processing practices is almost impossible (thermolabile patulin is an exception).
- Also some bacteria may produce toxins (e.g. botulin, *Staphylococcus aureus* enterotoxin and *Bacil-lus cereus* enterotoxin). Many of them are proteins which are not, contrary to most of mycotoxins, heat-stable and can be therefore in most cases reduced/eliminated by thermal treatment of contaminated matrix.
- Non-toxic raw materials of plant origin may be accident or unlucky circumstances be contaminated or being mixed with a toxic non-nutritive plant species, for example unripe berries of black nightshade (*Solanum nigrum*), containing several toxic glycoalkaloids may contaminate edible crops.

In spite of enormous progress in breeding/growing agricultural practices and advances in food processing technologies aiming at production of high quality and safe foods, number of anti nutrients (compounds with negative effects on availability of nutrients) and toxic compounds of natural origin still can occur in our diet. List of toxicants are presented in table below.

Toxicants	Plant family
Alkenyl benzenes	*Myristicaceae, Labiatae, Lauraceae, Piperaceae*
Anthraquinones	*Polygonaceae*
Capsaicinoids	*Solanaceae*
Coumarins	*Leguminosae, Rubiaceae, Umbelliferae*
Coumestans	*Leguminosae*
Cucurbitacins	*Cucurbitaceae*
Cyanogenic glycosides	*Leguminosae, Gramineneae, Rosaceae*
Furocoumarins	*Umbelliferae, Rutaceae,*
Glukosinolates	*Cruciferae*
Glykoalkaloids	*Solanaceae*
Glycyrrhizinic acid	*Leguminosae, Sapindaceae*
Hydrazons	*Morchellaceae*
Proteinase inhibitors	*Leguminosae*
Isoflavonoids	*Leguminosae, Rosaceae, Vitaceae*
Lectins	*Leguminosae*
Nitriles	*Leguminosae*

Compounds Exhibiting Adverse Effects

Glycoalkaloids

One of the widely discussed groups of plant toxins is represented by glycoalkaloids that are contained in all *Solanaceous* plants including potatoes, an important staple food.

Recommendation for maximum levels of 200 mg α -chaconine and α-solanine (sum) per kg potatoes is based on estimation of 300 g daily intake.

Solanine content considerably varies among individual varieties and is largely affected by environmental factors such as light, irradiation, mechanical injury, and storage.

On the other hand glycoalkaloids appear to be largely unaffected by common food processing practices such as baking, cooking, and frying. The most efficient way of lowering dietary exposure is peeling of tubers since their outer layers are rich in these toxins. Depending on tuber size and variety, up to 60% of total content can be removed by manual peeling.

Tomatoes are another important food crop of *Solanaceous* family contributing to the glycoalkaloids intake. However, this crop seems in this respect to be much safer for humans than are potatoes, since tomatine (contains mixture of dehydro tomatine and α- tomatine) is largely degraded as the tomato fruit ripens.

Cyanogenic glycosides

Glycosides of α-hydroxynitriles (cyanogenic glycosides) releasing hydrogen cyanide via enzymic breakdown catalysed by endogenic β-glycosidases are contained in several economically important plants, the most known of them being cassava; the main cyanogen contained in this crop is linamarin. Chopping, grinding, soaking in running water as well as fermentation and cooking, are traditional processing practices used by casssava African and South American consumers for detoxification.

Amgydalin is another cyanogenic glysoside that might be responsible for exposure to hydrogen cyanide when heat processed products prepared from stone fruits from which seeds were not removed are consumed.

Lectins

Lectins or haemagglutinins are carbohydrate binding (glyco)proteins which are ubiquitous in nature. They are present in the most commonly edible plant foods such as leguminous species and many others hence they are ingested daily in appreciable amounts by both humans and farm animals. Due to their high stability, lectins are able to survive digestion by the gastrointestinal tract of consumers and may cause severe gastric upset.

Pyrrolizidine alkaloids

Pyrrolizidine alkaloids are a large group of natural toxins involving almost 350 chemicals, many of them have been shown carcinogenic in animals and are therefore classified as potential human carcinogens. Intoxication of people can occur in several ways, often due to contamination of food supply by seeds containing these alkaloids. Another exposure route is occurrence of plants containing pyrrolizidines in traditional remedies or certain dietary supplements.

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Quality attributes – size, shape, color, viscosity, texture, taste and flavor. Principle and methods for subjective and objective evaluation of foods. Microbial examination of foods. Insect contaminants and pesticide residues in horticultural produce. Quality of organic produce.

Quality Characteristics of foods

The quality of a processed fruit or vegetable product ultimately depends upon the quality of the raw material that is used to make the product. Most of the fruits or vegetables are marketed as they are, without undergoing any further processing. For marketing purposes, the characteristics of primary importance are size, attractiveness, maturity, organoleptic quality and freedom from infection.

When the same vegetable/fruit is to undergo processing, other properties assume more importance; these are color, flavor and texture. Obviously, fruits or vegetables of poor quality cannot ensure that a good quality processed product will be obtained. In many countries, there are precise specifications of various characteristics for products intended for processing.

Quality characteristics are importance since they are related to the total yield of a finished product, and are, therefore major considerations in processing. Quality is a measure of the degree of excellence or degree of acceptability by the consumer. Quality characteristics of a product may be divided into three major categories

(A) **Sensory characteristics:** Include appearance (color, size and shape and defects), texture and flavor (taste and odor) which the consumer can evaluate with his senses.

(b) **Hidden characteristics:** Quality is those which the consumer cannot evaluate with his senses, such as nutritive value, presence of harmless adulterants, and presence of toxic substances.

(C) **Quantitative characteristics:** are also considered as an attribute of food quality, since it forms a part of the total quality evaluation of a product, e.g., the finished product yield of a variety of fruit or vegetable.

Sensory Characteristics

Appearance	Eye appeal judged by sense of light - determine acceptance or rejection. It includes color, size, shape and defects.
Size	Size grading is done mainly to facilitate succeeding operations such as cutting, peeling or blending, to obtain uniformity in the product, and to provide consumers with the preferred size
Shape	Shape of the raw materials sometimes determines the suitability for processing that reduces losses during mechanical trimming and handling.
Color	Color increases the attractiveness of fruits and vegetables and in most cases; it is used as a maturity index. It is also associated with flavor, texture, nutritive value, and wholesomeness. Three major classes of pigments occur in fruits: the carotenoids, the chlorophyll, and the anthocyanin pigments.
Texture	Texture characteristics involve touch sensations. It includes hand feel (firmness, softness, juiciness) and mouth feel (chewiness, fibrousness, grittiness, mealiness and stickiness) which determine the quality.
Flavor	Flavor distinguishes one food from another. It is a combination of taste and smell (odor or aroma).

Principle and methods for subjective and objective evaluation of foods

1. **Sensory Evaluation of Foods**

Sensory evaluation (subjective method) consists of judging the quality of food by a panel of judges. The evaluation deals with measuring, analyzing and interpreting the qualities of food as they are perceived by the senses of sight, taste, touch and hearing. Other characteristics such as transparency, opaqueness, turbidity, dullness and gloss could also be perceived.

Colors of foods contribute immeasurably to one's appreciation of them. In addition, color is associated with other attributes, e.g., the ripeness of fruits is judged by color. The strength of coffee and tea is judged in part, by color of the beverage. Other sensory organs, the nose and mouth are

utilized to obtain information on flavor.

Need for sensory evaluation

Sensory evaluation may be designed to reflect common preference, to maintain the quality of food at a given standard, for the assessment of process variation, cost reduction, product improvement, new market development and market analysis.

Requirements for conducting sensory tests

The requirements for conducting sensory tests are

(i) Trained panel members

The requirements for an ideal panel member

a. Good health
b. Ability to discriminate easily between samples with appreciable difference in taste and smell
c. High personal integrity
d. Interest in sensory analysis of sample and
e. Willingness to spend time for the sensory evaluation.

Persons possessing the above qualities must be enlisted for the panel training. They should be given sample tests for identifying known samples with varying tastes and smell.

Only those who are successful in preliminary tests should be selected for more intensive training in different methods of analysis. The number of members in the trained panel should be small, varying from 5 to 10. The semi-trained panel should consist of 25 to 30 members. The findings in the case of the untrained panel should be based at least on 100 independent judgments.

(ii) Testing laboratory

The sensory evaluation laboratory consists of three separate units.

1. The reception room where the panel members meet the person in charge of the laboratory and get acquainted with the type of samples to be tested.
2. The sample preparation and serving of samples and
3. The test booth area where the actual sensory evaluation of the samples are carried out by the panel members.

The entire testing laboratory or at least the test booth area should be air conditioned and free from noise, and extraneous odor. Whenever samples with differences in color are tested, colored lights should be used to mask the color of the samples.

(iii) Sample preparation and presentation

The methods of preparing the samples and the most appropriate way of presenting them have to be determined by the scientist-in-charge of the laboratory. The methods used should be uniform so as to avoid variation between batches of the same sample. The temperature of the test samples should be kept at an optimum level and kept constant during the test. The cooking or heating of the samples should be done using an elective heater. Stainless steel forks and spoons can be used for tasting the samples.

(iv) Technique of smelling and tasting

For odor tests of food products, a special technique is frequently used to perceive the aroma more clearly. Smelling is done with a short, rapid sequence of short “sniffs” and tasting of coffee (or) tea (or) fruit juice is done by slurping one teaspoonful of the liquid. By the slurping technique, the same effect is produced as by swallowing. Wine and milk tastes usually roll the liquid on their tongue so that the liquid reaches all parts of the tongue where taste buds are located.

(v) Testing time and fatigue

For getting uniform results, the testing should be done at a time when the panel members are fresh. The best time for conducting tests is between 10 am and 12 noon in the morning. Too many samples should not be given as they may produce fatigue in the panel members and vitiate the results.

(vi) Design of the experiment and statistical analysis of the results

The distribution of samples for testing should be done according to statistical design with the help of statistician. Experimental error and bias can be minimized using statistical design for the distribution of samples. The results should be statistically analyzed with the help of statistician.

Types of tests

The selection of a particular test method will depend on the defined objective of the tests, accuracy desired and personnel available for conducting evaluation.

a. Difference tests

Difference tests are used to determine if there is any difference between or among samples. The three basic types of differences tested are simple difference, directional and quantitative difference, and quality preference difference. The methods of difference testing commonly used are the paired comparison duo-trio and triangle tests.

In Paired comparison test two samples, one standard and the other experimental are presented to the panelists to determine if the samples are different and the directional difference in a specific characteristic.

The Duo-trio test employs three samples, two identical and one different. The panel lists are first given the reference sample and then the other two samples two identical and one different. All the three samples are given successively in random order and asked to match one of them with the first.

The triangle test also employs three samples are prescribed simultaneously to the panelists who are asked to determine which of the three the odd sample is.

b. Rating tests

These tests are difference tests with a quantitative aspect through direction and degree of judgments using suitable defined scores or scales. A number of methods are employed for this purpose.

In a ranking test judges are asked to rank a series of samples in the increasing or decreasing order of a specified characteristic such as flavor, odor, color (or) texture.

A single sample (Monadic) test is used for testing foods that have an after taste or flavor carry over which precludes the testing of a second sample in the same session.

In two sample difference tests, the panelists are served with four pairs of samples. In two pairs, the test sample is a duplicate of the reference sample. In the other two pairs, the test sample is the test variable. The panelist is asked to judge each pair independently as to the degree of difference between the test sample and standard on a scale indicating no difference to large difference.

When more than one test variable is to be evaluated, multiple sample difference tests are employed. Each panelist is served 3-6 samples depending upon the number of test variables. One sample is known standard. The panelist compares the test sample with the known standard. One test sample is a duplicate of the standard. The difference of the test

sample from the standard according to the scale-none, slight, moderate and large is evaluated.

A hedonic rating test is used to measure the degree of pleasurable and unpleasurable experience of the food product on a scale of 9 points from “like extremely” “to” “dislike extremely”.

The numerical scoring tests are used to evaluate a particular characteristic of one or more samples indicating the rating as excellent, good fair and poor.

C. Sensitivity Tests

These tests are done to assess the ability of individual to detect different tastes, odor, and feel the presence of specific factors like astringency or hotness. These tests are used to select and train panel members for evaluating the quality of the products containing spices. For this purpose threshold tests for the recognition of basic tastes are employed for selecting the panel members.

Sensitivity – threshold tests: These tests measure the ability of the individual to smell, taste or feel specific characteristics in food or beverages. The tests are most commonly used in selecting panel members for evaluating and with materials such as spices for assessing the intensity of odor or flavor. Threshold is defined as a statistically determined point on the stimulus scale at which a transition in a series of sensations or judgments occurs.

Dilution test - It is designated to establish the smallest amount of unknown material, developed as a substitute for a standard product that can be detected when it is mixed with the standard product, e.g. margarine in butter.

d. Descriptive tests

These tests help identify the perceptual characteristics for product and express them on an agreed scale. The panelists record the impact of all quality attributes in a total perspective but not a single attribute and judgment with precision, for statistical analysis. The tests include flavor

profile tests to describe the aroma and flavor intensity characteristics of food textural profile tests to describe the sensory manifestations of structure of inner make up of foods, comprising concepts of texture, body and consistency of foods.

2. Objective evaluation – evaluating quality that depends on some measure other than human senses.

- Less expensive.
- Analysis with lab equipments.
- Gives information that correlates well with the sensory characteristics.

Types

- **Imitative measures** – instrument which imitate the way in which humans perceive the sensory property. (machine - duplicate the bite of human teeth)
- **Non – imitative measures** – determination of physical and chemical properties of food system that statistically correlates with sensory properties (eg.)Taste intensity of a particular acid solution – predicted by pH.

Basic guidelines

Conduct all objective tests appropriate to the experiment for which equipment is available (ex.) checking the pH prior to and after heating.

- Obtain necessary testing devices.
- Be meticulous about maintenance of objective equipment.
- Carefully define the samples to be used for objective testing.
- Establish operating conditions for objective testing.

Methods

1. **Chemical methods**

Chemicals are estimated in food spoilage like peroxides in fats. Adulterants in food like presence of starch in milk, metanil yellow in turmeric powder and loss of nutrients during cooking can be estimated.

2. **Physico – chemical methods**

a. Measurement of Hydrogen ion concentration can be found out by the use of pH meter.
b. Sugar concentration can be found by refractometer. It is used to determine the concentration of a sugar solution.
c. Polariscope is used for quantitative analysis of sugar

3. **Microscopic examination**

Some properties of foods depend on their structure and valuable information can be obtained by microscopic examination.

4. **Physical methods:** It involves the measurement of weight, volume, specific volume, moisture, color and cell structure.

Physical methods

- **Weight**: Weight of a food indicates the quality like in case of apple or egg.
- **Volume**: Liquid volumes can be measured by using measuring cups. Solid food volume can be found by displacement method.
- **Specific volume:** The determination of specific volume of any product should be done with car an average of replicates. The volume may be measured by displacement with solvents like kerosene.

$$\text{Specific volume} = \frac{\text{Bulk volume}}{\text{Wt. of the substance}}$$

- **Specific gravity:** It is a measure of the relative density of a substance in relation to that of water. This technique is used for comparing the

lightness of products physically unsuited to the volume measurements e.g. egg white foams.

- **Moisture:** Moisture can be identified through various methods such as press fluids, drying and wettability (baked goods).

$$\text{Moisture content} = \frac{\text{Initial} - \text{dried weight}}{\text{Initial weight}} \times 100$$

- **Cell structure**

Cell structure of baked products is an important characteristic to measure the uniformity, size and thickness of cell walls. Photocopies of cross-sectional slices give this valuable information.

Measurement of color

Color is the first quality attribute a consumer perceives in food.

Color dictionaries	The dictionary of Maerz and Paul is most commonly used
Disc colorimeter	Here the discs have radial slits so that a number of them may be slipped together with varying portions of each showing
Tintometers	The instrument is provided with sets of red, yellow and blued glass slides to be used as permanent standards
Colored chips	A simple method is to match the color of the food with the color chips or color glass, chart or color tiles
Spectrophotometer	Visual matching of colours is subject to shortcomings of human observers. Such an instrument can also measure the clarity, cloudiness of a liquid depending on the amount of light the liquid allows to pass

Rheology is defined as the science of deformation and flow of matter. It has three aspects –elasticity, viscous flow and plastic flow.

- To determine the flow properties of liquid food stuffs
- To ascertain the mechanical behavior of solid foods when consumed and during processing.

Instruments used for liquids and semisolids

Percent sag	The depth of a sample such as jelly is measured in its container by using probe
Stormer viscometer	It is used to measure the viscosity or consistency of certain food products and to give an index of the resistance of the sample to flow
Brookfield synchrolectric viscometer	This is based on measurement of resistance to rotation of a spindle immersed in the test material. Measures the consistency of custards, pie fillings, tomato products, cream style corn, mayonnaise, salad dressings, and dairy products
Bostwick consistometer	This is used for measuring the consistency of tomato ketchup and sauce. The use of this instrument is based on the theory that the length of flow is proportional to consistency
Efflux-Tube viscometer	It measures the time necessary for a quantity of fluid to pass through an orifice or capillary under standard pressure e.g. tomato puree
Adams consistometer	Measures the consistency of cream style corn, tomato puree, apple sauce and fruit pulps
Penetrometer	Measure tenderness of some foods Ex. Gels and baked goods.
Brabender farinograph	This is used to measure the plasticity of wheat dough for preparing bread products

Instruments used for solids

Food texture can be reduced to measurements of resistance to force. If we squeeze food so that it remains as one piece this is called compression e.g. bread.

If we apply a force so that one part of the food slides past another it is shearing e.g. chewing gum. If the force goes through the food so as to divide it we call it cutting e.g. cutting an apple.

If the force is applied away from the material, the food pulls apart by which we measure tensile strength e.g. chapathi.

Magness – Taylor pressure tester (compression)	It consists of a plunger of variable diameter which is pressed into the fruit to a given depth
Succulometer (compression)	measure the maturity of corn and storage quality of apples as determined by the volume of juice extracted under controlled conditions of pressure and time
Fibrometer	This is based on the cutting principle and used to differentiate mature stocks from the tender stocks e.g. green beans
Christal texturometer (cutting)	Checks the tenderness of meat
Voldokevich bite tenderometer	Imitate the action of teeth on food.
Tensile strength	An instrument used to find out the tensile strength of chapathi
Warner-Bdratzler shear	Used to measure the tenderness of meat

Flavor measurements

- No imitative objective procedures are available – to measure taste & aroma – E nose and E tongue.
- Closest evaluation of flavor – nerve responses in experimental animals – that are triggered by stimulating a taste cell.
- Gas chromatography – a sensitive lab procedure – to study chemical molecule that contribute to a aroma and flavor in food

Advantages	Disadvantages
Confidence can be gained as they are reproducible	Time consuming
Results would be accurate	Expensive
Less subjected to errors	Technical knowledge is required
Provide permanent record so comparison is easy	Instruments may not be available
Cannot be affected by any other factors	Some aspects cannot evaluated – flavor

Microbial examination of foods

Introduction

The potential of micro- organisms to spoil food rests on their ability to produce metabolites that are associated with spoilage and that will lead to rejection of foods by consumers. The growth of spoilage microorganisms in foods may result in changes in sensory properties, such as color, odor, texture, and appearance. Additionally, some microorganisms pose a health risk, and they are considered pathogenic.

Factors Affecting Microbial Behavior in Foods

The fate of microorganisms in foods depends not only on the physical and nutritional characteristics of the food but also on a set of extrinsic and intrinsic factors of the food and their interactions. Factors, such as temperature, pH, water activity, and redox potential, can be considered the most important factors driving microbial fate

in foods. Food industry takes advantage of the fact that these factors can be conveniently manipulated to prevent microbial contamination and growth in foods.

(i) Temperature: Among factors affecting microbial behavior in foods, temperature is for sure the most important one. The microorganisms can be classified into three groups according to their growth temperature domains:

Psychrotrophs	Grow well at 7°C or below and have an optimal growth temperature range of 20 – 30°C
Mesophiles	Grow well between 20 - 45°C and have an optimal growth temperature range of 30 – 40°C
Thermophiles	Grow well at 45°C or higher and have an optimal growth temperature range of 55 – 65°C

Reduction of temperature leads to increase of lag time in food borne microorganisms, culminating with the extension of shelf life. Therefore, it is one of the most used methods to preserve shelf life of minimally processed, pasteurized, and raw foods.

(ii) pH: It is well established that most microorganisms grow better in pH values close to 7.0, although a few can grow in pH values below 4.0. Bacteria tend to be more sensitive to pH than filamentous fungi and yeasts, and pathogenic bacteria are even more sensitive.

Spoilage microorganisms of the lactic acid bacteria group, for example, may grow in pH values as low as 2.0. Pathogenic microorganisms, such as *Cl. botulinum*, will not grow in pH values below 4.6. Because of its pathogenic potential, pH 4.6 is used as a limit for a food to be classified as of low acidity or high acidity (<4.6).

The minimum and maximum pH values tolerated by each microbial species depend also on other factors. For example, the minimum pH required for the growth of certain lactobacilli depends on the type of acid used: Citric, hydrochloric, phosphoric, and

tartaric acids enable growth at lower pH values than acetic and lactic acids.

(iii) Water activity: Water activity is related to the amount of water available for the metabolic reactions within the cell. In fresh foods, a_w exceeds 0.99. In general, bacteria need higher water activity than fungi, and Gram-negative bacteria need higher water activity than Gram-positive bacteria. Most bacteria associated with food spoilage grow at a_w above 0.91, whereas most filamentous fungi can grow at a_w as low as 0.80.

The general effect of reducing water activity to a value below the optimum value is to increase the lag phase and reduce growth rate. Lowering the water activity causes what is known as osmotic stress.

(iv) Other factors: In addition to temperature, pH and water activity, other factors are also important, such as the redox potential (Eh), packaging system, food structure, relative moisture, and atmospheric composition.

Microbiological Spoilage of Foods

Bacterial spoilage of foods

Although many bacteria can grow in foods, only some specific groups are responsible for their spoilage. The survival, growth, and occurrence of these microorganisms in foods are affected by many different factors, including storage temperature, oxygen availability, food composition, pH, thermal treatment, and competing microbiota, among others.

However, the occurrence of certain microorganisms in these foods is mainly promoted by temperature and atmosphere. Temperature is a limiting factor as it can favor the growth of some spoilage microbial groups and impair the growth of others.

Yeast spoilage of foods

Yeasts are very important unicellular eukaryotic microorganisms involved in both food and beverage production and spoilage. These microorganisms spoil foods with high sugar or salt contents, low pH, or other characteristics that give them a competitive advantage over bacteria. Most yeasts produce extracellular enzymes, such as proteases, lipases, amylases and pectinases, and also volatile and nonvolatile metabolites that affect the sensory characteristics of food, especially flavor and texture. The main genera associated with food spoilage are *Saccharomyces*, *Candida*, *Zygosaccharomyces*, *Debaryomyces*, *Rhodotorula*, and *Pichia*.

Yeasts play an important role in the spoilage of fruits and vegetables, especially because of the exposure of these foods to the environment and their minimal processing. Some of their intrinsic factors, such as pH, also limit bacterial growth.

Filamentous fungi spoilage of foods

Filamentous fungi are capable of growing on many different foods, such as grains, meats, milk, fruits, vegetables, seeds, and high-fat products. They are an important group of food spoilage organisms and cause significant economic losses in agriculture and the food industry. Spoilage caused by filamentous fungi may manifest as discoloration, off-flavors, loss of structure, loss of texture, formation of visible mycelium, and production of volatile compounds, all of which affect the quality of foods and beverages. These obligate aerobic microorganisms are capable of growing in wide ranges of pH, temperature, and water activity and of using a great variety of substrates as food.

Controlling Microbiological Spoilage of Foods

The methods used for controlling microbial spoilage include preventing access of the organisms to the foods, removing their cells

or spores, inhibiting their growth, and using thermal and non thermal methods to inactivate them.

Pesticide residues in horticultural produce

Introduction

The term pesticide covers a broad variety of compounds including insecticides, fungicides, herbicides, rodenticides, molluscicides, nematicides, plant growth regulators and others.

Pesticides have consistently revealed their worth through increased agriculture productivity, reduced insect borne, endemic diseases and protection as well as restoration of plantations, forests, harvested wood products, homes and fiber.

Ideal pesticides must act selectively against certain pest organisms without adverse effects to non-target organisms. However, it is difficult to achieve absolute selectivity and most pesticides are also toxic to humans and other non-target organisms. Pesticide use raises a number of environmental worries, including human and animal health hazards. Food products contaminated with toxic pesticides are associated with severe effects on the human health.

Pesticides have been associated with a wide spectrum of human health hazards, ranging from short-term impacts such as headaches and nausea to chronic impacts like cancer, reproductive harm and endocrine disruption.

Pesticide residues in food grains, vegetables and fruits

Pesticide residue refers to the pesticides or metabolic products of the pesticides that may remain in food grains, vegetables and fruits after they are applied to crops. Many of these chemical residues, especially derivatives of chlorinated pesticides, exhibit bioaccumulation which could build up to harmful levels in the body as well as in the environment. Persistent chemicals can be magnified through the food chain and have been detected in products ranging from meat, poultry, and fish, to vegetable oils, nuts, and various fruits and vegetables. Insects and pests can cause a

loss in the quality and quantity of grains and their products. The application of pesticide is widely used for grains before harvest and after harvest to protect the grains from damage or loss.

Cereal grains are treated with degradable pesticides, including organophosphates, carbamate, synthetic pyrethroids and insect growth regulators, both in storages and prior to shipment in order to prevent insect infestation. The most consumed pesticides for vegetables, fruits and food grains in India include sulphur, endosulfan, mancozeb, phorate, methyl parathion, monocrotophos, cypermethrin, isoproturon, chlorpyrifos, malathion, carbendazim, butachlor, quinalphos, copper oxychloride, and dichlorvos

Toxic effects of pesticide residues on human health

Many pesticides achieve their intended use of killing pests by disrupting the nervous system. Due to similarities in brain biochemistry among many different organisms, there is much assumption that these chemicals can have a negative impact on humans as well. There are epidemiological studies that show positive correlations between exposures to pesticides through occupational hazard, which tends to be significantly higher than that ingested by the general population through food, and the occurrence of certain cancers. Although most of the general population may not expose to a large portion of pesticides, many of the pesticide residues that are attached tend to be lipophilic and can bio-accumulate in the body.

Toxic effects of pesticides depend upon their toxicological properties, the level of residues and degree of exposure of human beings to residues. The presence of pesticide residues in grains does not necessarily mean that it is hazardous. To be toxic, the residues have to be present in quantities large enough to be considered unsafe. The organophosphate, organochlorine and related pesticides act by binding to the enzyme acetylcholinesterase, disrupting nerve function, resulting in paralysis and

may cause death. They may produce acute effects manifesting as meiosis, urination, diarrhea, diaphoresis, lacrimation, excitation of central nervous system and salivation.

Neuronal damage due to cholinergic neuronal excitotoxicity and dysfunction

Following exposure to organophosphates, accumulation of acetylcholine at synapses results in rapid and profound excitotoxicity and dysfunction of cholinergic neurons in the brain. Overstimulation of muscarinic acetylcholine receptors may also disrupt the balance of excitatory and inhibitory mechanisms to cause neuronal excitotoxic lesions leading to seizures and respiratory depression. Therapeutic intervention to control the convulsions is unable to halt progressive neural injury and neuronal cell death caused by organophosphate poisoning.

In the first few hours after organophosphate poisoning, as the result of the cholinergic neuronal excitotoxicity, extensive intracellular edema, cerebral hemorrhages, intracellular calcium overload, oxidative stress and increased neuro inflammatory responses were generally observed in the affected brain regions.

Long-term neuropsychiatric and neurological disorders: Exposure to organophosphates involve damage to cholinergic neurons of basal forebrain and the limbic system, which may cause memory, cognitive, mental, emotional, motor and sensory deficits by disrupting this putative sensory-limbic gating mechanism.

Persistent memory and cognitive deficits: Memory and cognitive deficits are one of the most common and persistent behavioral sequelae in victims exposed to organophosphates.

Oxidative stress: In sub chronic or chronic organophosphate exposition induction of oxidative stress has been reported as the main mechanism of organophosphate toxicity. Oxidative stress is induced in both acute and

chronic intoxication with organophosphate compounds in humans and experimental animals. Hyperglycaemia is one of the mechanism of oxidative stress in organophosphate intoxication.

Development of cancer: The studies on cancer analyze the risks associated with the consumption of specific products which have some pesticide residues. These consumption products include fish, water, seafood, and milk or other dairy products. Organochlorine pesticide residue levels were reported significantly higher in the cancer patients.

Reproductive disorders: Results indicated that increase of insecticides in blood level in vertebrates causes reproductive dysfunction and suggested that for human beings food like fish, chick and goat containing beyond permissible limit of insecticides must be avoided. Consumption of high pesticide residue fruits and vegetables was associated with lower total sperm count, ejaculate volume and percentage of morphologically normal sperm among men attending a fertility clinic.

Pesticides exposure may lead to reduced fertility, early and late pregnancy loss, prolonged time to pregnancy, spontaneous abortion, and premature birth in female and genetic alterations in sperm, reduced sperm count, damage to germinal epithelium and altered hormone function in male.

Preventive measures to reduce pesticide residues in food grains, vegetables, and fruits

Different types of pesticides are used in different coun- tries for different types of crops to prevent pests, insects, and weeds. Because of the expansion of worldwide trade, more foods which are treated by pesticide are being imported into different countries. These worldwide trades increase the expansion of pesticide residues in different areas of the world and it's the issue of public health concern. There are a number of strategies which can be used to minimize pest and disease problems and reduce pesticide residues in food grains, vegetables and fruits.

Organic farming: One of the methods used to reduce the effect of pesticide residue in food is to eat organic foods than non-organic ones. Organic crops, on average, have higher concentrations of antioxidants and a lower incidence of pesticide residues than the non-organic foods across regions and production seasons. It is advisable to consume foods rich in antioxidant to reduce effects of the chronic disease by suppressing oxidative activity. An increased dietary intake of antioxidant rich foods protect against chronic diseases, including cardio vascular diseases, certain cancers (e.g. prostate cancer) and neurodegenerative diseases.

Washing food products: The second methods reported to reduce pesticide residue in food are washing. Washing may reduce pesticide residue in food commodities. Washing with water and various chemical solutions for domestic and commercial applications is necessary to decrease the pesticide residues.

Processing food products: An important factor leading to a reduction of any residues left on crops at harvest are processing treatments such as washing, peeling, canning or cooking that the majority of foods receive prior to consumption. Pesticide residue levels in fruit and vegetables may change due to processing, such as peeling, boiling, frying, fermentation, grinding. Cooking also reduces pesticide residues in food; boiling may remove 35 - 60% of organophosphate residues and 20 - 25% of organo chlorines. Husking and immersing of fruit and vegetables are reported to reduce pesticide residues especially organophosphates.

Rational use of pesticides: Rational use of pesticides involves selection of correct pesticides, dosage rates, dilutions, timing, and frequency of application, treatment intervals, and method of application, precautions, and limitations. Rational use of pesticides can be useful to reduce pesticide residues in food products. In many cases, there may not be any need of a pesticide, particularly where cultural or biological methods are effective.

Use of natural pesticides and bio-pesticides: Bio-pesticides are biodegradable so no harmful residues are produced and are eco-friendly. Bio-pesticides encompasses a broad array of microbial pesticides, biochemical's derived from micro-organisms and other natural sources that confer protection against pest damage. Some insect repellents can also be used for the prevention of pesticide residues accumulation in the food grains, vegetables and fruits. Natural pesticides such as extracts and compounds from neem tree are also very useful for the prevention of pesticide residues accumulation in the food products.

Implementation and amendment of pesticide-related laws: In India, the agriculture ministry regulates the manufacture, sale, transport, distribution, export, import and use of pesticides under the Insecticides Act, 1968. Still awaiting Parliamentary approval is the Pesticide Management Bill of 2008, which is meant to replace the Insecticides Act, 1968. The pesticide-related laws should be implemented strictly and amended so as to reduce the cases of pesticide residues in food grains.

Conclusion and future perspective

The impact of pesticide residues can be minimized by preventive measures such as rational use of pesticides, washing and proper processing of food products, practicing organic farming, use of natural pesticides and bio-pesticides, and strict implementation and amendment of pesticide-related laws.

Maximum Residue Limit values of some common insecticides on some vegetables

Insecticide	Commodity	MRL (mg/Kg)
Carbaryl	Okra and leafy vegetables Other vegetables	10 5
Diazinon	Vegetables	0.5
Dichlorvos	Vegetables	0.15
Dicofol	Fruits and Vegetables Chillies	5.0 1.0
Dimethoate	Fruits and Vegetables Chillies	2.0 0.5
Endosulfan	Fruits and Vegetables	2.0

	Chillies	1.0
Malathion	Vegetables	3.0
Lindane	Fruits and Vegetables	1.0
Methyl parathion	Vegetables	1.0
Chlorfenvinphos	Vegetables	0.05
Chlorpyriphos	Potato and onion Cauliflower and cabbage Other vegetables	0.01 0.01 0.2
Ethion	Cucumber and squash	0.2
Formathion	Vegetables Peppers and tomato	2.0 1.0
Phosalon	Potato Other vegetables	0.1 1.0
Trichlorfon	Fruits and Vegetables	0.1
Thiometon	Potato Other vegetables	0.05 2.5
Carbofuran	Fruits and Vegetables	0.1
Cypermethrin	Egg plant Cabbage Okra	0.2 2.0 0.2
Fenvalerate	Cauliflower Egg plant Okra	2.0 2.0 2.0
Phorate	Tomato Other vegetables	0.1 0.05
Permethrin	Cucumber Soybean	0.5 0.5
Quinalphos	Cardamom	0.01
Triazophos	Chillies	0.2
Fenpyroximate	Vegetables	0.02
Spiromesifen	Tomato Cucurbits	0.45 0.1
Dicofol	Fruits and Vegetables	5.0 (PFA)

Insect contaminants in horticultural produce

Some facts about insects

- Insects are the most prevalent features of our environment.
- Everybody has to deal with insects. Some find then fascinating while others may see them as a hindrance
- It is the abundance (large number) of these insects which make them important and attract our attention

- The abundance of insects depends upon their inherited traits and environmental factors. Since both these factors are dynamic, insect number is also dynamic

Beneficial effects of insects

- Industrial importance
- Pollination
- Entomophagous insects
- Nutrient cycling
- Human food
- Aesthetic value
- Study tools
- Insect collection can be adopted as a hobby
- Scavengers

Insects of industrial importance

- Honeybees: Honey, beeswax, bee venom, royal jelly, propolis and pollination
- Silk worm: Silk
- Lac insect: Shellac

FACTORS INFLUENCING PEST POPULATIONS:

- Abiotic factors (Temperature, humidity, light)
- Biotic factors (Food, predators, parasitoids, pathogens)

Temperature: Affects the following parameters of individuals of population such as endocrine system, growth, development and reproduction.

Humidity: Encourages diseases and Excessive body moisture during winter may reduce its capabilities to withstand low temperatures.

Light: Light acts as stimulus for insects to synchronize and regulate their life cycles with change in seasons. Influences the motor activity rhythm of

insects such as locomotion, feeding, adult emergence, mating, oviposition, and also moulting and growth in some species.

Biotic factors:

- Food:
  - Food quality and quantity affects growth, development, survival, longevity, reproduction, distribution, etc.
  - When the food is in short supply there is intraspecific or interspecific competition.
  - Competition acts in density dependent manner.
  - Food supply may be affected by many factors
- Natural enemies: Predators, parasitoids and entomopathogens like bacteria, fungi, viruses, nematodes, rickettsiae, etc.
- Natural enemies act negatively on insect populations.
- Influence is variable because their own populations are influenced by various environmental factors.
- Predators generally respond to increase in pests population through:
  - Numerical response (By increasing their number)
  - Functional response (By increasing the consumption).

ECOLOGICAL BASES OF PEST MANAGEMENT:

CONCEPTS OF IPM

- Avoidance of economic damage with minimum affects on the environment
- IPM: In simple language IPM is the utilization of all possible control tactics to suppress the pest population below economic injury level with minimum adverse impacts on environment.
- Economic Injury Level (EIL): It is the minimum pest population which causes the economic damage.
- Economic damage: The damage caused by the pest to a crop which justifies the cost of control or in other words it is the damage equal to the cost of control.

- Economic Threshold Level: It is the pest population where control measures should be initiated to prevent the pest population in reaching the EIL.

Basic necessities in IPM:

- Measurement of pest population intensity.
- Determining the influence of natural enemies on the pest population
- Crop loss assessment by the pest
- Monitoring of pest population for decision making.

COMPONENTS OF IPM:

- Cultural control
  - Tillage
  - Planting and harvesting time
  - Sanitation
  - Plant diversity
  - Trap cropping
  - Crop rotation
  - Nutrient and water management
- Mechanical control
  - Hand picking
  - Exclusion by screens and barriers
  - Clipping and pruning
- Physical control
  - Hot and cold treatment
  - Light trapping
- Legal control
  - Legislation for foreign quarantine to prevent the introduction of new pests from abroad.
  - Legislation for domestic quarantine to prevent the spread of established pests within country or a particular state.
  - Legislation for notified campaigns of control against pests.

- Legislation to prevent the adulteration and mishandling of insecticides or other devices used for the control of pests.

- Biological control
  - Predators: Lady bird beetles, syrphid flies, lace wings, etc.
  - Parasitoids:*Trichogramma* spp, *Apanteles* spp, *Bracon* sp, etc
  - Bacteria: *Bacillus thuringiensis*
  - Viruses: NPVs and GVs have been successfully used.
  - Fungi:
- *Beauveria bassiana*: Against beetles and caterpillars
- *Metarhizium anisopliae*: Against beetles and caterpillars
- *Nomuraea rileyi*: Against caterpillars
- *Verticillium lecanii*: Against sucking pests
- *Paecelomyces* sp: Against sucking pests
- Chemical control
- Semiochemicals
- Other components:
  - Growing resistant cultivars
  - Use of sex pheromones for monitoring, mass trapping, mating disruption and auto confusing the target pests.
  - Use of botanical pesticides especially neem based insecticides.
  - Need based, safe and judicious use of synthetic pesticides.

Advantages of IPM:

- It provides sustainable control of the pest and also adds to sustainable crop productivity.
- It is economically viable and is affordable by marginal farmers.
- It is environmentally safe.
- Less health hazards.
- Social and political stability
- Quality produce with minimum pesticide residue and hence will enhance the export of agricultural commodities

Methods of estimating the crop losses:

Estimation of crop losses caused by the pests is very important in pest management programmes. Estimation of pest damage is useful in pest management in following ways:

- To determine the economic status of a given pest species.
- For establishing the economic threshold levels and economic injury levels of the pest.
- To estimate the effectiveness of control measures.
- For evaluating the crop or a variety for its reaction to the pests.
- Helping in deciding the allocations for research and extension in plant protection.
- Helping in assigning the priorities on the bases of relative importance of different pests.

A brief account of the techniques adopted for the assessment of crop losses caused by insect-pests has been given below:

Mechanical protection: The crop is grown in enclosures under protected conditions by using anti-insect nets or cotton cloths in order to keep the pests away. The yield obtained under theses enclosures is compared with that obtained from infested crop grown under similar conditions. This technique has been used with various modifications for estimating the crop losses caused by jassids and whiteflies. The limitation with this method is that the plants generally become week and pale in enclosures due to changes in micro-environment. Further, this technique cannot be used on a large scale because it is time consuming and impracticable under field conditions.

Chemical protection: In this case the crop is protected from pest damage by applying chemical pesticides. The yield of treated plot is compared with that of untreated which is exposed to natural infestation. This technique has been extensively used and can be employed on a larger area. Here care should be taken that the treated and untreated plots should be as identical as possible in respect of soil type, variety grown, fertilization and other

cultural practices. The major drawback in this method is that the crop treated with chemicals may be physiologically affected and hence may vary in yield to some extent.

Comparison of yield in different fields: In this case the yield of the crop is calculated per unit area in different fields having different degree of infestation. Correlation between crop yield and level of infestation is worked out to estimate the loss in yield. This technique can be used for estimating crop loss due to different pests over a larger area, however the soil heterogeneity may influence the yield.

Comparison of yield of individual plants: In this case the yield of individual plants in the same field is measured and the average yield of healthy plants is compared with the plants showing different degree of infestation and the loss in yield is estimated. The data so obtained can also be used to work out the correlation between yield and infestation level on the bases of the yield of individual plants. This technique has been used with different modifications for the estimation of crop losses in different crops. In this case the soil heterogeneity is greatly reduced, however, plant to plant variation in infestation level may be there.

Damage caused by individual insect: Preliminary information is obtained from studies on the biology of the pest. The details regarding the amount of damage caused by different stages of pest are worked out and the amount of loss is calculated. This technique is quite convenient in case of leaf feeding insects. However, it is difficult to use this technique over a large area because it is time consuming.

Manipulation of natural enemies: Here the pest is controlled by introducing the natural enemies in to the field and the yield is compared with the plot without natural enemies. This technique is also feasible in a small area.

Simulation of damage: In this method the pest injury is simulated by removing or injuring the plant parts. The simulated damage may, however, not always be equivalent to the damage caused by an insect. Insects may inject toxins in to the plant rather than producing injury instantly. Feeding on margins of the leaf may not be equivalent to the tissue removed from the centre of the leaf. Insect feeding is usually extended over a period of time and is rather difficult to incorporate the concept of rate of injury in simulating studies. Furthermore the period of leaf removed may be important, as for example the age, quality and position of the leaf on the plant. In addition the time of simulating damage with respect to the stage of growth is also critical.

Quality of organic produce

Introduction

Fruits and vegetables are big reservoirs of all the dynamic nutrients. These are the economical source of protective nutrients available in fresh or processed or preserved form for human consumption throughout the year. These raw horticultural produce are rich in minerals, vitamins, along with trace elements like copper, manganese and zinc, which are the integral part of various enzyme cofactors required in different metabolic reactions. Consistent intake of fruit and vegetables is highly beneficial and has been associated with reduced chances of cancer, stroke, cardiovascular disease, cataracts, Alzheimer disease and other dysfunctionalities due to aging.

In India, there is a vast market for fruits and vegetables, and a variety of them are available in plenty throughout the year due to favorable agro-climatic situations. Although nutritional composition of fruits and vegetables varies with the varieties, cultural practices, post-harvest handling, stage of maturity and storage conditions, there is a huge potential for processing fruits and vegetables for value addition and divergence for expanding food industry horizons.

Good amount of nutrients with high moisture content, internal metabolism and microbial infestation make horticultural produces more susceptible and thus shorten post harvest shelf life. Being highly perishable,

about 20-40 per cent of the total fruits and vegetables produced goes waste due to lack of processing and efficient supply chain.

To ensure sufficient food availability for every inhabitant in our planet in quantity and in quality, reduction of the post-harvest losses is very crucial. It will ensure that sufficient food availability and ensures about global food security. There is immense need of preservation and storage methods to extend their shelf life, for throughout the year availability either in preserved or processed form and to avoid huge losses. Although, the prime target is still to maintain the quality of the produce which is based on the various attributes such as chemical composition, nutritive values, mechanical properties like texture, firmness and sensory properties.

Quality evaluation

Produce quality is an important criterion for growers because it determines marketable yield and can affect the price of the produce. The ideal characteristics for quality grades vary with commodity, and it is important to be aware of market standards for each commodity.

In fruits and vegetables, these characteristics include maturity, size, shape, color, flavor, appearance, texture and the absence of damage and spots.

Color and flavor are vital constituents of food, giving it a distinctive behavior. The perception of flavor is a complex interaction of taste (e.g. sweet, bitter), texture (e.g. smooth, crisp) and aroma (e.g. fruity). The absence of harmful substances is also an important indicator of quality, especially in commodity consumed raw like fresh produce. All these quality parameters regulate the produce quality and decide about its nutritional status, consumer acceptance and economic value.

Post-harvest malpractices

Fresh horticulture produce respire continuously after harvest and thus are highly perishable. Commodities picked too early or too late have a shorter storage life comparatively than those picked at the proper maturity. Fresh fruits and vegetables comprises with more amount of water (70-95 per

cent) and high respiration rates making such crops highly perishable and thus leads to the loss of produce during marketing and until it reaches to the consumer level.

Generally, the consumers observe only the produce appearance for selection. There is increased risk that these commodities may be either chemically treated or colored to enhance its appeal and to misguide the consumer about the real quality. These post-harvest maltreatments are potentially harmful to the produce nutritional quality along with their dangerous effect on human body.

Consumption of fresh fruits and vegetables loaded with carcinogenic materials and laden with toxins may not result in immediate health implications, but on prolonged consumption, it may lead to severe health ailments such as cancer, ulcers and also cause other health ailments in major body parts including liver, kidneys, teeth, intestinal tract and brain.

Color

Natural colors like chlorophyll, caramel, annatto and other synthetic colors are used in food industry. Low cost and easy availability of non-permitted colors is increasing by unscrupulous traders. These artificial coloring ingredients, synthesized from coal tar and petrochemicals, are dangerous to our health.

Synthetic colors are chemically synthesized, more stable, inexpensive, convenient and possess high tinctorial strength. The color enhances the appearance; consumer appeal and marketability. The health unconscious attitude of the consumer along with enhanced marginal benefits intention of traders is leading to adulteration of foods.

Cut fruits, vegetables, spices (like chili powder, turmeric) are usually adulterated with colors, permitted and non-permitted both, such as rhodamine B, auramine, metanil yellow, congo red, orange II and malachite green, to attract the consumer. These toxic and health hazardous chemicals alter the physical appearance of product as well as affect the nutritional and physiological values.

Horticultural fresh produce are given a dose of artificial color to suit the consumer's eye. Artificial colors used in the fresh supply should be avoided, as it contributes to major health problems; the most critical is attention deficit hyperactivity disorder (ADHD), a behavioral pattern.

Margin seeker people are practicing these malpractices of dipping green fruits and vegetables in artificial colors to provide a fresh, shiny, pleasant and attractive appearance. In vegetables malachite green, a potent carcinogen is frequently used to polish green vegetables such as green chili, green peas, bitter gourd, lady finger and pointed gourd to show them green and fresh. This accentuates bright, glowing green color of vegetables. The colored dye has proven to be carcinogenic for humans on prolonged consumption. Though this can easily be detected by placing sample on the moistened white blotting paper, colored impression indicates about the presence of adulterant.

Copper sulfate had been reportedly used in green vegetables such as bitter guard and lady fingers. It is pale green in anhydrous form and bright blue in hydrous form. Vegetables are dipped in copper sulfate solution to look greener and so more appealable to consumer but prolonged consumption may cause anemia.

On consuming juices from treated vegetables (bottle gourd, bitter gourd) may cause abdominal pain, vomiting and other serious problems leading to hospitalization.

Another common example of malpractices is in case of melons and watermelons. Consumer prefers ripe, bright red melons and asks to vendor to confirm his quality at buying stage. This forced vendor to manipulate the quality by injecting red dye and sweeteners in fruit to meet the consumer demand. The colors used in these foods include methanol yellow, lead chromate and Sudan red. Methanol yellow may lead to stomach ailments, cancer and degeneration of the reproductive organs in male, whereas lead chromate causes brain damage, blindness and anemia and Sudan red can cause stomach problem and is carcinogenic.

FSSAI prohibits use of such colors in fruits and vegetables also. Horticultural crops are rich source of phytochemicals. Chemicals like colors

and dyes used for horticultural crops may lead to the deterioration of such phytochemicals. Chemical treatments hinder the maintained phenolics and causes deterioration of fat soluble vitamins.

Chemical treatments

Active metabolism and numerous biochemical conversions in fruits and vegetables are responsible for continuous decline in original composition and various quality parameters and thus overall profit. In this chain of constant decline in quality, only initial condition is considered as fresh. Traders apply chemical treatments on minimally processed fresh produce for controlling decay, browning and retaining texture and firmness.

Freshness

Most of the vegetables we buy from the markets are treated with a heavy dose of chemicals to make them look fresh, attractive and pleasant. Cabbage sellers were caught spraying formaldehyde to keep them fresh post-harvest storage. The head portion of cabbage is cut from the ground and cabbage is dipped in a formaldehyde solution immediately and then stored/processed. This formaldehyde application assures freshness for about a week, and this practice was more common in warmer climate. Formaldehyde irritates skin, may cause breathing and digestive problems and is reported as carcinogenic.

Fruit ripening

Ripening of fruits is a complex process involving biochemical, physiological and molecular changes leading to change in color, acidity, sugar content, texture and aroma compounds. Ripening provides distinctive characteristics, i.e. sweetness, flavor, color, softness and palatability to horticulture produce. It may take several days from harvesting of fruit to reach to consumer's basket and different metabolic activities are still going on during transportation and storage deteriorating overall acceptability of commodity, thus providing fewer benefits to retailers.

The profit-based approach of retailers has drifted toward the stage at which horticultural produces are ripened at the destination markets just before retailing with the help of artificial ripening to avoid or restrict these changes. Ethephon/calcium carbide/ethylene and oxytocin are commonly used in fruit and vegetable markets/farms for size enlargement and ripening artificially.

Calcium carbide reacts with moisture and releases acetylene gas which is analogous to ethylene and fastens the process of fruit ripening. Besides being synthetic, ripening effect of acetylene is not comparable to ethylene, as it changes only the surface color of sample; the inside of the fruit is still un-ripened.

Acetylene being acidic in nature may lead to ulcer, kidney and liver damage on long run consumption. Calcium carbide is a cheap and easily available chemical ripening agent with the name Masala and possesses carcinogenic property. Masala is indiscriminately used for ripening as compared to other recommended ripening practices in different countries.

Ethephon has been reported to hasten ripening of several fruits like apples, cherries, blueberries figs, pineapple, tomatoes, peaches, guava, grapes, citrus and walnut. The released ethylene gas increases the rate of ripening process. Ethephon ripens the fruits faster than calcium carbide and thus considered better. Ethephon-ripened fruits have better color profile than fruits which are naturally ripened and also have longer shelf life than fruits ripened with calcium carbide.

Sweetness

Attempts are also made to alter the natural sweetness of horticultural produce specially fruits. Saccharine mixture was injected into melons and water melons to make them extra sweet even if they are totally lacking in sweetness. This became evident in those fruits which turned out to be half sweet and half tasteless. Injector pumps the sweetener mixture on the one side of fruit presuming its uniform distribution throughout the pulp. Vendors have started injecting saccharine drops from several points in the fruit to ensure uniform sweetness.

Growth hormones

Chemicals like gibberallic acid, alpha naphthyl acetic acid, oxytocin and copper sulfate are used by many farmers to ripen and enhance growth and color in vegetable crops. Oxytocins are mammalian hormones, used as veterinary drug and are not suitable for use in fruits and vegetables. This is available with various common names like cocin and paani to dawai at drug stores throughout the country. This hormone is commonly used to plump up vegetables like bottle gourds, bitter gourds, pumpkins and cucumbers. They inject their veggies in early stages with oxytocin to enhance size and color in comparison to normal natural sizes to attract the consumers.

Oxytocin acts primarily as a neurotransmitter in the brain and has important role in sexual, emotional behavior and female reproduction. Unfortunately, this is just impossible to distinguish between a normal vegetable and one that's been pumped with oxytocin.

Medical experts reports that these hormones may cause irrepairable damage to our health, when consumed through fruits and vegetables over a prolonged time. This overlong consumption may result in uterine cancer, male impotency, excessive hair and early or erratic periods on women, balding for man, exhaustion and loss of energy.

Waxing

Waxing is an old age art and has been used as preservation technique for fruits in the beginning of the nineteenth century. Wax is an ester formed with conjugation of high molecular weight alcohol and fatty acid. Wax coatings offered great resistance to moisture loss as compared to other coatings. Wax coating applied on produce is dried properly before further unit operations and handling. Food grade waxes are used to reduce the water loss, surface abrasion and control internal gas composition during handling and marketing.

Beeswax, wax from Camauba palm tree (Carnauba wax), and shellac (secretion from the lac beetle) are preferred over petroleum-based waxes, which contain wood rosins or solvent residues. Examples of fruits on which wax coating is possible are breadfruit, passion fruit, coconut, carambola,

grapefruit, guava, mango, lime, lemons, orange, papaya, avocado (pear), tangerine, pineapple and vegetables are melon, bittergourd, cassava, eggplant, peppers, sweet potato, tomato, pumpkins, yam, cucumber, asparagus, turnip, brinjal, okra, parsnip, sweet peppers and tomato.

Wax coating is applied to replace natural wax which has been lost during primary processing and thus reduced water losses further and provides shiny and attractive appearance. There is provision for usage of waxes as per Good Manufacturing Practice (GMP) for use as food additives under proper declarations on label. Application of wax and post-harvest antimicrobial substances must be indicated on each shipping container.

Residue or maximum limits

FSSAI, FDA and other regulatory bodies permitted carnauba or bee wax (white and yellow) or shellac wax only as per GMP for use of food additives.

Artificial ripening agent carbide gas is strictly prohibited for fruit ripening under FSSA, 2006, so its residue has no tolerance limit permitted. Regulatory bodies assign no tolerance limit and not allowed any type of mineral oil or color on fruits and vegetables.

Heavy metals are allowed up to some tolerable limits and should not exceed the value assigned by regulatory bodies in fruits and vegetables given under FSSA, 2006.

Crop contaminants presence and presence of naturally occurring toxic substances or anti-nutrients in fruit and vegetables should not be more than or exceed the maximum limit as per specifications of FSSAI and FDA.

In India, as per FSSA, 2006, “The fresh fruits and vegetables coated with wax (bees or carnauba) should have proper declaration on label”. The information should be clear and clearly states about the origin of wax (animal based or vegetable based wax) used in coating of the product with food-grade certification like beeswax, petroleum and/or shellac-based wax or resin to maintain freshness.

Additives or ingredients used in coating may contain allergens such as milk, soybeans, fish, peanuts, nuts and wheat. Therefore, the presence

known allergen either in product or coating on a food must be also clearly mentioned on label.

Wax coating and other agent used in apples for coating forms an insoluble layer inside the intestine or alimentary canal, thus reducing nutrient absorption. So, consumers are advised to wash the fruits thoroughly and wash properly or boil the vegetables for a while before consumption; however, negative impacts cannot be fully omitted.

Regulation

Various food safety rules have been designed for produce quality, containment, presentation and safety. These rules either leave a gap or are not implemented strictly. Codex alimentarious standard for fresh fruits and vegetables states that fresh fruit/vegetables are generally free of additives

Regulatory bodies, FSSAI and FDA permitted usage of carnauba wax or beeswax (yellow and white) or shellac wax as food additives and ingredients according to GMP. FSSA, 2006 and CODEX set the tolerance limits of heavy metal present in the food item. No color and mineral oil has been allowed in fresh fruits and vegetables, still these chemicals are consistently in use.

Food Safety and Standards Act 2006 is not in existence practically, so the strict implementation of FSSA and Rules by the State Governments should be there. The concerned health and food safety authorities should keep a keen eye on use of hazardous post-harvest treatments. There should be provision of some legal actions for violation of the provisions of act.

The FDA and Codex Alimentarius should ban dyes usage in food, which serve no purpose other than coloring and cosmetic effect, but there are difficulties in law. In the meantime, companies voluntarily should replace dyes with safer, natural colorings.

Food inspectors and food safety officers are empowered and educated under FSSA 2006 to inspect and examine food items intended for sale and to send them for further examination to the Food Quality Laboratory. FSSAI started training programs for the food handlers in organized and unorganized sectors regarding food handling and safe food production.

Vigilance in wholesale market should be strengthened, and officials should take steps to curb adulteration. Legal and regulatory frameworks for product chain management should be there to ensure safe and quality food. Proper training should be given to fruit traders and sellers, and there should be awareness about the possible health hazards and imbued with a sense of moral responsibility to the society.

There are no simple solutions to tackle the menace of adulteration: adequate food testing facilities, complete transparency in the functioning of the department of civil and food supplies and getting samples of suspected food tested at regular intervals, are just some answers. Governments should upgrade the infrastructural facilities for proper handling, storage and marketing the fresh produce.

Advice for consumer

Food malpractices can occur at various levels such as production, entrepreneurship or sale. Consumers should prefer to buy the locally grown horticultural produce because the chances of malpractices are minimal in such produce. Consumer should check ISI, GMP, FPO, Agmark, etc., labeled food products to ensure best quality of produce. There is need of awareness programs and campaigns about quality food. FSSAI has taken a step forward and is organizing training programs for all food handlers. The misbranded/mislabeled product manufacturer is liable under the Food Safety and Standards Act, 2006 to be punished with imprisonment and fined.

Unit – III National food laws and standards

Standards for food packaging and labeling – Prevention of Food Adulteration Act (PFA), FSSAI, Bureau of Indian Standards (BIS), Agricultural Grading and Marketing (AGMARK) and APEDA.

Standards for food packaging and labeling

Definitions

- "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.
- "Date of manufacture" means the date on which the food becomes the product as described.
- "Date of packaging" means the date on which the food is placed in the immediate container in which it will be ultimately sold.
- "Infant" means a child not more than twelve months of age.
- "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.
- "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.
- "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.

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

General Requirements

- 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:—
    - containers which are rusty;
    - enameled containers which have become chipped and rusty;
    - copper or brass containers which are not properly tinned
    - containers made of aluminium

- Containers made of plastic materials should conform to Indian Standards Specification.

Packaging requirement for canned products

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

Packaging requirement for fruits and vegetable products

- Every container 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.
- For Canned fruits, juices and vegetables, sanitary top cans made up of suitable kind of tin plates shall be used.
- For Bottled fruits, juices and vegetables, only bottles/ jars capable of giving hermetic seal shall be used.
- 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.
- 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.
- 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.
- 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.

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

Labelling

General requirements

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

- The particulars of declaration required under these Regulations to be specified on the label shall be in English or Hindi in Devnagri script:
- 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;
- Label in pre-packaged foods shall be applied in such a manner that they will not become separated from the container;
- Contents on the label shall be clear, prominent, indelible and readily legible by the consumer under normal conditions of purchase and use;
- 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.

Labelling of packaged Foods

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

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

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

(a) The list of ingredients shall contain an appropriate title, such as the term "Ingredients";

(b) 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.

- Nutritional information or nutritional facts per 100g or 100ml or per servings of the product shall be given on the label containing the following:
    - Energy value in Kcal
    - The amounts of protein, carbohydrate and fat in grams
    - The amount of any other nutrients for which a nutrition or health claim is made.
- The product should well differentiate veg or non veg.
- Name and complete address of the manufacturer.
- Net quantity of the product.
- Lot/Code/batch identification
- Date of manufacture or packing.
- Best before and use by date.
- Country of origin for imported foods.
- Instructions for use.

Prevention of Food Adulteration Act (PFA): One of the early acts to be promulgated in this connection by the Indian Government was the Prevention of Food Adulteration Act 1954, which has been in force since June 1, 1955. The objective of this act was to ensure that food articles sold to the customers are pure and wholesome. It also intended to prevent fraud or deception and encourages fair trade practices.

The PFA act is to make provision for the prevention of adulteration of the food entering to the market. The act empowers to the government agencies to prevent this evil and safeguard the consumers. The implementation of the act / rules is done by the State Governments and

Union Terrorists through food inspectors. The Central Committee for Food Standards advises the government on the implementation of the provisions of the act/ rules. The provisions made under PFA are mandatory and it is the responsibility of the manufacturer / whole seller / vendor etc. to abide by the standards of various food commodities. Broadly the control of the quality can be categorized under three heads:

1) Enforcement, 2) Analysis and 3) Prosecution.

The PFA standards are the minimum standards of purity and are based on the agricultural and manufacturing practices followed in the country. Samples which do not conform to the specifications are considered unfit for human consumption from hygienic angle. The Act deals with preservatives, poisonous metals, naturally occurring toxic substances, antioxidants, emulsifying and stabilizing agents, flavouring agents, colouring matter and other food additives, insecticides and pesticides, solvent extracted oils and edible flours, non - alcoholic beverages, starchy foods, spices and condiments and their mixes, honey, jaggery, saccharin, coffee, tea, milk and milk products, fruit products, edible oils, cereals, baked products, sweets and confectioneries and a range of similar products. The act deals with definitions and standards of quality elaborately.

To enforce the provisions in the act and rules, the government has set up 4 central food laboratories and number laboratories at state and union territories level where analysis of seized articles of food is done by trained analysts. These laboratories are well equipped with modern instruments.

Fruit Products Order (FPO): The Government of India promulgated a Fruit products order in 1946 and in 1955, the order was revised under section 3 of the Essential Commodities Act, 1955. The FPO aims at regulating sanitary and hygienic conditions in manufacture of fruit and vegetable products. It is mandatory for all manufacturers of fruit and vegetable products to obtain a license under this order. To ensure good quality products, manufactured under hygienic conditions, the Fruit Products Order lays down the minimum requirements for:

- Sanitary and hygienic conditions of premises, surrounding and personnel.
- Water to be used for processing.
- Machinery and equipment.
- Product standards.
- Besides this, maximum limits of preservatives, additives and contaminants have also been specified for various products.

This order is implemented by Ministry of Food Processing Industries through the Directorate of Fruit and Vegetable Preservation at New Delhi. The Directorate has four regional offices located at Delhi. The Directorate has four regional offices located at Delhi, Mumbai, Calcutta and Chennai, as well as sub - offices at Lucknow and Guwahati.

The Central Fruit Advisory Committee comprising of the officials of concerned Government Departments, Technical experts, representatives of Central Food Technology Research Institute, Bureau of Indian Standards, Fruits and Vegetable Products and Processing Industry is responsible for recommending amendments in the Fruit Product Order.

No person can carry on the business of manufacturer except under and in accordance with the terms of an effective license granted to him under this order. A fee is levied on the manufacturer depending on the scale of production. The manufacturer has to manufacture fruit products in conformity with the sanitary requirements and the appropriate standard of quality and composition specified in the schedule to this order. The manufacturer has to comply with the specified requirements in regard to the packing, marking and labeling of containers of fruit products. Each container should display license number of the special identification mark, code number indicating the lot or date of manufacture of such fruit products. The labels should not contain any statement, claim, design or device which is false or misleading concerning the contents in the container.

The licensing officer can inspect manufacturing unit, collect samples intended for sale and get them analyzed at a laboratory authorized for this purpose. Penalties such as fine, closure of the unit and even imprisonment

will be levied if malafide intentions and neglect are proved in the manufacture and complying with the FPO.

The FPO covers all types' fruit products such as juices, pulp, concentrates, squashes, nectar, and aerated water containing fruit juices, bottled and canned fruits and vegetables, jams, jellies, fruit cheese, preserves, chutneys, soup, ketchup, paste, dehydrated vegetables, dehydrated onions.

AGMARK - Agricultural Produce Grading and Marketing Act, 1937: It is set up by the Directorate of Marketing and Inspection of the Government of India. The Agmark seal ensures quality and purity. A lot of care is taken in laying down the Agmark grade and affixing the Agmark quality label. The quality of product is determined with reference to the size, variety, weight, colour, moisture and fat content and other factors. The act defines the quality of cereals, spices, oil seeds, butter, ghee, legumes and eggs and provides criterion for the categorization of commodities into various grades depending upon the degree of purity in each case. The grades incorporated are grade2,3 and 4 or special, good, fair and ordinary. The standards also specify the types of packaging to be used for different products. The physical and chemical characteristics of products are kept in mind while formulating the AGMARK specifications. The Directorate of Marketing and Inspection of Central Government has 21 laboratories and 50 sub offices spread all over the country. The Central Agmark laboratory at Nagpur keeps on carrying out research and development works in this field. The Certificate of Authorization is granted only to those is the trade having adequate experience and standing in the market. The staff of the Directorate of Marketing and Inspection or of the State Government is generally present at the time of selection of goods, their processing, grading and packing before applying the appropriate AGMARK labels.

Grading of commodities like ghee, butter, vegetable oils, atta, spices and honey is voluntary. On the other hand, grading of commodities like tobacco, walnuts, spices, basmati rice, essential oils, onions, potatoes etc. that are meant for export is compulsory under AGMARK, which ensures the

quality of produce to the importers. The process of grading and administering the programme entails some cost and hence the graded products are priced slightly higher. The grading of agricultural commodities has three main purposes. Firstly, it protects the consumer from exploitation. By knowing the quality and grade of his produce, he is in better bargaining position against the trader. Secondly, it serves as a means of describing the quality of the commodities to be purchased or sold by the buyers and sellers all over the country and abroad. This establishes a common trade language and avoids the need for physical checking and handling at many points. Thirdly, it protects the consumer by ensuring the products he purchases.

Bureau of Indian Standards (BIS): Bureau of Indian Standards (National Standards Body of India) is a statutory organization established under the Bureau of Indian Standards (BIS) Act, 1986. It also prescribes standards for agricultural products and processed foods such as milled wheat, maize, barley, pulse products, corn flakes, macroni, spaghathi, biscuits, bread etc. The bureau is a corporate body and comprises members representing industries, consumer organizations, scientific and research institutes, professional bodies, technical institutions, central ministers, state governments and members of parliament. The minister in charge of the union ministry of consumer affairs and public distribution is the president of the bureau and the minister of state as its vice - president. The executive committee of the bureau is responsible for its day - to - day functioning and the director general is its ex- officio chairman, the bureau is responsible for facilitating harmonious development of standards, product certification, quality certification, quality system certification and environmental management systems certification.

Agricultural and Processed Food Products Exports Development Authority (APEDA): The APEDA was created by an Act of parliament in 1986 and is entrusted with the responsibility of export promotion and development of fruits, vegetables, flowers and 12 other scheduled agricultural products. It is managed by a high level body consisting of

members of parliament, planning commission, several ministries of central government, trade and industry representatives. APEDA has been giving financial assistance for the promotion of exports of horticultural products through schematic lending for the development of infrastructure and promotion of transportation by air. APEDA provides financial assistance for: a) establishing pre - cooling facilities b) setting up mechanized post harvest handling facilities and sheds for grading, sorting, quality control and packaging c) establishing vapour heat treatment / fumigation / screening machines for exports d) establishing cold stores at ports / sea ports for export purpose. APEDA provides assistance to the registered exporters under the following schemes: a) development of infrastructure b) promoting transportation of horticultural exports by air c) assistance to promote quality and quality control d) packaging development e) export promotion and market development f) organization building and HRD.

FSSAI (Food Safety and Standards Authority of India)

- Established under Food safety and standards act, 2006.
- Consolidates various acts and 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.

Establishment of the Authority

- Ministry of Health & Family welfare, GoI is the administrative Ministry for the implementation of FSSAI.
- The chairperson and Chief Executive Officer of Food Safety and Standards Authority of India (FSSAI) have been appointed by Government of India.
- The chairperson is in the rank of Secretary to Government of India.

FSSAI has been performing the following functions

- Framing of regulations to lay down the standards and guidelines in relation to articles of food and specifying appropriate system of enforcing various standards thus notified.
- Laying down mechanisms and guidelines for accreditation of certification bodies engaged in certification of food safety management system for food businesses.
- Laying down procedure and guidelines for accreditation of laboratories and notification of the accredited laboratories.
- To provide scientific advice and technical support to Central government and state governments in the matters of framing the policy and rules in areas which have a direct or indirect bearing of food safety and nutrition.
- Collect and collate data regarding food consumption, incidence and prevalence of biological risk, contaminants in food, residues of various, contaminants in food products, identification of emerging risks and introduction of rapid alert system.
- Creating an information network across the country so that the public, consumers, panchayats etc receive rapid, reliable and objective information about food safety and issues of concern.
- Provide training programmes for persons who are involved or intend to get involved in food businesses.
- Contribute to the development of international technical standards for food, sanitary and phyto-sanitary standards.
- Promote general awareness about food safety and food standards.

Procedure for registration

- Filling of application
- Processing of application
- Either grant or reject registration certificate
- Issue notice for inspection
- After the inspection grant the registration

Unit – IV International standards and organizations

Food and Drug Administration Act (FDA), International organization for Standards (ISO) and it's implication, Generally recognized as safe (GRAS), European Council (EU), Codex Alimentarius Commission (CAC), Total Quality Management (TQM), Good Manufacturing Practices (GMP), Good Agricultural Practices (GAP) and Good Hygienic Practices (GHP), Hazard Analysis Critical Control Point (HACCP)

International Standards and Organizations

Introduction

Quality standards of food products

Quality has been commonly thought of as degree of excellence. In general terms, quality is defined as the composite of those characteristics that differentiate individual units of a product and have significance in determining the acceptability of that unit by the buyer. Quality control is defined as the operational techniques and activities that are used to fulfill quality requirements. Quality assurance is defined as all activities and functions concerned with the attainment of quality.

International Food laws and Standards

1. Food and Drug Administration (FDA): The FDA of the Department of Health, Education and Welfare enforces the Federal, Drug and Cosmetics Act as amended in 1980. The FDA is charged with protecting consumers against food that is impure, unsafe, produced under unsanitary conditions or fraudulently labeled. Some of the activities of the FDA with particular impact on imported produce include:

- Inspecting food production establishments and food warehouses and collecting and analyzing samples for physical, chemical and microbial contamination.
- Establishing good agricultural practices and good manufacturing practices and other production standards, such as plant sanitation, packaging requirements and Hazard Analysis and Critical Control Point programmes.

- Sampling and inspection of imported foods.
- Working with foreign governments to ensure safety of imported foods.
- Taking appropriate enforcement actions.
- Educating industry and consumers on safe food handling practices.

2. International Organization for Standardization (ISO): It is a worldwide federation of national standardization bodies having its headquarters at Geneva in Switzerland. The main objectives are: 1) to promote development of quality standards and related activities 2) to facilitate international exchange of goods and services and 3) to develop co - operation in the sphere of intellectual scientific, technological and economic activities. The principles of ISO are: customers focus, leadership, involvement of people, process approach, systems approach to management, continual improvement, factual approach to decision making and mutually beneficial supplies systems.

3. Generally recognized as safe (**GRAS**)

It is an American Food and Drug Administration (FDA) designation that a chemical or substance added to food is considered safe by experts, and so is exempted from the usual Federal Food, Drug, and Cosmetic Act (FFDCA) food additive tolerance requirements.

Established on March 6, 1961, of the enforcement provisions of the "Food Additives Amendment of 1958", referred to as GRAS.

GRAS exemptions are granted for substances that are generally recognized, among experts qualified by scientific training and experience to evaluate their safety, as having been adequately shown through scientific procedures to be safe under the conditions of their intended use.

Code of Regulations

The Code of Federal Regulations, Revised as of April 1, 2010, includes (CFR) title 21 170.30(b) that provides general recognition of safety through scientific procedures requires the same quantity and quality of scientific evidence as is required to obtain approval of the substance as a food

additive and ordinarily is based upon published studies, which may be corroborated by unpublished studies and other data and information.

Intended use

The substance must be shown to be "generally recognized" as safe under the conditions of its intended use. The proponent of the exemption has the burden of proving that the use of the substance is "generally recognized" as safe. To establish such recognition, the proponent must show that there is a consensus of expert opinion regarding the safety of the use of the substance. The existence of a severe conflict among experts regarding the safety of a substance precludes a finding of general recognition.

Failure to qualify

When a use of a substance does not qualify for the GRAS exemption, that use of the substance is subject to the premarket approval mandated by the FFDCA. In such circumstances, the FDA can take enforcement action to stop distribution of the food substance and foods containing it on the grounds that such foods are or contain an unlawful food additive.

Designation

A GRAS designation typically exists in one of three forms:

1. **Self-affirmed.** The manufacturer of this chemical or substance had performed all necessary research, including the formation of an expert panel to review safety concerns, and is prepared to use these findings to defend its product's GRAS status.
2. **FDA-pending.** The manufacturer has performed all the aforementioned due diligence, and submitted to the Food & Drug Administration for GRAS approval.
3. **No comment.** The FDA has reviewed a product's GRAS claim and responded with "no comment"; i.e., no further challenges on the product's GRAS status.

4. European Council (EU)

The **European Food Safety Authority** (**EFSA**) is an agency of the European Union that provides independent scientific advice and communication on existing and emerging risks associated with the food chain, created by European Regulation 178/2002. The Authority's work covers all matters with a direct or indirect impact on food and feed safety, including animal health and welfare, plant protection and plant health and nutrition.

EFSA supports the European Commission, European Parliament and EU member states in taking effective and timely risk management decisions that ensure the protection of the health of the European consumers and the safety of the food and feed chain.

The Authority communicates to the public in an open and transparent way on all matters within its remit. EFSA was set up in January 2002 and is based in Parma, Italy.

EFSA is composed of four bodies:

The Management Board sets the budget, approves the annual work programme, and is responsible for ensuring that EFSA co-operates successfully with partner organisations across the EU and beyond. The Executive Director is the legal representative of the Authority, and is responsible for operational matters, staffing issues and drawing up the annual programme in consultation with the European Commission, European Parliament and EU Member States.

The Executive Director is assisted by an Advisory Forum composed of representatives of national bodies responsible for risk assessment in the Member States, with observers from Norway, Iceland, Switzerland and the European Commission.

EFSA's scientific opinions and advice are provided by the Scientific Committee (SC) and Scientific Panels, each within their own sphere of competence. EFSA's Scientific Committee and Panels are composed of highly qualified experts in scientific risk assessment.

5. **Codex Alimentarius Commission (CAC):** The Codex Alimentarius Commission implements the joint FAO/ WHO Food standard programme the purpose of which is to protect the health of consumers and to ensure fair practices in the food trade. The CAC is a collection of internationally adopted food standard presented in a uniform manner. It also includes provisions of an advisory nature in the form of codes of practice, guidelines and other recommended measures to assist in achieving the purposes of Codex Alimentarius. The commission has expressed the view that codes of practice might provide useful checklists of requirements for national food control or enforcement authorities. The publication of the Codex Alimentarius is intended to guide and promote the elaboration and establishment of definitions and requirements for foods, the assist in their harmonization and, in doing so, to facilitate international trade. The codex general principles of food hygiene are aimed to identify the essential principles of food hygiene applicable throughout the food chain, to achieve the goal of ensuring that foods is safe and suitable for human consumption, to recommend a HACCP based approach as a means to enhance food safety, to indicate how to implement those principles and to provide a guidance for specific codes which may be needed for sectors of the food chain; processes; or commodities, and to amplify the hygiene requirements specific to those area.

Total Quality Management (TQM) or Quality Assurance systems (QA Systems) or Quality Management Systems (QMS)

A quality management system organizes overall activities of the company in such a way that the technical, administrative and human efforts affecting the quality of its products or services are under control. All such controls are oriented towards the reduction, elimination and most importantly, prevention of quality deficiencies.

The quality management system puts into practice the cost effective concepts of “Getting right first-time every time”. The quality management starts with identification of customer needs and quality requirements, and

ends only when the product has been placed in the hands of the customer who remains satisfied.

The QMS embraces all activities of the organization-marketing, design and engineering, purchasing, production, quality control, finance personnel, sales after sales service.

Benefits of QMS

1. As a result of well planned and installed QMS, following benefits accrue:-
2. Satisfied and loyal customer, because goods supplied to them and the services rendered are always in accordance with their requirements.
3. Reduction in operating or manufacturing costs, as wastages due to errors and non-conformity costs are reduced and efficiency is increased.
4. Improved competitiveness and profitability of an organization.
5. Improved morale of employees, as they better understand business, work efficiently and are involved in managing their work environment by themselves.

Good Manufacturing Practices

Good Manufacturing Practice or GMP (also referred to as “c GMP” or “current Good Manufacturing Practice”) is a term that is recognized worldwide for the control and management of manufacturing and quality control testing foods, pharmaceutical products and medical devices. GMP takes the holistic approach of regulating the manufacturing and laboratory testing environment itself. An extremely important part of GMP is documentation of every aspect of the process, activities, and operations involved with drug and medical device manufacturing and testing equipment has been qualified as suitable for use, and that all operational methodologies and procedures (such as manufacturing, cleaning, and analytical testing) utilized in the drug manufacturing process have been validated, to demonstrate that they can perform their purported function. By

2010, the same cGMP requirements will apply to all manufacture of dietary supplements.

GMP regulations address issues including recordkeeping, personnel qualifications, sanitation, cleanliness, equipment verification, process validation, and complaint handling. Most GMP requirements are very general and open-ended, allowing each manufacturer to decide individually how to best implement the necessary controls. This provides much flexibility, but also requires that the manufacturer interpret the requirements in a manner which makes sense for each individual business. GMP requirements are largely common sense practices which will help your company better itself as it moves toward a quality approach using continuous improvement.

Personnel

(a) Disease Control

Any person who, by medical examination or supervisory observation, is shown to have, or appears to have, an illness, open lesion, including boils, sores, or infected wounds, or any other abnormal source of microbial contamination by which there is a reasonable possibility of food, food-contact surfaces, or food packaging materials becoming contamination until the condition is corrected.

(b) Cleanliness

All persons working in direct contact with food, food-contact surfaces, and food- packaging materials shall conform to hygienic practices while on duty to the extent necessary to protect against contamination of food.

(1) Wearing outer garments.

(2) Maintaining adequate personal cleanliness.

(3) Washing hands thoroughly

(4) Removing all unsecured jewelry and other objects

(5) Maintaining gloves, if they are used in food handling, in an intact, clean, and sanitary condition.

(6) Wearing, where appropriate, in an effective manner, hair nets, headbands, caps, beard covers, or other effective hair restraints.

(7) Storing clothing or other personal belongings in areas other than where food is exposed or where equipment or utensils are washed.

(c) Education and training

Personnel responsible for identifying sanitation failures or food contamination should have a background of education or experience, or a combination thereof, to provide a level of competency necessary for production of clean and safe food. Food handlers and supervisors should receive appropriate training in proper food handling techniques and food-protection principles and should be informed of the danger of poor personal hygiene and insanitary practices.

(d) Supervision

Responsibility for assuring compliance by all personnel with all requirements of this part shall be clearly assigned to competent supervisory personnel.

Buildings and Facilities

Plant and grounds

(a) **Grounds:** The grounds about a food plant under the control of the operator shall be kept in a condition that will protect against the contamination of food.

(b) **Plant construction and design:** Plant buildings and structures shall be suitable in size, construction, and design to facilitate maintenance and sanitary operations for food-manufacturing purposes.

Sanitary Operations

(a) General maintenance

Buildings, fixtures, and other physical facilities of the plant shall be maintained in a sanitary condition and shall be kept in repair sufficient to

prevent food from becoming adulterated within the meaning of the act. Cleaning and sanitizing of utensils and equipment shall be conducted in a manner that protects against contamination of food, food-contact surfaces, or food-packaging materials.

(b) Substances used in cleaning and sanitizing; storage of toxic materials

(1) Cleaning compounds and sanitizing agents used in cleaning and sanitizing procedures shall be free from undesirable microorganisms and shall be identified, held, and stored in a manner that protects against contamination of food, food-contact surfaces, or food-packaging materials.

(2) Toxic cleaning compounds, sanitizing agents, and pesticide chemicals shall be identified, held, and stored in a manner that protects against contamination of food, food-contact surfaces, or food-packaging materials.

(c) Pest control

No pests shall be allowed in any area of a food plant. Guard or guide dogs may be allowed in some of a plant if the presence of the dogs is unlikely to result in contamination of food, food-contact surfaces, or food-packaging materials. Effective measures shall be taken to exclude pests from the processing areas and to protect against the contamination of food on the premises by pests.

(d) Sanitation of food - contact surfaces

All food-contact surfaces, including utensils and food-contact surfaces of equipment, shall be cleaned as frequently as necessary to protect against contamination of food.

(e) Storage and handling of cleaned portable equipment and utensils

Cleaned and sanitized portable equipment with food-contact surfaces and utensils should be stored in a location and manner that protects food-contact surfaces from contamination.

Sanitary Facilities and Controls

Each plant shall be equipped with adequate sanitary facilities and accommodations including, but not limited to:

(a)Water supply

The water supply shall be sufficient for the operations intended and shall be derived from an adequate source. Any water that contact food or food-contact surfaces shall be safe and adequate sanitary quality. Running water at a suitable temperature, and under pressure as needed, shall be provided in all areas where required for the processing of food, for the cleaning of equipments, utensils, and food-packaging materials, or for employee sanitary facilities.

(b) Plumbing

Plumbing shall be of adequate size and design and adequately installed and maintained.

(c) Sewage disposal

Sewage disposal shall be made into an adequate sewerage system or disposed of through other adequate means.

(d) Toilet facilities

Each plant shall provide its employees with adequate, readily accessible toiltet facilities.

(e) Hand-washing facilities

Hand washing facilities shall be adequate and convenient and be furnished with running water at a suitable temperature.

(f) Rubbish and offal disposal

Rubbish and any offal be so conveyed, stored, and disposed of as to minimize the development of odor, minimize the potential for the waste becoming an attractant and harborage or breeding place for pests, and

protect against contamination of food, food-contact surfaces, water supplies, and ground surfaces.

Equipment

Equipment and utensils

All plant equipment and utensils be so designed and of such material and workmanship as to be adequately cleanable, and shall be properly maintained. The design, construction, and use of equipment and utensils shall preclude the adulteration of food with lubricants, fuel, metal fragments, contaminated water, or any other contaminants. All equipment should be so installed and maintained as to facilitate the cleaning of the equipment and of all adjacent spaces.

Food - contact surfaces shall be corrosion - resistant when in contact with food. They shall be made of non - toxic materials and designed to withstand the environment of their intended use and the action of food, and, if applicable, cleaning compounds and sanitizing agents. Food - contact surfaces shall be maintained to protect food from being contaminated by any source, including unlawful indirect food additives.

Production and Process Control

Processes and controls

All operations in the receiving, inspecting, transporting, segregating, preparing, manufacturing, packaging and storing of food shall be conducted in accordance with adequate sanitation principles. Appropriate quality control operations shall be employed to ensure that food is suitable for human consumption and that food packaging materials are safe and suitable. Overall sanitation of the plant shall be under the supervision of one or more competent individuals assigned responsibility for this function. All reasonable precautions shall be taken to ensure that production procedures do not contribute contamination from any source. Chemical, microbial or extraneous material testing procedures shall be used where necessary to identify sanitation failures or possible food contamination. All food that has become contaminated to the extent that it is adulterated

within the meaning of the act shall be rejected, or, if permissible, treated or processed to eliminate the contamination.

(a) Raw materials and other ingredients

1. Raw materials and other ingredients shall be inspected and segregated or otherwise handled as necessary to ascertain that they are clean and suitable for processing into food and shall be stored under conditions that will protect against contamination and minimize deterioration. Raw materials shall be washed or cleaned as necessary to remove soil or other contamination. Water used for washing, rinsing or conveying food shall be safe and of adequate sanitary quality. Water may be reused for washing, rinsing or conveying food if it does not increase the level of contamination of the food. Containers and carriers of raw materials should be inspected on receipt to ensure that their condition has not contributed to the contamination or deterioration of food.
2. Raw materials and other ingredients shall either not contain levels of microorganisms that may produce food processing or other disease in humans or they shall be pasteurized or otherwise treated during manufacturing operations so that they no longer contain levels that would cause the product to be adulterated within the meaning of the act. Compliance with this requirement may be verified by any effective means, including purchasing raw materials and other ingredients under a suppliers guarantee or certification.
3. Raw materials and other ingredients susceptible to contamination with aflatoxin or other natural toxins shall comply with current Food and Drug Administration regulations and action levels for poisonous or deleterious substances before these materials or ingredients are incorporated into finished food.
4. Raw materials, other ingredients, and rework susceptible to contamination with pests, undesirable microorganisms, or extraneous material shall comply with applicable Food and Drug Administration

regulations and defect action levels for natural or unavoidable defects if a manufacturer wishes to use the materials in manufacturing food.

5. Raw materials, other ingredients, and rework shall be held in bulk, or in containers designed and constructed so as to protect against contamination and shall be held at such temperature and relative humidity and in such a manner as to prevent the food from becoming adulterated within the meaning of the act. Material scheduled for rework shall be identified as such.
6. Frozen raw materials and other ingredients shall be kept frozen. If thawing is required prior to use, it shall be done in a manner that prevent the food from becoming adulterated within the meaning of the act.
7. Liquid or dry raw materials and other ingredients received and stored in bulk form shall be held in a manner that protects against contamination.

(b) Manufacturing operations

1. Equipment and utensils and finished food containers shall be maintained in an acceptable condition through appropriate cleaning and sanitizing as necessary. Insofar as necessary, equipment shall be taken apart for thorough cleaning.
2. All food manufacturing, including packaging and storage, shall be conducted under such conditions and controls as are necessary to minimize the potential for the growth of microorganisms, or for the contamination of food.
3. Food that can support the rapid growth of undesirable microorganisms, controlling a manner that prevents the food from becoming adulterated within the meaning of the act.
4. Measures such as sterilizing, irradiating, pasteurizing, freezing, refrigerating, controlling pH or controlling aw that are taken to destroy or prevent the growth of undesirable microorganisms, particularly those of public health significance, shall be adequate under the

conditions of manufacture, handling, and distribution to prevent food from being adulterated within the meaning of the act.

5. Work-in-process shall be handled in a manner that protects against contamination.
6. Effective measures shall be taken to protect finished food from contamination by raw materials, other ingredients, or refuse. Food transported by conveyor shall be protected against contamination as necessary.
7. Equipment, containers, and utensils used to convey, hold, or store raw materials, work-in-process, rework, or food shall be constructed, handled, and maintained during manufacturing or storage in a manner that protects against contamination.
8. Effective measures shall be taken to protect against the inclusion of metal or other extraneous material in food. Compliance with this requirement may be accomplished by using sieves, traps, magnets, electronic metal detectors, or other suitable effective means.
9. Food, raw materials, and other ingredients that are adulterated within the meaning of the act shall be disposed of in a manner that protects against the contamination of other food.
10. Mechanical manufacturing steps such as washing, peeling, trimming, cutting, sorting and inspecting, mashing, dewatering, cooling, shredding, extruding, drying, whipping, defatting and forming shall be performed so as to protect food against contamination.
11. Heat blanching, when required in the preparation of food should be affected by heating the food to the required temperature, holding it at this temperature for the required time and then either rapidly cooling the food or passing it to subsequent manufacturing without delay.
12. Batters, breading, sauces, gravies, dressings and other similar preparations shall be treated or maintained in such a manner that they are protected against contamination.

13. Filling, assembling, packaging and other operations shall be performed in such a way that the food is protected against contamination.
14. Food such as, but not limited to , dry mixes, nuts, intermediate moisture food, and dehydrated food, that relies on the control a_w for preventing the growth of undesirable microorganisms shall be processed to and maintained at a safe moisture level.
15. Food such as, but not limited to, acid and acidified food, that relies principally on the control of pH for preventing the growth of undesirable microorganisms shall be monitored and maintained at a pH of 4.6 or below.
16. When ice is used in contact with food, it shall be made from water that is safe and of adequate sanitary quality and shall be used only if it has been manufactured in accordance with current good manufacturing practice.
17. Food manufacturing areas and equipment used for manufacturing human food should not be used to manufacture nonhuman food-grade animal feed or inedible products, unless there is no reasonable possibility for the contamination of the human food.

Warehousing and Distribution

Storage and transportation of finished food shall be under conditions that will protect food against physical, chemical, and microbial contamination as well as against deterioration of the food and the container.

Good Agricultural Practices (GAP)

Our country's economy is predominantly agrarian. Agriculture constitutes 33% of our GDP, supports 64% of workforce, and earns 19% of our export. With a total crop output of 600 million tonnes, India is only marginally less than the United States (608 million tonnes) and second to China (800 million tonnes). Apart from this, we are the second largest producer of fruits (46 million tonnes) and vegetables (80 million tonnes) next to Brazil and China, respectively.

Though we produce more raw materials for food and reach self sufficiency, “Temporarily”, we cannot ignore the projected population growth of 1500 million by 2030 AD and challenges in the areas of productivity and production. The ever-increasing population not only demands food to live but also fibers to wear and shelter to reside. All these share the lands already under production and thereby reduce its availability for cultivation. Among the other alternates remains before us to increase the food material availability is the reduction of post harvest losses which accounts for 10 - 15% in the case of durables and 30 to 40% in the case of perishables.

It has been estimated that in India about, 50 % of all available foodstuffs are lost in the interval between production and consumption. This is mainly due to poor handling and storage. The most important agents of destruction are microorganisms (fungi and bacteria).

The fresh produce carries human pathogens too. In developed countries number of food borne disease outbreak associated with fresh produce were reported. The documented evidence had shown that the food borne risks are due to poor agricultural practices. To avoid these, strategies were formulated to reduce the microbial contamination of food. Consequently, the importers from developed countries are insisting to follow certain practices which could reduce the microbial contamination of fresh produce. These practices are known as Good Agricultural Practices (GAP). Good Agricultural Practices are procedures that improve conventional methods of production, beginning with the choice of the cultivation areas reaching until post-harvest procedures with emphasis on the health, well-being and safety of the workers and the consumers.

According to the Food and Agriculture Organisation (FAO), GAP is the application of available knowledge to addressing environmental, economic and social sustainability for on-farm production and post-production processes resulting in safe and healthy food and non-food agricultural products. Many farmers in developed and developing countries already apply GAP through sustainable agricultural methods such as integrated pest management, integrated nutrient management and conservation agriculture. These methods are applied in a range of farming systems and

scales of production units, including as a contribution to food security, facilitated by supportive government policies.

Presently, GAP is formally recognized in the international regulatory framework for reducing risks associated with the use of pesticides, taking into account public and occupational health, environmental and safety considerations. The use of GAP is also being promoted increasingly by the private sector through informal codes of practice and indicators developed by food processors and retailers in response to emerging consumer demand for safe food. This trend may create incentives for the adoption of GAP by farmers by opening new market opportunities.

Considering the importance of GAP, fruits and vegetable farmers should adopt it and minimize the risk of contamination, right from pre planting to post harvest stage of the crop. Some of the major risk minimizing measures are:

Pre Planting Measures

Site history and Soil

To ensure quality produce site history and soil health are the two important factors. The land should be selected on the basis of land history, previous manure applications and crop rotation. The site history will provide the needed primary information about the land for further exploitation. Appropriate soil management aims to maintain and improve soil productivity by improving the availability and plant uptake of water and nutrients through enhancing soil biological activity, replenishing soil organic matter and soil moisture, and minimizing losses of soil, nutrients, and agrochemicals through erosion, runoff and leaching into surface or ground water. Though soil management is generally undertaken at field level, it affects the surrounding by runoff, sediment deposition, nutrients movement, and mobility of farm animals, pests, predators, and bio-control agents. The field should be away from animal sheds and the entry of animal should not be there. The grower should make sure that animal waste should not enter the fields through runoff or drift.

Good practices related to soil include maintaining or improving soil organic matter by appropriate crop rotations, manure application, application of mineral fertilizers and other agro-chemicals in amounts and timing and by methods appropriate to agronomic, environmental and human health requirements.

Manure handling and field application

The partially decomposed cattle manure is a source of human pathogens. Proper and thorough composting of manure, incorporating it into soil prior to planting, and avoiding top dressing of farm yard manure are important steps toward reducing the risk of microbial contamination of fresh produce. Manure should be stored as far away as practical from areas where fresh produce is grown and handled. Physical barriers or wind barriers should be erected to prevent runoff and wind drift of manure. Manure should compost well. The high temperature achieved during composting can kill most harmful pathogens.

Timely application of manure

Manure should be applied at the end of the season, preferably when soils are warm, non-saturated, and cover-cropped. If manure is being applied at the start of a season, then the manure should be spread two weeks before planting. Farmers should avoid growing root and leafy crops in the year that manure is applied to a field. The long period between application and harvest will reduce the risks.

Production Measures

Irrigation water

Water is an important and renewable resource for effective agriculture. Its quality will directly reflect upon the produce. Water used for irrigation or sprays should be free from pathogen. However, the use of potable water is not feasible for crop production. Hence, surface water used for irrigation should be quarterly tested in laboratory for pathogen. Farmers can filter or use the settling ponds to improve water quality.

Irrigation methods

Drip irrigation method should be used, whenever possible to reduce the risk of contamination because the edible parts of most crops are not wetted directly. Many plant disease levels are also reduced and water use efficiency is maximized.

Field sanitation and animal exclusion

Farmers should stay out of wet fields to reduce the spread of plant or human pathogens. Tractors that were used in manure handling should be cleaned prior to entering produce fields. Animals, including poultry or pets should not be allowed to roam in crop areas, especially close to harvest time.

Human Welfare, Health and Safety

Health and safety are also important concerns for those involved in farming operations. Due care and diligence is required at all times. Farm workers should be provided clean, well-maintained and hygienic toilet facilities around the farming areas. Farmers and farm workers should get proper training to make them understand the relationship between food safety and personal hygiene. These facilities should be monitored and enforced.

Harvest

Clean harvest aids

Use proper tools for harvesting to avoid incidental injuries and damage to the produce. Baskets and all containers have to washed and rinsed properly. The harvest knife and tools need to be sterilized properly everyday after harvest. All crop containers should be sanitized before harvest. Containers should be properly covered, when not in used to avoid contamination by birds and animals.

Worker hygiene and training

Good personal hygiene is particularly important during the harvest of crops. Sick employees or those with contaminated hands can spread

pathogens to produce. Employee awareness, meaningful training and accessible toilet facilities with hand wash stations encourage good hygiene. The toilets should be provided with soaps and disposable towels.

Post Harvest Handling

Worker hygiene

Hands can contaminate fresh fruits and vegetables with harmful microbes. Packing area should be cleaned and sanitized regularly. Supply liquid soap in dispensers, potable water, and single use paper towels for hand washing. Workers should be properly educated about the importance of good personal hygiene, toilet use and proper hand washing. Encourage proper use of disposable gloves on packing lines. Sick employee should not be given food-contact jobs.

Monitor wash water quality

Potable water should be preferably used in all washing operations. Clean water should be maintained wash tank by sanitizing and changing water regularly. Use chlorinated water and other labeled disinfectants to wash fresh produce.

Sanitize packinghouse and packing operations

Loading, staging, and all food contact surfaces should be cleaned and sanitized at the end of each day. Exclude all animals, especially rodents and birds from the packinghouse. Provide bird proof and insect proof netting. Wash, rinse and sanitize the floor, table, baskets, trays and crates at the end of each day to avoid buildup of pathogenic microbes. Packaging material should be stored in a clean area.

Pre cooling and cold storage

After harvesting, fruits and vegetables the field heat should be removed immediately to minimize the growth of pathogens and maintain quality. Pre cooling unit should not be overloaded beyond cooling capacity.

Transportation of produce

Proper cleanliness of the transportation vehicles should be ensured before loading. Fruits and vegetables should not be transported in vehicles which were used to transport cattle, poultry, manure and harmful chemicals. If these vehicles must be used, they should be washed, rinsed, and sanitized before transporting of fresh produce. For traceability norms, it must be ensured that each package leaving the farm can be traced to field of origin and date of packing.

Some GAP programmes are market-driven. These can be private sector supply chain-driven systems where a key player in the supply chain, e.g. the retailer, introduces a set of proprietary GAP guidelines for its suppliers. Alternatively, private sector initiatives can be sector-wide being driven by industry groups, with key roles played by retailer and/or producer associations in developing guidelines. Examples include the retailer-led EUREPGAP.

EUREPGAP

EUREPGAP is a private certification system driven by 22 large-scale retail chains and large fresh produce suppliers/producers in Europe that form the core members of the Euro-Retailer Produce Association (EUREP). There are also associate members (mainly suppliers of agrochemicals, certification bodies and consultancy firms) who may participate in meetings but are not part of the EurepGap decision making process. Under EurepGap, there are about fifteen selected agricultural components to be adhered to which are listed below:

1. Traceability
2. Record keeping
3. Varieties and Rootstocks
4. Site history and Management
5. Soil and substrate management
6. Fertilizer use
7. Irrigation and Fertigation
8. Crop Protection

9. Harvesting
10. Produce handling
11. Waste and pollution
12. Worker Health and safety
13. Environmental Issues
14. Complaint form
15. National Legislation

Among the components, traceability and record keeping are the two major compliances to satisfy the certification standards. Besides, Complaint form and National Legislation are the other two compliances stipulated by EurepGap.

Though GAP is highly important to ensure food safety and quality, only few farmers involved in the exporting of fresh produce are practicing them to meet the requirements of the buyer. Since the farmers are not storing their fresh produce, they are not aware of the post harvest losses and quality. It is the responsibility of every one to ensure food safety and quality in the entire food chain. In addition to growers, all the stakeholder such as retailers, food processors, food service workers, and consumers have a responsibility for food safety. Hence training all the stakeholders farmers in the field of food safety and development of crop specific GAP are need of the day.

Good Hygienic Practices (GHP)

Good Hygienic Practices may be defined as all practices regarding the conditions and measures necessary to ensure the safety and suitability of food at all stages of the food chain.

General Principle

Identify the essential principles of food hygiene applicable throughout the food chain, to achieve the goal of ensuring that food is safe and suitable for human consumption.

Areas Examined Under GHP

1. Primary production
2. Establishment: design and facilities
3. Control of operation
4. Establishment: maintenance and sanitation
5. Establishment: personal hygiene
6. Transportation
7. Product information and consumer awareness
8. Training

1. Primary Production:

Hygienic practices should reduce the likelihood of introducing hazards that may be difficult or impossible to control at later stages of the food chain Examples: pesticides, antibiotics, mycotoxins, microorganisms in food eaten raw or fresh.

Objectives

- Primary production should be managed in a way that ensures that food is safe and suitable for its intended use. Where necessary, this will include:
- Avoiding the use of areas where the environment poses a threat to the safely of food;
- Controlling contaminants, pests and diseases of animals and plants in such a way as not to pose a threat to food safety;
- Adopting practices and measures to ensure food is produced under appropriately hygienic conditions

2. Establishment: design and facilities

Premises, equipment, surfaces and facilities should be located, designed and constructed to ensure

- Minimum contamination
- Proper maintenance,
- Cleaning, disinfection

- Protection against pests

Objectives

- Depending on the nature of the operations and the risks associated with them, premises, equipment and facilities should be located, designed and constructed to ensure that:
- Contamination is minimized;
- Design and layout permit appropriate maintenance, cleaning and disinfections and minimize air-borne contamination;
- Surfaces and materials, in particular those in contact with food, are non-toxic in intended use and where necessary, suitably durable, and easy to maintain and clean

3. Control of operation

- Control of food hazards through HACCP
- Hygiene control: Time and temperature
- Humidity
- Cross contamination
- Microbiological specifications
- Incoming materials (including packaging materials)
- Water, air, steam
- Management, documentation, recall procedures

Objective

To produce food which is safe and suitable for human consumption by formulating design requirements with respect to raw materials, composition, processing, distribution, and consumer use to be met in the manufacture and handling of specific food items and- designing, implementing, monitoring and reviewing effective control systems.

4. Establishment: Maintenance and sanitation

Objectives

- To control possible sources of food contamination through:
- Maintenance and cleaning
- Pest control systems
- Waste management
- Monitoring

General

- Establishments and equipment should be kept in an appropriate state of repair and condition to:
- Facilitate all sanitation procedures
- Function as intended, particularly at critical steps
- Prevent contamination of food, e.g. from metal shards, flaking plasters, debris, chemicals.
- Cleaning should remove food residues and dirt which may be a source of contamination. The necessary cleaning methods and materials will depend on the nature of the food business. Disinfection may be necessary after cleaning. Cleaning chemicals should be handled and used carefully and in accordance with manufacturers' instructions and stored, where necessary, separated from food, in clearly identified containers to avoid the risk of contaminating food.

Maintenance

- Establishments and equipment should be kept in condition to:
- Facilitate all sanitation procedures
- Function as intended, particularly at Critical Control Points (CCPs)
- Prevent contamination of food e.g. metal shards, flaking plaster, debris, chemicals, pests, dust

5. Establishment: personal hygiene

- To prevent food from being contaminated, personnel who come in contact with it must receive clear instruction on the following

- Health status
- Illness and injuries
- Personal cleanliness
- Personal behaviour

Objective

To ensure that those who come directly or indirectly into contact with food are not likely to contaminate food by maintaining an appropriate degree of personal cleanliness behaving and operating in an appropriate manner.

Illness and Injuries

- Conditions which should be reported to management so that any need for medical examination and/or possible exclusion from food handling can be considered, include:
- Jaundice
- Diarrhea
- Vomiting
- Fever sore throat with fever
- Visibly infected skin lesions (boils, cuts, etc.)
- Discharges from the ear, eye or nose

Personal Cleanliness

- Food handlers should maintain a high degree of personal cleanliness and, where appropriate, wear suitable protective clothing, head covering, and footwear. Cuts and wounds, where personnel are permitted to continue working, should be covered by suitable waterproof dressings.
- Personnel should always wash their hands when personal cleanliness may affect food safety, for example:
- At the start of food handling activities;
- Immediately after using the toilet; and

- After handling raw food or any contaminated material, where this could result in contamination of other food items; they should avoid handling ready-to-eat food, where appropriate.

6. Transportation

Objectives

- Measures should be taken where necessary to protect food from potential sources of contamination
- Protect food from damage likely to render the food unsuitable for consumption
- Provide an environment which effectively controls the growth of pathogenic or spoilage micro-organisms and the production of toxins in food.
- Food must be adequately protected during transport. The type of conveyances or containers required depends on the food and the conditions under which it has to be transported.
- Where necessary, conveyances and bulk containers should be designed and constructed so that they;
- Do not contaminate foods or packaging;
- Can be effectively cleaned and where necessary , disinfected
- Permit effective separation of different foods or foods from non - food items where necessary during transport
- Provide effective protection from contamination, including dust and fumes
- Can effectively maintain the temperature , humidity, atmosphere and other conditions necessary to protect food from harmful or undesirable microbial growth and deterioration likely to render it unsuitable for consumption; and
- Allow any necessary temperature, humidity and other conditions to be checked.

Conveyances and containers for transporting food should be kept in an appropriate state of cleanliness, repair and condition. Where the same conveyance or container is used for transporting different foods or non

foods, effective cleaning and where necessary, disinfection should take place between loads.

Where appropriate, particularly in bulk transport, containers and conveyances should be designed and marked for food use only and be used only for that purpose.

7. Product information and consumer awareness

Objectives

Products should bear appropriate information to ensure that:

- Adequate and accessible information is available to the next person in the food chain to enable them to handle, store, process, prepare and display the product safely and correctly
- The lot or batch can be easily identified and recalled if necessary.
- Consumers should have enough knowledge of food hygiene to enable them to:
- Understand the importance of product information
- Make informed choices appropriate to the individual
- Prevent contamination and growth or survival of food borne pathogens by storing, preparing and using it correctly.
- Information for industry or trade users should be clearly distinguishable from consumer information, particularly on food labels.

8. Training

Objective

Those engaged in food operations who come directly or indirectly into contact with food should be trained, and/or instructed in food hygiene to a level appropriate to the operations they are to perform

Training Programmes

Factors to take into account in assessing the level of training required include:

- The nature of the food, in particular its ability to sustain growth of pathogenic or spoilage micro-organisms;
- The manner in which the food is handled and packed, including the probability of contamination;
- The extent and nature of processing or further preparation before final consumption;
- The conditions under which the food will be stored; and
- The expected length of time before consumption.

Instruction and Supervision

- Periodic assessments of the effectiveness of training and instruction programmes should be made, as well as routine supervision and checks to ensure that procedures are being carried out effectively.
- Managers and supervisors of food processes should have the necessary knowledge of food hygiene principles and practices to be able to judge potential risks and take the necessary action to remedy deficiencies.

Refresher Training

- Training programmes should be routinely reviewed and updated where necessary. Systems should be in place to ensure that food handlers remain aware of all procedures necessary to maintain the safety and suitability of food.

Hazard Analysis and Critical Control Point (HACCP)

HACCP stands for Hazard Analysis and Critical Control Point. HACCP is a preventive system of hazard control rather than a reactive one. Food processors can use it to ensure safer food products for consumers. To ensure safer food, the HACCP system is designed to identify hazards, establish controls and monitor these controls. Hazards can be harmful microorganisms or chemical and/or physical contaminants.

The Pillsbury Co. pioneered the application of the HACCP concept to food production during its efforts to supply food for the U.S. space program

in the early 1960s. Pillsbury decided that their existing quality control techniques did not provide adequate assurance against contamination during food production. The company found that end-product testing necessary to provide such assurance would be so extensive that little food would be available for space flights. In 1985 National Advisory Committee on Microbiological Criteria for Foods (NACMCF) formulated HACCP principles.

Hazard is a biological, chemical or physical agent that is reasonably likely to cause illness or injury in the absence of its control. To perform a hazard analysis for the development of a HACCP plan, food processors must gain a working knowledge of potential hazards. The HACCP plan is designed to control all reasonably likely food-safety hazards. Such hazards are categorized into three classes: biological, chemical and physical.

In HACCP, "hazards" refer to conditions or contaminants in foods that can cause illness or injury. It does not refer to undesirable conditions or contaminants such as:

- Insects,
- Hair,
- Filth,
- Spoilage,
- Economic fraud and
- Violations of regulatory food standards not directly related to safety.

Biological Hazards

Foods can contain biological hazards. These hazards can come from raw materials or from food-processing steps used to make the final product. Microorganisms like everywhere: air, dirt, fresh and salt water, skin, hair, animal fur and plants. Microorganisms are classified into various groups. A few groups important in food include yeasts, molds, bacteria, viruses and protozoa. Since microorganisms are so widespread, it is important to understand when to be concerned about them and how to deal with them. Although thousands of kinds of microorganisms exist, only a few pose hazards to humans.

Although microorganisms are too small to be seen without a microscope, they are alive and have certain needs to live and grow. Without adequate food, water and temperature, microorganisms stop growing and multiplying. Some preservation methods, such as drying or smoking, control the water or nutrients in food, making these essential elements unavailable to microorganisms.

Chemical Hazards

Chemical contamination can happen at any stage in food production and processing. Chemicals can be helpful and are purposefully used with some foods, such as pesticides on fruits and vegetables. Chemicals are not hazardous if properly used or controlled. Potential risks to consumers increase when chemicals are not controlled or the recommended treatment rates are exceeded. The presence of a chemical may not always represent a hazard. The amount of the chemical may determine whether it is a hazard or not. Some may require exposure over prolonged periods to have a toxic effect. Regulatory limits are set for some of those contaminants.

Chemical hazards can be separated into three categories: Naturally occurring chemicals, intentionally added chemicals and unintentionally or incidentally added chemicals.

Physical hazards

Physical hazards include any potentially harmful extraneous matter not normally found in food. When a consumer mistakenly eats the foreign material or object, it is likely to cause choking, injury or other adverse health effects. Physical hazards are the most commonly reported consumer complaints because the injury occurs immediately or soon after eating, and the source of the hazard is often easy to identify.

HACCP Principles: Seven principles. They are:

1. Conduct hazard analysis
2. Determine the critical control points (CCPs) in the process
3. Establish critical limits

4. Monitor each CCP
5. Establish corrective actions
6. Establish verification procedures
7. Establish record - keeping and documentation procedures.

Principle: 1. Conduct hazard analysis

The HACCP team has initial responsibility to decide which hazards are significant and must be addressed by the HACCP plan. Keep in mind that there may be differences of opinion, even among experts, as to the significance of a hazard. The HACCP team may rely on available guidance materials and the opinions of experts who assist in the development of HACCP plans. During the hazard analysis, safety concerns must be differentiated from quality concerns.

A hazard - analysis work sheet can be used to organize and document the considerations in identifying food - safety hazards. Although there is no specific or required form, the worksheet should document specific information. For example, each step in the process flow diagram should be listed in Column 1. The results of the hazards identification are recorded in Column 2. The results of the hazard evaluation should be recorded in Column 3, with the justification for accepting or rejecting the listed potential hazards stated in Column 4.

Principle: 2. Determine the Critical Control Points (CCPs)

For every significant hazard identified during the hazard analysis **(Principle 1),** there must be one or more CCPs where the hazard is controlled. The CCPs are the points in the process where the HACCP control activities will occur. A CCP should be a specific point in the process flow where application of a control measure effectively prevents, eliminates or reduces the hazard to an acceptable level.

Principle: 3. Establish Critical Limits

Critical limits must be established for each CCP identified in the hazard analysis. A critical limit represents the boundaries that are used to

ensure that an operation produces safe products. Each CCP must have one or more critical limits for each food - safety hazard. When the process deviates from the critical limit, a corrective action must be taken to ensure food safety. In many cases, the appropriate critical limit may not be readily apparent or available. Tests may need to be conducted or information gathered from sources such as scientific publications, regulatory guidelines, experts or experimental studies. If the information gathered from sources such as scientific publications, regulatory guidelines, experts or experimental studies. If the information needed to define the critical limit is not available, a conservative value should be selected. The rationale and reference material used to establish a critical limit should become part of the support documentation for the HACCP plan.

Principle 4: Critical Control Point monitoring

Accurate monitoring indicates when there is a loss of control at a CCP and a deviation from a critical limit. When a critical limit is compromised, corrective action is needed. The extent of the problem needing correction can be determined by reviewing the monitoring records and finding the last recorded value that meets the critical limit. Monitoring also provides a record that products were produced in compliance with the HACCP plan. This information is useful in the verification of the HACCP plan as discussed in principle 7.

Monitoring procedures must identify:

- What will be monitored.
- How the critical limits and control measures will be monitored.
- How frequently monitoring will be performed.
- Who will perform the monitoring.
- What will be monitored

Monitoring may mean measuring a characteristic of the product or of the process to determine compliance with a critical limit. Examples include:

- Measurement of cold-storage compartment temperature when critical for temperature-sensitive ingredients.

- Measurement of the pH of an acidifying ingredient when critical for the production of an acidified food.
- Measurement of line speed when critical to adequate cooking or chilling processes

Principle 5: Corrective Actions

When critical limits are violated at a CCP, the predetermined, documented corrective actions should be instituted. These corrective actions should state procedures to restore process control and determine the safe disposition of the affected product. It may be possible, and is always desirable, to correct the problem on the spot

Corrective action options include:

- Isolating and holding product for safely evaluation.
- Diverting the effected product or ingredients to another line where deviation would not be considerable critical.
- Reprocessing.
- Destroying product.

The primary objective is to establish a HACCP program that permits rapid identification of deviations from a critical limit. The sooner the deviation is identified, the more easily corrective actions can be taken and the greater the potential for minimizing the amount of noncompliant product. An individual who has a through understanding of the process, product and HACCP plan and who has the authority to make decisions needs to be assigned the responsibility of making corrective actions.

Effective corrective action plans must:

- Correct and eliminate the cause of the noncompliance to assure that the CCP is brought back under control.
- Segregate, assess and determine the disposition of the noncompliant product.

Principle 6: Verification Procedures

One of the more complex HACCP principles is verification. Although it is complex, the proper development and implementation of the verification

principle is fundamental to the successful execution of the HACCP plan. The element of verification focused on collecting and evaluating scientific and technical information to determine if the HACCP plan, when properly implemented, will effectively control the hazards.

Validation is an essential component of verification and requires substantiation that the HACCP plan, if implemented effectively, is sufficient to control the food safety hazards that are likely to occur. Validation of the plan occurs before the plan is actually implemented. The purpose of validation is to provide objective evidence that all essential elements of the plan have a scientific basis and represent a "valid" approach to controlling the food - safety hazards associated with the specific product and process. There are several approaches to validating the HACCP plan, among them are: incorporation of fundamental scientific principles, use of scientific data, reliance on expert opinion or conducting in - plant observations or tests.

Principle 7: Record Keeping Procedures

Accurate record keeping is an essential part of a successful HACCP program. Records provide documentation that the critical limits have been met or that appropriate corrective actions were taken when the limits were exceeded. Likewise, they provide a means of monitoring so that process adjustments can be made to prevent a loss of control.

- HACCP-Plan Support Documents
- Monitoring Records
- Corrective Action Records
- Verification Records

Unit – V Quality control measures in industrial and marketing centres

Quality control system in storage, Quality control aspects in food industries, importance of Quality control in marketing of horticultural products – domestic and export markets. Role of government agencies in export market – International standards for export and quarantine requirements for export of horticultural produce.

Quality control system in storage

The processing of fruits and vegetables involves several steps or unit operations which start with the procurement of the raw material. Following preparative treatments such as cleaning, peeling, blanching and mixing; the product is processed and packaged to give the required finished product. The manufacturing processes fall into four groups:

- Canning
- Dehydration
- Freezing
- Pickling, syruping, crystallizing and chemical preservation

1. Storage of raw fruits and vegetables

Quality control staff should also inspect the raw fruits and vegetables during storage at the processing plant to ensure they are:

- Protected from attack by rodents and insects,
- Stored under suitable conditions of temperature and humidity for periods which do not allow excessive deterioration.
- Handled carefully to minimize mechanical damage.

2. Storage of sugar, salt, spices, food acids and other minor ingredients

These materials may also have a market effect on the quality and safety of the finished product so quality control staff should require these ingredients to be obtained from reputable suppliers and the materials should be of at least “food grade” quality. If possible quality control staff should visit suppliers to satisfy themselves that these items are produced, packed and stored under conditions of good manufacturing practice. Again

it is seldom possible for quality control staff to analyse such materials for purity or for the presence of any of a large number of potentially dangerous contaminants.

(i) Inspection on receival: Quality control staff should inspect all consignments of ingredients on receipt to confirm that they comply with the company's purchasing specifications. It resources are limited the quality control staff may restrict the inspection to the essential minimum of:

a. Confirming that the material delivered are the ones ordered (e.g. salt should be confirmed to the salt and not another white crystalline substance)
b. Determining that the consignment was not damaged or contaminated to the extent that the materials are not suitable for their intended use.

Acceptance testing may require simple chemical tests, e.g. to determine the concentration of acetic acid in vinegar or the ingredient may have to be used in the production of a small batch of the produce to test that it is satisfactory, e.g. to assess the potency of spices.

Microbiological tests of ingredients for the manufacture of processed fruits and vegetable products are seldom warranted. However, it is prudent to limit the number of thermophilic sporing bacteria that may be incorporated in low-acid canned products such as soups through the use of contaminated ingredients such as thickening agents or dry spices, especially if these products are intended for distribution to hot climates. Mouldy materials such as dried peas and beans must not be accepted as ingredients because of the risk of aflatoxins. It is seldom feasible to test mouldy materials for such toxic substances; although relatively simple methods of detection are available.

Quality control system in food industries

Quality control is generally defined as the regulation by law of food manufacture, distribution and sale, in order to prevent health hazards and fraud to the consumer. Thus, it becomes a criminal offence to sell (deliberately or in any other way), adulterated, filthy or contaminated food. There are three main aspects to the application of food quality control: moral, 2) commercial, and 3) legal. The application of controls on food quality put a moral responsibility on the food manufacturer towards the consumer.

Fruit and vegetable processing industries produce very large quantities of products which are intended for consumption, often on a daily basis, by the population at large. Such industries, therefore, have a special responsibility to ensure that their products are both wholesome and safe, as well as successful in the marketplace. The control of food quality by law leads to:

(1) Improved quality of product.

(2) Achievement of greater consumer satisfaction.

(3) The promotion of quality consciousness.

(4) Increased consumption and sales.

(5) Employment opportunities for scientific and technical personnel.

(6) Avoidance of controversy and litigation in marketing at the national and international level.

(7) Promotion of national and international trade.

(8) Provision of the means for the intelligent comparison of prices in relation to quality and grade.

(9) Greater confidence in the minds of consumers.

Quality control within a food manufacturing industry demands constant vigilance at all stages in processing, so that any necessary adjustments can be made at the appropriate time. The responsibility for quality control in industrial food manufacture is generally delegated to a person, or a department, depending on the size of the factory.

The specific responsibility of quality control is to ensure that the system used produces a standard product with acceptable quality in respect

to nutrition, purity, wholesomeness and palatability. The specific responsibilities of quality control assigned to a department or to an individual include:

(1) Standardizing procedure for sampling and examining raw materials.

(2) Development of test procedures.

(3) Establishment and implementation of quality standards for fresh and processed products.

(4) Setting up preventive quality control methods for in-plant liaison between manufacturing section and test laboratories.

(5) Examination of finished products.

(6) Storage controls.

(7) Recording and reporting.

(8) Special problems, including attendance to consumer complaints by locating their cause and eliminating them.

(9) Research and development into new products and their packaging.

The sequence of operations in quality control is as follows:

(1) Raw material control.

(2) Process control, or the control of the manufacturing process

(3) Production inspection, including the inspection of the finished product, packaging and storage.

(4) Sensory evaluation, or evaluation of the acceptability of the final product.

(1) Raw material control

The principal aim in any food industry is to produce standardized products that do not vary significantly. The quality of a food material is judged in terms of its nutritional value, its purity, its wholesomeness and its palatability. If any of these properties is not optimal, the food quality is affected.

The definition given to a 'raw material' in the food industry is anything purchased by the manufacturer for direct or indirect use in food processing.

Raw materials include: food ingredients, water and packaging materials. The quality of raw materials required varies according to the material, the product to be manufactured, and the standard qualities desired in the end-product.

Before buying raw materials in bulk, large food manufacturers generally examine a buying sample to make sure that it conforms to the factory's specifications. This is very important, especially if samples have to be obtained from different sources. It is also necessary to examine the representative samples of any subsequent delivery to make sure that the bulk is up to approved factory specifications. Failure to check conformity to the specifications may lead to the acquisition of unusable qualities of raw materials.

Raw materials examinations generally include tests for genuineness and composition, freedom from contaminants, and conformity with official or factory. Once raw material quality standards are established, regular checks are carried out to bring about a uniformity of properties such as colour, clarity, particle size, and other factors which affect palatability. .

Examinations carried out vary with the nature and type of ingredient and its expected use. Where fats and oils are included in the ingredients used, they are examined to determine their identity, purity, freshness and keeping qualities because chemical changes or rancidity occur in facts during storage will develop unpleasant taste and odour if the fat is used below the required quality.

In order to achieve desirable specified qualities in raw materials manufacturers demand a certain quality in crops. For these reasons, successful food product manufacturer depends, to a large extent, upon close collaboration between plant breeders, agronomists and food technologists. The food technologist defines the characteristics required in raw materials in order to obtain products with specified qualities and the plant breeder and the agronomist collaborate to provide crops with these qualities. After their control and selection, a sample batch of raw materials is put through a 'trial run'. The trial run gives a preview of the end-product. All control tests are run on the sample and any adjustments in processing procedure made

where necessary. The shelf-life of the end-product is also checked. Equipment used for the trial run is examined for signs of corrosion due to the acidity or alcohol content of the materials used. Approval for processing is only given after all quality specifications on the sample run have been met.

(2) Process control

During the actual processing, careful attention is given to the processing procedure. All treatments given during the processing are standardized, ingredients are used in the correct amounts, accurate methods of preparation and mixing are employed, checks are made on the containers used to make sure that they are sound, and processing times and temperatures are standardized to make sure that the desired results are obtained. A set of specifications is established by the technical staff in every factory to cover every product that is handled.

It is the duty of the laboratory personnel to acquaint the production staff with the quality specifications and to evaluate production samples for compliance with these. It is vital that quality control tests run continuously and concurrently with a 24 hour production schedule. Failure to maintain a round-the-clock check that means considerable quantities of material being rejected as substandard, because it does not meet the quality specifications. This can be very costly to the manufacturer, as sometimes a salvage operation is not always practicable. Liaison between the quality control and production department is, therefore, of paramount importance.

Intermediary product samples are taken for routine tests to establish that specific targets of quality are being achieved. The desired composition, consistency, colour and concentration are checked and ensured. Rapid on-the-spot analysis are used to give prompt results so that appropriate information can immediately be fed back to the factory floor, and any necessary modifications made to the original formulation. This rapid communication of information is very important in process control. Where processing controls are not properly employed as, e.g., during dehydration, the quality of the product may be seriously impaired. There may be change

in shape or structure: cracks, case hardening, a browning reaction, and the oxidation of unstable components due to physical, chemical or biological processes.

Satisfactory hygienic conditions are also maintained during processing, in order to protect the product from bacterial contamination. For the routine bacteriological control of the plant or factory, counts on utensils, equipment, working surfaces, walls, and floors are regularly carried out and the results tabulated or recorded on charts to give an immediate indication of any change. The counts are used as a check on the sanitary conditions of the plant. If the sanitary conditions of manufacture are to be passed as being 'good', the general bacterial counts must be low. In addition, periodic inspection of the plant is made by a trained inspector to make sure that adequate hygiene standards are maintained.

(3) Inspection of finished product

Inspection or examination of the finished product is carried out to determine to what extent the desired quality specifications have been achieved. Although the purity of individual ingredients was determined earlier on, there may have been some contamination during processing. The ability to withstand storage can only be confirmed on the finished product, e.g., in a cannery, representative samples of the canned product are taken for inspection. Careful inspection is made of the external conditions of the can and distinctive signs looked for. A can where both ends are concave is said to be 'flat', this is considered to be good because it means that the vacuum inside is high enough to maintain the ends in a concave condition. The cans which have the problem of flipper, springer or swell do not pass inspection.

Finally, the seams are inspected for leakage, as contamination is likely to occur along these zones. Acceptable cans are then weighed to determine gross weight. A gauge is used to check both the vacuum and the pressure within the can. Vacuum and pressure in the can are indicated by deflections of a needle on the dial of the gauge. Only cans which are passed are measured.

In case of canned products a sample of the passed cans is opened and their contents inspected. This is done against a known standard. Under filling and overfilling can be detected at this stage by head space gauge. Cloudiness in the syrup or brine, or the unsatisfactory appearance of the product is more frequently evident when the colour of the product is observed. Finally, the drained weight is determined to check the net weight of the product.

Where the product is dried, samples are examined for a blemish count. A limited number of minor blemishes are often allowed which will mainly disappear on reconstitution. The dried product is regularly checked for its reconstitution value to enable the correct cooking instructions to be supplied on the package for the ultimate user. A 50 g sample is rehydrated and cooked in the prescribed manner and time. The cooking water is drained off, and the drained weight calculated against the original dry weight to obtain a reconstitution ratio.

At the end of the production line, packets are weighed individually. Manufacturers are expected to supply customers with finished products of the correct volume as specified.

Chemical analyses are carried out on samples of the finished product to:

(1) Determine the general composition of the essential ingredients (to check if there are variations from the limits set), and

(2) To check that the composition conforms to the set legal requirements for contaminants, such as heavy metals.

Tests are also performed to check certain physical properties, such as crispness, colour, viscosity and texture, which are related to the palatability and acceptability of the product The keeping qualities of foods, which depend upon sugar, salt, or acid for their preservation are checked to ensure that they will keep the conditions to which they are most likely to be exposed. Both the contents and the containers are examined for faults, rancidity, microorganisms development, colour and flavour, the other attributes. Microbiological examinations are carried out to check whether proper hygienic procedures have been followed, and whether the finished product is safe to keep and to eat.

4) Sensory evaluation

After physical, chemical and microbiological examinations have been performed on a finished product with a satisfactory result, the product is considered for distribution, but only after its palatability or sensory quality has been assessed. The ultimate criterion for the desirability of a food product to consumer its eating quality. Palatability or sensory quality is of great importance to both processors and consumers. To the processor, a palatable product ensures sales because palatability attracts consumers; to the consumer, palatability satisfies his appetite and gustatory senses. Sensory quality is a combination of different senses perception which comes into play in choosing and eating a food. The principal sensory properties with affect the palatability of food are as follows:

(i) Appearance

(ii) Texture

(iii) Flavor

Although chemical and physical tests have been devised to measure differences in the sensory qualities of foods, these alone are not adequate to give the information. Human judges, therefore, have to be used. Measurement of the relative palatability of a food product by testing the preferences of a sample of the public for whom the product is intended - this is also known as market testing.

(i) Expert sensory judgment

Sensory evaluation (acceptance measurement) is generally performed by a panel. The members are trained in order that their sensitivity and consistency are established by repeated test. These tests determine the significance of variation of average scores and the contribution of individual quality characteristics to the overall quality. A trained panel is generally formed to look after in-line quality, quality of the final product, process development and, to a limited extent, preliminary acceptance testing. This small group of people works in the rigorously controlled environment of the quality control laboratory.

(ii) Market testing

Market testing is carried out to obtain the preferences of a sample of the public for whom the food product is intended. An untrained panel, made up of a number of men and women selected to be representative of the population to be surveyed, is used. Their natural emotional reaction to the selected food is ascertained. Such surveys are time consuming and costly. They are, therefore, usually restricted to products selected through a series of laboratory tests and presented in their marketable form to a sample of the public. Data from these surveys, known as consumer surveys, are analyzed statistically to determine the significance of preference and rejection.

Broad demand for the measurement of actual consumer preference has led to the development of three major survey techniques:

(1) Summarizing market data on what consumers buy.

(2) Surveying consumer opinions about products of different quality.

(3) Setting up experiments designed to test preferences on the spot.

(4)Obtaining a representative sample of consumers and the interpretation of market survey data are very difficult.

(5) Packaging

Agricultural Marketing and Quality Control

In a broader sense, agricultural marketing may be viewed as a process encompassing all the steps involved from the producer to the consumer including pre and post harvest operations such as assembling, grading, storage, transportation and distribution. According to the National Commission on Agriculture (XII report) agricultural marketing is a process which starts with the decision to produce a saleable farm commodity and it involves all the aspects relating to pre and post harvest operation including assembling, grading, storage, transportation and distribution. By performing these operations, it adds value to the produce in terms of time, place and farm utilities. Storage facilities are also essential in marketing infrastructure. Agricultural marketing has assumed increased importance after launching of the new economic policy and consequent opening up of India's markets to foreign suppliers and buyers and access by Indians to

world markets. To enable Indian farmers to derive the full benefits from the new liberalized world trade regime, it is necessary to remove various constraints and deficiencies in the existing domestic markets and marketing practices.

The Union Finance Minister in his Speech for Budget 2004-05 has indicated that India must become a single market for all products, particularly agricultural produce. The existing Acts governing agricultural produce marketing committees have outlined their utility. The GOI has circulated a model law to the States for initiating legal or administrative action for 'direct marketing' and 'contract farming' arrangement in line with the model law. Strategy proposed during the State's X Plan in Agr. Mktg. and Agri-business • Enhancing marketability of agriculture commodities by providing infrastructure facilities, revamping the regulated markets • Provision of post harvest handling facilities for value addition and prevention of wastage (like cold storage) • Provision of backward and forward linkages through marketing, agro-processing and export • Ensuring better realization for agriculture produce through alternative markets like product-wise Terminal Markets • Stepping up export of agri / horti produce-with setting up of AEZ and establishment of Food Laboratories • Policy to attract private sector in storage and agro-processing industries Integrated approach from planting to marketing, which includes choice of crops, grading, packaging, storage and marketing for domestic and international, is required.

A new revolution - the Food Chain Revolution is needed. An important part of this revolution is to reduce wastage of food grains, fruits, and vegetables. Important and modernisation of the existing post harvest operations at farm level to minimise the post harvest losses need to be encouraged. Value addtion techniques for adoption by farmers at farm level to increase their income are to be developed. Rural markets likely weekly, monthly shandies need to be strengthened. An efficient agriculture marketing system requires a healthy environment, smooth channels for the transfer of produce, physical infrastructure to support marketing activities, easy cash support to the widely scattered community of producers and also

a sense of market orientation among the farmers. The absence 442 9.3 Agricultural Marketing and Quality Control of rural road connectivity and other infrastructure, combined with improper management, lack of market intelligence and inadequate credit support results in a system unfavourable to the farmers.

The adverse impact of all these is more pronounced in the case of the small and marginal farmers who constitute a large chunk in the farming community. Department of Agricultural Marketing and Agri Business The prime objective of the department of Agricultural Marketing & Agribusiness is to help the farmers in marketing their agricultural produce in a fair manner and to ensure remunerative returns to them. The objective is being achieved by regulating the agricultural produce trade under the Tamil Nadu Agricultural Produce Marketing (Regulation) Act 1987 and Rules 1991 (which replaced the earlier Act of 1959). Further this department is also focussing on the other related activities like creation of modern marketing infrastructure, post harvest management, food processing, agri exports, which indirectly help the farmers to realize better returns.

The strategy of the department and the measures taken are discussed below. • Enhancing marketability of Agri commodities, by providing necessary Infrastructural facilities • Preventing the wastage through post harvest facilities • Value addition through post harvest handling facilities like cold storage, grading and packing centres • Provision of backward and forward linkages through marketing, agro processing, and contract farming • Educating the farmers on marketing practices - with extension network • Better realization to agri produce through alternative markets like product - wise Terminal Markets/Mega Markets • Revamping Regulated Markets with structural changes in the existing system. • Stepping up export of agri / horti produce - with setting up of AEZ and establishment of Food Parks • Providing marketing extension services at the cutting edge level by integrating extension network of Agriculture and Horticulture departments • Commercialization of agriculture - market driven approach • Policy interventions to attract private sector into storage and agro processing industries • Integrated approach - from planting to marketing - which

includes choice of crops, grading, packaging, storage and marketing in domestic and international markets Market Committees and Regulated Markets At present 20 Market committees are functioning in Tamil Nadu covering various districts and functioning with nominated Members and Chairperson elected by the Members from January 2003.

There are 273 Regulated Markets, 15 SubMarkets, 16 Check posts, 108 Rural Godowns and 108 Grading centres functioning under 20 Market Committees. Competitive and remunerative prices are ensured for the produce sold by the farmers through closed tender system in the Regulated Markets. The Market Committees are collecting 1% of the value of produce transacted as market fee from the traders. Licence fee is also collected from the 9.3 Agricultural Marketing and Quality Control 443 traders and weighmen. No fee is collected from producers / sellers for any service rendered in the Regulated Markets. 40 agricultural commodities like cereals, pulses, oilseeds, cotton, turmeric etc have been notified. To help the producers to get better price for the produce according to their grades, 96 Commercial Grading Centres, 11 Kapas Grading Centres and 1 Tobacco Grading Centre are functioning in the Regulated Markets.

The Commercial grading Centre in the villages are renamed as Post Harvest Technology Information Centres which are educating the farmers in post harvest technologies. Infrastructure Creation Required infrastructure like transaction sheds, input shops, godowns, office cum godowns, payment counters, rest sheds, drinking water facility, sanitary facilities drying yards etc are being created in the regulated markets year by year in a phased manner to enhance the facilities to farmers and traders which will ensure better marketability of agricultural produce.

During the year 2002–2003 Rs.566.65 lakhs was spent towards creation of above such infrastructures in the regulated markets. Works costing to the tune of Rs.1692.00 lakhs were taken up during 2003 – 2004. Post harvest management Post harvest management is another important area that needs research and capital investments. The minimise post harvest losses, adequate post harvest, cold chain and cold storage facilities have to be established.

In Tamil Nadu there are about 133 cold storage units with a combined capacity of 1 lakh MT. In these cold storages mostly dry commodities like tamarind, pulses, eggs, chillies and seafood are stored. Taking into account the present production of fruits and vegetables and projected future production it is estimated that cold storage units with capacity of another one lakh MT would be required in the next five years. Efforts have been taken to encourage private participation to establish the cold storage units in the state but the response is very poor.

The main prohibitive factors in cold storage business are the high capital investment and maintenance cost, National Horticulture Board, GOI is extending a subsidy of 25% of capital cost or Rs.50 lakhs whichever is less. But this is not adequate to attract the entrepreneurs to go for cold storage business. The need of the hour is not just cold storage units but the cold chain, which comprises pre cooling chambers, reefer vans and cold storage units with latest technology, which again hikes the capital cost. Construction of Drying Yards in the Villages In order to help farmers to minimize the post harvest losses in grains, the Department has taken up construction of drying yards at village level.

Under this scheme, 580 drying yards have been constructed at a total cost of Rs.10.24 crores. Construction of 150 drying yards at a total cost of Rs.3.00 crores for the year 2003- 2004 were in progress. Locating suitable site in villages for putting up drying yards takes longer time and hence it is considered that mechanical or solar driers can be installed in villages for drying commodities like chillies, pulses, cereals etc. On a trial basis solar driers are being installed in Surandai and Naduvayal villages of Thirunelveli District at a total cost of Rs.19.00 lakhs under World Bank sponsored programme. If the response for the solar driers is good this facility will be extended to other places. 444 9.3 Agricultural Marketing and Quality Control Product specific markets At Madurai, a market complex is being established exclusively for paddy at a total cost of Rs.12.60 crores.

This market complex will cater to the marketing needs of paddy growing farmers and traders. Another Market Complex for Turmeric at a total cost of Rs.36.32 Crores is to be established near Erode town. A mega

wholesale market for fruits and vegetables at a total cost of Rs. 245.20 lakhs is being established at Oddanchatram of Dindigul district. Agricultural Production And Marketing Information Centre Market intelligence plays a vital role in marketing of agricultural produce.

If information on commodity prices and demand in various markets etc. are made available, the farmers could plan in advance the crops to cultivate and decide the market to sell their produce in order to get better returns. Taking this objective into consideration, establishment of Agricultural Production and Marketing Information Centre was in progress in fourteen Regulated Markets at a cost of Rs.45.00 lakhs and another five Regulated Markets would to get this facility at a cost of Rs.20.00 lakhs during 2003-04.

Based on the success and usefulness of the facility to the farmers, this scheme will be further expanded. The above centres will have Internet facility and electronic display board. The daily price and arrivals that prevail in different regulated markets will be transmitted to all information centres which will be displayed in the electronic display boards for the benefit of farmers and traders. Agro food processing Food Processing Industries provide the vital link between farm and industry which accelerates overall agricultural growth, adding value to the produce, generating employment opportunities and ensuring assured income to the farmers.

While in India, only 2% of the total horticultural produce is processed, in developing countries like Philippines, Brazil it is in the range of 50%and 70%. Considering the rising demand for good quality processed products, there is an urgent need to enhance capacities for value added and processed products in the country.

At present, value addition is estimated at 7% of the total production and within next 5 years, there is a need to increase value addition to 20% and processing at 7% in order to reduce the post harvest wastage and to gain advantage in both domestic and international markets. Tamil Nadu with varied agro climatic zones can produce almost all the commodities and thus there is vast scope for setting up of Food Processing Industries in Tamil Nadu. Agricultural Marketing and Agri-Business Department is acting as

State Nodal Agency for Ministry of Food Processing industries, Govt. of India from July 2002.

Project proposals for setting up new food industries and expansion and modernisation are scrutinized, recommended and forwarded to the Ministry of Food Processing Industries for subsidy. So far 117 proposals received from food processing industries for grant have been recommended to the Ministry. The Ministry has cleared 14 proposals and sanctioned grant to the tune of Rs.421.99 lakhs.

In total 124 proposals are under the consideration of the Ministry of Food Processing Industries, Government of India. Further a Directory of Food Processing Industries in the State is under preparation. A data bank on area and production of various agricultural commodities including fruits and vegetables, wholesale markets etc. is maintained in this department. These particulars are given to the entrepreneur, who intends to establish Food Processing industries in the state.

It is proposed to prepare a shelf of model food processing projects through consultants and the same will be made available in all District Industry Centers for the use of entrepreneur. Agricultural Marketing and Agri Business department participates in all the agriculture and food related exhibitions, seminars in which the advantages of food processing and value addition are disseminated. Contract Farming Contract farming is defined as farming of any agricultural produce on the basis of a contract between farmers and a big wholesale buyer. The contract may be entered into by the parties any time from the starting of the farming to the cutting, processing, packaging and marketing of the crop. Basically the contract is entered before the farming activity starts because the buyer can then stipulate the condition of the cultivation, use of the grade of the seed, pesticides, insecticides, caring of the crop, grading processing and packaging. Contract farming is beneficial in several ways.

It reduces the risk of farmers, ensures a proper price, makes up the market, increases quality consciousness, ensures higher production and reduces distribution cost. Further it also ensures supply of quality agricultural produces to the industry at right time, at lesser cost and

canalizes direct private investment in agriculture. A legally valid risk sharing mechanism should be formulated to avoid legal wrangle between the producers and contracting firms, which might crop up due to price fluctuations. The risk sharing mechanism should bind both farmers and contracting firms to share the price difference equally so that they do not incur loss during market price fluctuation. Contract farming involving business agreements for purchase of output and often provision of inputs and extension advice is increasing in the State, particularly for sugarcane, cotton and horticultural crops.

Contract farming needs to be encouraged by provision of incentives, if necessary. Food Parks The Food Park will have common facilities like Cold storage, Pack House, Grading centre, Quality Control Lab, Drying yard and warehouse, Effluent treatment, Post harvest management unit, Technical information centre, and special common facilities like fruit processing and aseptic packaging, printing and labeling, Dehydration of fruits and vegetables, value add centre, spray drying units etc. Food Parks with common processing facilities enable small entrepreneur, small-scale industries and even farmers to take up food processing without much capital investment. A Food Park in private sector at Virdhunagar has already been established with assistance from MFPI, GOI. Another Food Park at a total cost of Rs.13.00 Crores with assistance from the MFPI is proposed at Nilakkottai Industrial Estate of Dindigul District as a Joint venture of Tamil Nadu State Agricultural Marketing Board (TANSAMB) and State Industries Promotion Corporation of Tamil Nadu Limited (SIPCOT). It is reported that GOI has so far sanctioned more than 39 Food Park project in the country but the progress in making them operational has been slow.

Units get from MFPI 25% subsidy on investment subject to a maximum of Rs.50 lakhs but this is found to be not adequate for Food Parks to take off considering the massive investment involved. A National Consultation on Food Parks, Agri-business and Quality Literacy was convened at Virudhunagar on 24th November 2003. This event was sponsored by MFPI, APEDA, NABARD & IOB. In recognition of the fact that in the present scenario, a large potential in food, fruit, vegetable, milk, meat

and fish processing is largely untapped and that food processing can generate ample off-farm rural employment opportunities which is the need of the hour. The Consultation recommended that it was time to strengthen the Food Parks by providing various concessions/ benefits to both the Food Park promoters and the Food Processing units. Agri Export Zones In a competitive Global Trade Scenario, with a view to provide remunerative returns to the farming community in a sustained manner, efforts are made to provide improved access to the produce / products of the Agriculture, Horticulture and allied sectors in the global market by setting up of Agri Export Zones. The concept of AEZ attempts to take a comprehensive look at a particular Agriculture / Horticulture produce located in contiguous area for the purpose of developing and sourcing the raw materials, their processing, packing, leading to final exports.

This department is in the process of establishing AEZs for various commodities with the above objective. An Agri Export Zone has been established exclusively for cut flowers at Hosur in Dharmapuri district at a project cost of Rs.24.85 crores. TANFLORA, a Joint venture company of TIDCO provides infrastructure facilities like common processing unit, common marketing and leasing the lands for floriculture units. This Agri Export Zone is expected to be ready with all the facilities very soon. Agri Export Zone for flowers in The Nilgiris is being established with participation from a private entrepreneur at a project cost of Rs. 15.89 crores.

Infrastructure facilities like cold storage, reefer vans, common marketing facility, etc., would be created within a year. Another Agri Export Zone exclusively for mango has been established in Theni district with private sector participation at a project cost of Rs.24.60 crores covering the districts of Theni, Dindigul, Madurai, Virudhunagar, Tirunelveli and Kanniyakumari. Facilities like collection centres, processing units, cold storage, etc., would be completed within a year. I It is proposed to establish an Agri Export Zone exclusively for cashew at Cuddalore district with private sector participation at a project cost of Rs. 10.36 crores. Another Agri Export Zone exclusively for banana in Tiruchirappalli District with private sector participation at a project cost of Rs. 10.00 crores is proposed to be

established. Necessary proposals have been sent through Government of Tamil Nadu to APEDA for approval for these AEZs.

Further proposals to establish AEZ for Grapes at Theni, Turmeric at Erode, Medicinal Plants at Tuticorin District, Onion at Coimbatore and Dindigul Districts are under consideration. Department of Seed Certification Seed is the basic input for increasing agricultural productivity. Quality seed forms the basis to produce quality output. For protecting the farming community, a strong seed certification programme and a quality control mechanism are a must. Making available adequate quantity of quality seeds at the doorsteps of the farmer at the right time is essential for increasing agricultural production. The following strategy is enunciated during the Tenth Plan Period under Seed Certification • Increasing the production of certified seed to maintain the quality of produce. • Improving the storage facilities to preserve the guard samples for a long period.

• Ensuring quality of certified seed distribution among the farming community by strengthening the seed inspection wing of the department. The department of Seed Certification started functioning with effect from 24th October 1979 and is implementing the following activities in order to make available quality seeds to the farming community: 1. Seed Certification 2. Seed Inspection 3. Seed Testing and 4. Training Seed Certification: Seed certification is done to encourage the production of adequate quantities of genetically pure and good quality seeds, particularly of high yielding improved varieties and hybrids of different crops. The Department carries out the functions of the seed certification agency according to the provisions of the Central Seed Act 1966 and Seed rules 1968 to ensure the quality of the certified seeds produced in the state.

Seed Certification is a regulatory process designed to secure, maintain and make available the prescribed levels of seed quality namely germination, physical purity, genetic purity and seed health. These quality attributes are ensured by way of verification of source materials used for seed production, carrying field inspections at the appropriate crop stages, supervising the harvest and harvest operations, sampling, testing and tagging the seed lots and grant of certificate for the seed lots possessing minimum required

standards. In order to fill up the gap between availability and requirement of quality seeds, it is proposed encourage the private in the seed sector. During 2003-04, as against the target of 45,000 M.T. a quantity of 41,331 M.T. seeds were certified. It is proposed to increase it to 46,500 M.T.during 2004-05. Seed Inspection: The basic object of the Seed legislation is to regulate the quality of seeds sold to farmers.

The Seed Inspection wing of this department is in charge of regulating the seeds sold in accordance with the provisions of Seeds Act 1966, Seed rules 1968 and Seeds (Control) Order 1983. To ensure the quality of the seeds distributed to the farmers, seed selling points are inspected periodically and seed samples are drawn and sent for analysis in the notified Seed Testing Laboratory and based on the results legal actions are being initiated against the offenders. Besides this the Seed Inspection wing is issuing the licenses for Seed dealers under Seed (Control) Order 1983. During the year 2002-03 and 2003-04, 29,371 and 29,382 seed selling points inspection were made respectively and 20,775 and 21,685 seed samples respectively were drawn for quality check. It is proposed to make 28,800 seed selling points inspections and to draw 21,500 seed samples for quality check during 2004-05.

Seed Testing: Seed testing plays a pivotal role in modern agriculture. The seed testing is being carried out to analyse the quality of the seed lots. Factors like germination, physical purity, moisture, seed health and admixture of other distinguishable varieties are being analysed in the notified seed testing laboratories as per the hand book on seed testing released by Government of India. Seven notified Seed testing laboratories are functioning in the State.

Besides certified seed samples and official seed samples of Seed Inspection wing, service samples sent by the farmers, seed dealers and Seed producers are also being tested in these laboratories. The grow-out test is conducted to determine the genetic purity of a given seed lots. The grow-out test is conducted at Kannampalayam (Coimbatore) farm and at glass house attached to the Director of Seed Certification. This test is conducted for the certification of parents and hybrids of cotton, foundation class cotton, and

castor hybrids and also for the samples received from the Seed Inspection wing.

During 2002-03, 51,193 numbers of seed samples were tested. In the year 2003-04 as against the target of 56,000 seed samples, 47,991 seed samples were tested. It is proposed to test 60,000 samples during 2004-05. Training: the Training wing organizes the following training programs. Orientation training: Training is given to the newly jointed Officers of this department Refresher Training: The already positioned technical officers of this department are trained. Training to Seed Producers: Training is given on the seed production aspects to the seed producers. Quality control Training to Seed Dealers: Training is given to the seed dealers on quality maintenance, storage of seeds and also on the regulatory aspects of seed legislation. The number of beneficiaries under various training programme was 25,591 and 28,680 during year 2001-02 and 2002-03 respectively. It is proposed to train 27,000 persons during 2004-05.

New schemes for 2004-05. During the 2004-05 it is proposed to improve the existing infra structure and basic facilities in the seed quality control wing by upgrading the glass house at the Directorate at a cost of Rs.2 lakhs and by providing Elisa kit for Bt deduction at Rs.4.78 lakhs. To increase the efficiency in seed testing an amount of Rs.1.60 lakhs for purchase of mini generator and Rs.2.32 lakhs for purchase of digital camera, LCD projector and communication facilities. To strengthen the electric facilities at the Directorate an amount of Rs.0.60 lakhs is provided.

Plant quarantine

Strengthening & Modernisation of Plant Quarantine Facilities In India

Plant Quarantine regulatory measures are operative through the 'Destructive Insects & Pests Act, 1914 (Act 2 of 1914) in the country. The purpose and intent of this Act is to prevent the introduction of any insect, fungus or other pest, which is or may be destructive to crops. The import of agricultural commodities is presently regulated through the Plant Quarantine (Regulation of Import into India) Order, 2003 the provisions of New Policy on Seed Development, 1988.

Further, the significance of Plant Quarantine has increased in view of Globalization and liberalization in International trade of plants and plant material in the wake of Sanitary and Phytosanitary (SPS) Agreement under WTO. The phytosanitary certification of agricultural commodities being exported is also undertaken as per International Plant Protection Convention (IPPC), 1951.

In line with the New Policy on Seed Development, 1988 and the provisions of PQ Order, 2003, the specified planting material for propagation (viz., cuttings, saplings, bud woods, etc.) require growing under Post Entry Quarantine (PEQ) for a specified period. The import permit for such planting material is granted based on a certificate from Designated.

Inspection Authorities of the concerned jurisdiction stating that the importer possesses the post entry quarantine facility for the imported planting material. Such consignments are released with the intimation to the concerned Inspection Authorities for conducting further PEQ inspections and the final clearance is granted based on the PEQ Inspection Report. The pest risk analysis is mandatory for all the plants/plant material prior to its import into India as per PQ Order, 2003.

The risk of exotic pests and diseases is minimized by identifying the potential pests which can get into the country with the specified commodity and seeking export certification for their freedom/pest free area status, etc. from the exporting country. Inspection of agricultural commodities meant for export as per the requirements of importing countries under International Plant Protection Convention (IPPC) 1951 of FAO which's now replaced by revised text of IPPC as per the model certificates prescribed under IPPC and issue Phytosanitary Certificate.

The export inspections are carried out to facilitate certification of exportable plants and plant material as per the requirement of importing country in line with the above Convention. The export inspections involves sampling and detailed laboratory tests in case of seeds and planting material for propagation whereas visual examination with hand lens and washing tests, etc are carried out for plant material meant for consumption.

The export inspections are conducted at exporters' premises also to facilitate exports for agricultural commodities meant for consumption. As per Plant Quarantine (Regulation of Import into India) Order, 2003 a total of 60 entry points including 34 seaports, 12 airports and 14 land custom stations are notified points of entry for import of plants and plant material. Besides, 60 Inland Container Depot/Container Freight Station, 11 Foreign Post Offices have also been notified for the entry of plants/plant material under the PQ Order, 2003.

Objectives

1. Inspection of imported agricultural commodities for preventing the introduction of exotic pests and diseases inimical to Indian fauna and flora through implementation of DIP Act, 1914 and the Plant Quarantine (Regulation of Import into India) Order, 2003 issued there under.
2. Inspection of plants and plant material meant for export as per the requirements under International Plant Protection Convention (IPPC) 1951 of FAO to facilitate pest free trade.
3. Detection of exotic pests and diseases for their containment by adopting domestic quarantine regulations, if introduced.

   The ongoing activities assigned under the scheme include:

- To issue import permits with additional declarations and special conditions to facilitate safe imports of agricultural products.
- To undertake quarantine inspection and laboratory testing of plants and plant material to ensure freedom from exotic pests.
- To undertake phytosanitary certification (for issuance of Phytosanitary Certificates (PSCs); 150 Nos. of Officers from Central/ State/ UT Governments have been authorized for this purpose.
- To undertake fumigation/disinfestations/disinfections of commodities to control infestation/infection.
- To undertake certification of post-entry quarantine facilities and inspection of imported growing plants and plant material; 41 Nos. of Inspection Authorities have been designated.

- To support Export market access for India's Agriculture products from the phytosanitary point of view.
- To facilitate safe global trade in agriculture by assisting the producers and exporters by providing a technically competent and reliable phytosanitary certificate system to meet the requirements of trading partners.
- To provide Grants-in-aid to Designated Inspection Authorities to meet the travel expenses and also to State PSC issuing authorities for equipping them with minimal equipments required for export inspection/certification.
- Granting approval/accreditation of Treatment providers in line with the requirement of ISPM-15.
- To undertake PRAs of different agricultural commodities with respect to their import or export in relation to the countries concerned.

Present Setup

Presently, there are 70 Plant quarantine Stations at different International Airports, Seaports and Land Frontiers implementing the Plant Quarantine Stations regulations with its Headquarters at Faridabad. The lists of existing Plant Quarantine Stations are listed below.

Plant Quarantine Stations under RPQS, Mumbai

1. RPQS, Sewari(East), Mumbai
2. PQS, Air Cargo, Mumbai
3. PQS, JNPT, Nhava Sheva, Mumbai
4. Navkar Unit, Mumbai
5. PQS, Nashik
6. PQS, Nagpur
7. PQS, Goa
8. PQS, Indore
9. PQS, Raipur

Plant Quarantine Stations under RPQS, Kandla

1. RPQS, Kandla
2. PQS, Jamnagar
3. PQS, Pipavav Port
4. PQS, Mundra (Kutch)
5. PQS, Ahmedabad
6. PQS, Sanand
7. PQS, Mandvi*
8. PQS, Navlakhi*
9. PQS, Okha*
10. PQS, Virawel*

Plant Quarantine Stations under RPQS, Chennai

1. RPQS, Chennai
2. PQS, Coimbatore
3. PQS, Tuticorin
4. PQS, Tiruchirapalli
5. PQS, Madurai
6. PQS, Cuddalore*
7. PQS, Kakinada
8. PQS, Vishakapatnam
9. PQS, Krishnapatnam
10. PQS, Guntur
11. PQS, Machilipatnam*
12. PQS, Pondicherry*

Plant Quarantine Stations under RPQS, Bengaluru

1. RPQS, Bengaluru
2. PQS, Hyderabad
3. PQS, Mangalore
4. PQS, Karwar*
5. PQS, Thiruvananthapuram
6. PQS, Cochin

7. PQS, Airport, Cochin
8. PQS, Calicut
9. PQS, Vizhinjam*
10. PQS, Alleppy*

Plant Quarantine Stations under RPQS,Kolkata

1. RPQS, Kolkata
2. PQS,Air Cargo Complex, Kolkata
3. PQS, Haldia
4. PQS,Panitanki
5. PQS, Bangaon
6. PQS, Bagdogra
7. PQS, Moreh
8. PQS, Kalimpong
9. PQS, Paradip
10. PQS, Gopalpur*
11. PQS, Guwahati
12. PQS, Port Blair
13. PQS, Agartala
14. PQS, Gopalganj*
15. PQS, Raxual
16. PQS, Jogbani

Plant Quarantine Stations under RPQS,New Delhi

1. RPQS, Rangpuri
2. PQS,Air Cargo , New Delhi
3. PQS, Tuglakabad
4. PQS,Rupadiah
5. PQS, Sanauli
6. PQS,Banbasa
7. PQS, Varanasi*
8. PQS, Lucknow

Plant Quarantine Stations under RPQS, Amritsar

1. RPQS, Amritsar
2. PQS, Attari-Waga Border-LCs
3. PQS, Attari-Waga Railway Station*
4. PQS, Chakandabagh*
5. PQS, Salamabad*

* Station made functional by deputing staff from other PQ Stations.

Import & Export Procedure

Import Procedure

This involves two phases:-

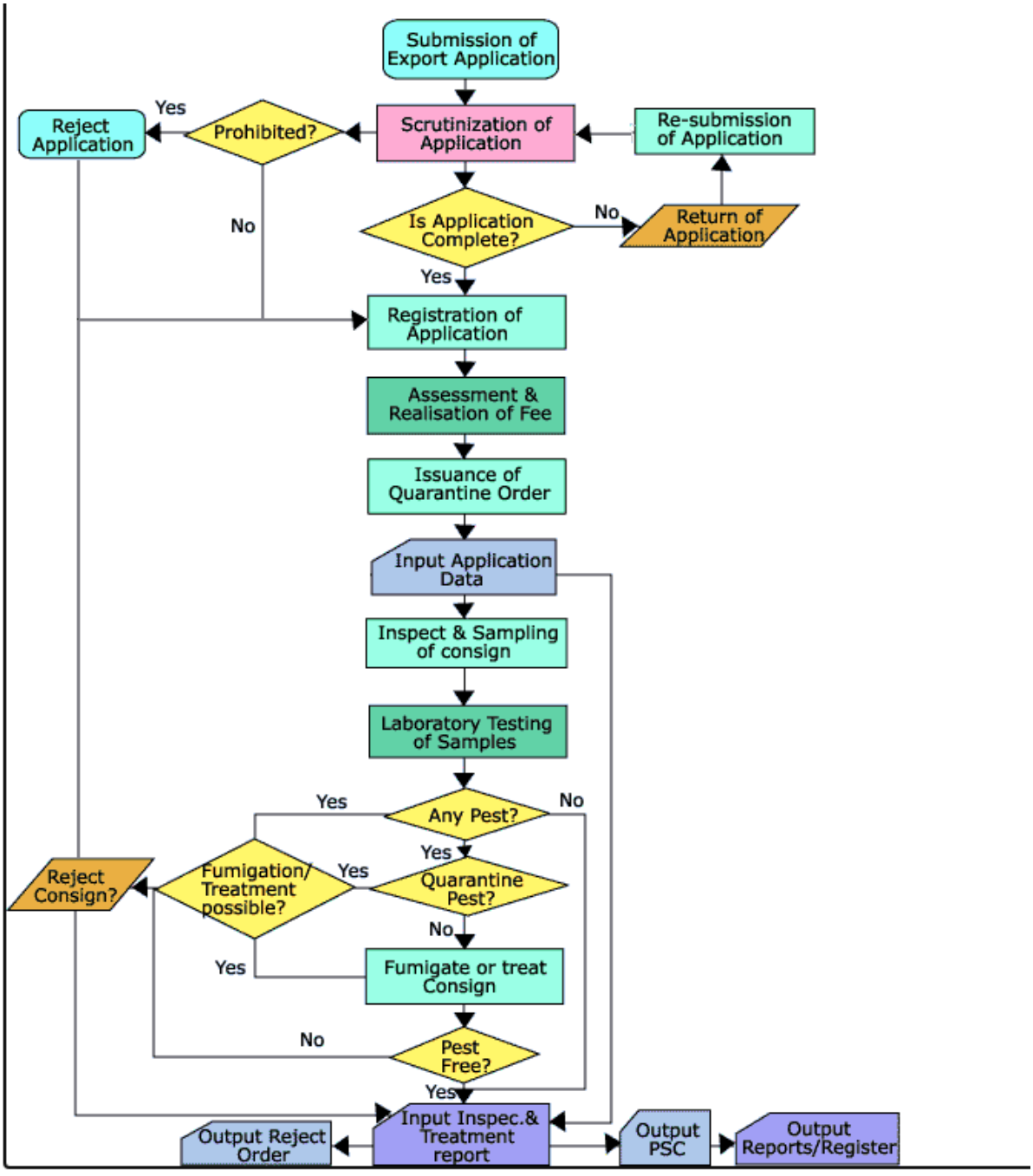
- Issue of Import Permit: An Importer intending to import agricultural commodities has to apply in advance for the issue of Import Permit in respect of the commodities listed in Schedule V and VI of PQ Order, 2003 in the prescribed form. The procedure to be followed has been shown in the flow chart at Annexure-II
- Inspection of imported agricultural commodities on arrival at the port of entry for preventing the introduction of exotic pests and diseases inimical to Indian Fauna and Flora through implementation of DIP Act, 1914 and Plant Quarantine (Regulation of Import into India) Order, 2003 issued thereunder.
- The import clearance involves various steps from receipt of reference from Customs until recommendation for its release or otherwise to the Customs including sampling, detail testing viz., bacteriological, mycological, entomological, nematological, etc., besides the post entry quarantine (PEQ) testing at the importers premises under the PEQ facility. The flow chart for import inspection and clearance is attached (Annexure-III). The post entry quarantine inspections which are required in case of cuttings, saplings and bud woods are carried out by the Designated Inspection Authorities constituting mainly the head of the Department of Entomology/Plant Pathology of the Sate Agricultural Universities/ICAR Institutions.

- Undertaking Post Entry Quarantine Inspection in respect of identified planting materials: In line with the New Policy on Seed Development, 1988 and the provisions of PQ Order, 2003, the specified planting material for propagation (viz., cuttings, saplings, bud woods, etc.) require growing under Post Entry Quarantine for a specified period. The import permit for such planting material is granted based on a certificate from Designated Inspection Authorities of the concerned jurisdiction stating that the importer possesses the post entry quarantine facility for the imported planting material. Such consignments are released with the intimation to the concerned Inspection Authorities for conducting further PEQ inspections and the final clearance is granted based on the PEQ Inspection Report.

Export Procedure

Inspection of agricultural commodities meant for export as per the requirements of importing countries under International Plant Protection Convention (IPPC) 1951 of FAO as per the model certificates prescribed under IPPC and issue Phytosanitary Certificate:

The export inspections are carried out to facilitate certification of exportable plants and plant material as per the requirement of importing country in line with the above Convention. The export inspections involves sampling and detailed laboratory tests in case of seeds and planting material for propagation whereas visual examination with hand lens and washing tests, etc are carried out for plant material meant for consumption. The export inspections are conducted at exporters' premises also to facilitate exports for agricultural commodities meant for consumption. The flow chart for various steps involved in export certification is shown below.



Export Inspection – Flow chart