UNIT 13 QUALITY CHARACTERISTICS AND PARAMETERS OF PROCESSED FOOD

Structure

13.0 OBJECTIVES

After reading this unit, you should be able to :

- explain the physical appearance of food
- know the textural properties
- understand flavour and aroma characteristics of processed food
- explain chemical and microbiological characteristics of food
- know importance of quality standards
- understand requirement of packaging and labelling

13.1 INTRODUCTION

Food is the basic necessity of life and therefore we have the right to expect the food we eat to be safe and suitable for consumption. Food can cause us illness/ injury if not properly made or at worst, it can be fatal. Outbreaks of food-borne illnesses, like dropsy due to use of substandard mustard oil, can damage trade, loss of earnings, unemployment and litigation. Food spoilage is wasteful, costly and can adversely affect trade and consumer's confidence. The food safety and quality is of paramount importance in the food sector.

Food laws all over the world are becoming more and more stringent and ensure that food are processed under hygienic conditions to avoid microbial contamination. This has also become necessary on account of excessive use of chemicals and other ingredients, which may contaminate food. Further, the consumer awareness is further strengthened by the influence of Consumer Forums on Food Laws and Regulations. The explosive population growth and migration of people from rural to urban areas have put tremendous pressure on food growers and producers to produce more and more quantity of food and at the same time due to consumer's awareness to produce quality and safe foods. In other words, everyone including

farmers and growers, manufacturers and processors, food handlers and consumers, policy makers and regulators, has a responsibility to ensure that food is safe and suitable for consumption.

13.2 PHYSICAL CHARACTERISTICS

Appearance

Sensory attributes of food, those related to appearance are the most susceptible to objective measurement, but appearance is important to all of us. You have certain expectations of how food should look. Two separate categories of appearance include:

1. Colour attributes
2. Geometric attributes (size and shape)

Colour

Colour is by-far the most important. We expect meat to be red, apple juice to be light brown and clear, orange juice to be orange, egg yolks to be bright yellow-orange and so on.

Food colour measurements provide an objective index of food quality. Colour is an indication of ripeness or spoilage. The end point of cooking processes is judged by colour. Changes in expected colours can also indicate problems with the processing or packaging. Brown and blackish colours can be either enzymatic or non-enzymatic reactions. The major non-enzymatic reaction of greatest interest to all of us is the Maillard reaction, which is the dominant browning reaction. Other less explained reactions include blackening in potatoes or the browning in orange juice. The enzymatic browning, found widespread in fruits and selected vegetables is due to the enzymatic-catalyzed oxidation of the phenolic compounds.

Naturally occurring pigments play a role in food colour. Water-soluble pigments may be categorized as anthocyanins and anthoxthanins. Lesser known water-soluble pigments include the leucoanthocyanins. Fat-soluble plant pigments are primarily categorized into the chlorophyll and carotenoid pigments. These green and orange-yellow pigments considerably impact the colour.

Measuring colour

In order to maintain quality, the colour of food products must be measured and standardized. If a food is transparent, like a juice or a coloured extract, colorimeters or spectrophotometers can be used for colour measurement. The colour of liquid or solid foods can be measured by comparing their reflected colour to defined (standardized) colour tiles or chips. For a further measurement of colour, reflected light from a food can be divided into three components: value, hue, and chroma. The colour of a food can be precisely defined with numbers for these three components with tri-stimulus colorimetry. Instruments such as the Hunterlab Colour and Colour Difference Meter measure the value, hue, and chroma of foods for comparisons.

Size and shape

Depending on the product, we expect foods to have certain sizes and shapes. For example, you have some idea of what an ideal french fry should look like, or an apple, or a cookie, or a pickle. Size and shape are easily measured. Fruits and vegetables are graded based on their size and shape, and this is done by the

openings they will pass through during grading. Now computerized electronic equipments can determine the size and shape of foods.

13.3 TEXTURAL PROPERTIES

We as consumers, expect gum to be chewy, crackers to be crisp, steak to be tender, cookies to be soft and breakfast cereal to be crunchy. The texture of food refers to the qualities felt with the fingers, the tongue, or the teeth. Textures in food vary widely, but any deviation from what you expect is a quality defect.

Texture is a mechanical behaviour of foods measured by sensory (physiological/ psychological) or physical (rheology) means. Rheology is the study of the science of deformation of matter. The four main reasons for studying rheology include:

1. Insight into structure
2. Information used in raw material and process control in industry
3. Applications to machine design
4. Relation to consumer acceptance

Regardless of the reason for studying texture, classification and understanding are difficult because of the enormous range of materials. Moreover, food materials behave differently under different conditions.

Texture testing in foods is based upon the action of stress and strain. Many of the methods are based upon compression, shearing, shear-pressure, cutting or tensile strength. For example, the compressimeter was used to determine the compressibility of cakes and other "spongelike" products. Historically, the penetrometer has been used to measure gel strength. The Warner-Bratzler shear apparatus has been the standard method of evaluating meat tenderness. The Instron has adapted many of the historical texture measuring instruments. It measures elasticity. The Brookfield viscometer will measure the viscosity in terms of Brookfield units. Other instruments used to measure texture include a succulometer and tenderometer.

Changes in texture are often due to water status. Fresh fruits and vegetables become soggy as cells break down and lose water. On the other hand, if dried fruits take on water, their texture changes. Bread and cake lose water as they become stale. If crackers, cookies and pretzels take up water, they become softy and undesirable.

Various methods are used to control the texture of processed foods. Lipids are softeners and lubricants used in cakes. Starch and gums are used as thickeners. Protein can also be a thickener, or if coagulated as in baked bread, it can form a rigid structure. Depending on its concentration in a product, sugar can add body as in soft drinks or in other products add chewiness, or in greater concentrations it can thicken and add chewiness or brittleness.

13.4 FLAVOUR AND AROMA

Food flavour includes taste sensations perceived by the tongue like sweet, salty, sour and bitter and smells perceived by the nose. Often the terms flavour and aroma are used interchangeably. Food flavour and aroma are difficult to measure and difficult to get you all to agree on. A part of food science called sensory science is

dedicated to finding ways to help humans accurately describe the flavours and other sensory properties of their food.

Flavour is a quality factor. It influences the decision to purchase and to consume a food product. Food flavour is a combination of taste and smell, and it is very subjective and difficult to measure. People differ in their ability to detect tastes and odours. People also differ in their preferences for these.

Besides the tastes of sweet, salty, sour, and bitter, an endless number of compounds give food characteristic aromas, such as

- Fruity
- Astringency
- Sulfur
- Hot

Sweetness may result from sugars like arabinose, fructose, galactose, glucose, ribose, xylose, and other sweetners. Organic acids may be perceived on the bottom of the tongue. Some of these common acids are citric, isocitric, malic, oxalic, tartaric, and succinic acids. The fruity flavours are often esters, alcohols, ethers or ketones. Many of these are volatile and are associated with acids.

Phenolic compounds are closely related to the sensory and nutritional qualities of plants. They are found in many fruits, including apples, apricots, peaches, pears, bananas, and grapes; and vegetables such as avocado, eggplant, and potatoes, and contribute to colour, astringency, bitterness, and aroma. Most phenolic compounds are found around the vascular tissues in plant, but they have the potential to react with other components in the plant as damage to the structure occurs during handling and processing. Loss of nutrients and changes in colour and flavour occur in foods due to the phenolic compounds reaction with polyphenol oxidase.

The sense of taste is a powerful predictor of food selection. The four main tastes the body experiences are sweet, sour, salty, and bitter. Humans like sweet-tasting foods. Possibly this preference for sweet is a holdover from ancient ancestors, who found that sweetness indicated that the food provided energy.

Judgment of flavour is often influenced by colour and texture. Flavours such as cherry, raspberry, and strawberry are associated with the colour red. Actually, the flavour essences are colourless. As for texture, we expect potato chips to be crunchy and gelatin to be soft and cool.

Depending on the food, flavour can also be influenced by:

- Bacteria
- Yeasts
- Molds
- Enzymes
- Heat/cold
- Moisture/dryness
- Light

- Time
- Additives

Taste attributes consist of saltiness, sweetness, bitterness and acidity. These attributes are largely determined by the formulation used and are mostly unaffected by processing. Exceptions to this include respiratory changes to fresh foods and changes in acidity or sweetness during food fermentations. Fresh foods contain complex mixtures of volatile compounds, which give characteristic flavours and aromas. These compounds may be lost during processing, which reduces the intensity of flavour or reveals other flavour/aroma compounds. Volatile aroma compounds are also produced by the action of heat, ionizing radiation, oxidation or enzyme activity on proteins, fats and carbohydrates. Examples include the Maillard reaction between amino acids and reducing sugars or carbonyl groups and the products of lipid degradation, or hydrolysis of lipids to fatty acids and subsequent conversion to aldehydes, esters and alcohols. The perceived aroma of foods arises from complex combinations of many hundreds of compounds, some of which act synergistically.

Table 1: Textural Characteristics of Foods

Primary characteristic	Secondary characteristic	Popular terms
Mechanical characteristics		
Hardness		Soft – firm – hard
Cohesiveness	Brittleness	Crumbly, crunchy, brittle,
	Chewiness	Tender, chewy, tough
	Gumminess	Short, mealy, pasty, Gummy
Viscosity		Thin, viscous
Elasticity		Plastic, elastic
Adhesiveness		Sticky, tacky, gooey
Geometrical characteristics		
Particle size and shape		Gritty, grainy, coarse
Particle shape and orientation		Fibrous, cellular, Crystalline
Other characteristics		
Moisture content		Dry - moist - wet- watery
Fat content	Oiliness	Oily
	Greasiness	Greasy

Finally, depending on the product, the influence these factors have on a food flavour can be positive or negative and sometimes differs depending on the person.

13.5 CHEMICAL AND MICROBIAL CHARACTERISTICS

Ensuring the safety of food involves careful control of the process from the farm gate to the consumer. Safety includes control of both chemical and microbiological characteristics of the product. Most processing places emphasis on microbial control, and often has as its objective the elimination of organisms or prevention of their growth.

Chemical hazards in foods

Permitted food additives

Government regulations permit numerous chemical and biochemical substances to be added to foods at specified maximum levels. These substances are intended to impart some improved nutritional effect (*e.g;* vitamin fortification) or some specific technical function (*e.g;* preservative action, sensory attribute, stabilizing effect etc.). Permissible food additives with their established levels for use can be found listed in government food regulations. In addition, the Codex Alimentarius contains specifications of permitted food additives. Although food additives are permitted by government regulations, many can be harmful if they are present in the food at levels above the maximum permitted and are therefore, potential chemical hazards. In some instances, a permitted food additive present below the maximum allowable level in a food can be health hazardous for specific segments of the population. For example, sodium bisulfite is a permitted food additive in some foods. However, individuals who are asthmatic could be at risk from foods containing sodium bisulfite. The labels on the containers containing the foods must clearly indicate the presence of the additives for the benefit of individuals who may be at risk from these additives.

Naturally occurring harmful compounds

It is well known that many foods contain as their normal or inherent components naturally occurring substances that can be harmful if they are present in excess of certain levels. Examples are oxalate in rhubarb, alkaloids in potatoes, toxins in mushrooms and shellfish. In the U.S.A., the FDCA considers foods containing these naturally occurring substances to be adulterated only if the harmful substance is present in sufficient quantity that is likely to cause illness.

Unavoidable contaminants

Some foods can contain naturally occurring harmful substances that are not normal or inherent components of the foods. These substances are considered unavoidable contaminants in the food and cannot be removed through processing or manufacturing practices, examples are aflatoxin from moulds in peanuts and in some cereals. If the normal level of a naturally occurring harmful substance in food is increased to an unsafe level as a result of mishandling of the food or by any other action, then the harmful substance can be considered as an added harmful substance.

Agricultural residues

Agricultural residues are a group of residual chemical or biochemical substances found in foods and are directly attributable to certain substances that have been approved for use in the production of crops and livestock for food. They include residues of permitted pesticides, herbicides, fungicides, drugs, hormones and antibiotics. Some of these residues are considered as added harmful substances attributable to human actions and are regulated by government. The Codex Alimentarius establishes maximum residual levels (MRL) for various harmful pesticides and veterinary drugs.

Industrial contaminants

Several harmful chemicals that enter the environment as a result of industrial activity have been shown to be present in foods. These substances include heavy metals (lead, mercury, arsenic) organic-chlorinated compounds such as polychlorinated biphenyls (PCBs) and are considered as industrial or environmental contaminants

Chemical residues

In food processing operations, some chemical compounds that are not permitted substances in food are used during certain operations and care must be taken to prevent unintentional contamination. These substances include chemical compounds used for cleaning and sanitizing food contact surfaces of processing, handling and storage equipments and for lubricating certain parts of food processing equipment.

Prohibited chemicals

No chemical substance is permitted for use in a food unless it meets all of the requirements that are covered in the applicable food laws and regulations. In addition, some chemical substances are specifically prohibited from direct or indirect addition to food through food contact surfaces.

Food allergens

Certain foods are known to contain inherent components that cause serious immunological, allergic responses in a relatively small proportion of food consumers. These foods are entirely safe for most consumers who are not sensitive to the allergens. The following foods and some of their products are generally considered to be the most common food allergens: peanuts, soybeans, milk, eggs, fish, crustacea, tree nuts and wheat. Some other foods (*e.g;* sesame seeds) are also known to cause allergenicity occasionally. In addition, sulfates (bisulfate and metabisulfites) used on ingredients in certain foods can produce nonimmunological allergic reactions in certain sensitive individuals.

Biological hazards in foods

Pathogenic bacteria

Food-borne pathogens are responsible for a large proportion of food poisoning incidents. Therefore, the importance of this group of hazards must be emphasized. More than 40 different pathogenic bacteria are known, however, a large proportion of the reported cases of food poisoning can be attributed to the following pathogenic bacteria: *Salmonella* spp., *Escherichia coli* 0157:H7, *Listeria monocytogenes*, *Clostridium perfringens*, *Clostridium botulinum*, *staphylococcus aureus* and *campylobacter jejeuni*. Food poisoning from these organisms occur frequently, with symptoms that include headache, muscle pain, nausea, fatigue, fever, stomach or abdominal pain, vomiting and diarrhoea Numerous severe and fatal illnesses occur as a result of food poisoning from pathogenic bacterial infection and the elderly people are particularly vulnerable. The foods that are commonly involved in these food poisoning incidents include meat and poultry and their products, seafood and their products, eggs and egg products, milk and dairy products, fruits & vegetables and their products, low-acid canned foods and water.

Viruses

Foods can be a medium for transmission of certain viruses. Examples of viruses that are known to be food safety hazards are the hepatitis A and E viruses, the Norwalk group of viruses and rotavirus.

Parasites

Several human parasites can be transmitted by foods. The most common human parasites include parasitic protozoan species (*e.g; Entamoeba histolytica, Giardia lambia, Cryptosporidium parvum),* and parasitic worms (*Ascaris lumbricoides, Taenia solium, Trichinela spiralis).*

Microbiological quality issues in primary processing of agricultural produce

Three major microbiological quality issues at different stages of post-harvest processing of agricultural produce are as under:

- Improper and unhygienic storage condition at the farm level leads to accelerated development of microflora in the food.
- Improper handling during transportation from field to procurement center leads to increase in the microbial load in the food
- Microbial spoilage during transportation from procurement centre to processing facility – long distance, vehicle breakdowns, absence of cold chain, poor condition of the roads etc. are the contributing factors.

Microflora and mycotoxins associated with food grains and oil-seeds

The effect of organisms on safety and quality of foods is dependent on the initial number of microorganisms present, processing steps for elimination of organisms and control of environment to prevent growth and sanitation. The main factors that influence growth of microorganisms are pH, oxygen availability, available moisture and nutrients, storage temperature, lag time and generation time. The food industry depends upon minimizing microbial population in the food or control of the environment. Generally microorganisms especially pathogens cannot grow at pH levels below 4.0.

A thumb rule for the number of microorganisms required to produce toxin or to produce desired or undesired flavours is one million/gram (10^6/g). Thus for food-borne intoxication (*Clostridium botulinum, Bacillus cereus and Staphyloccus aureus)* there has to be a large number of organisms. But in case of *E.coli 0157, Listeria monocytogenes and Salmonella,* the number of organisms that can cause the disease can be very small.

Mycoflora, mycotoxins and coliforms are chemical and biological risks to the food safety of grains. These hazardous contaminants are either directly deleterious to the health of humans and animals through ingestion or indirectly through the harmful toxins they produce. They are generated both in the field and in storage and occur through out the handling system. Mycotoxins that have been detected in cereals include aflatoxin, ochratoxin A, deoxynivalenol, citrinin, zearelenone and fuminisoins. It is known that microorganisms of public health significance may present a potential threat if cereal grains and grain based foods are improperly stored, processed or handled. The spoilage microorganisms can proliferate if the cereals or their finished products are stored under improper conditions such as excessive moisture or temperature. Oil-seeds, especially soya beans and groundnuts are harvested for longer-term storage every year and may be susceptible to mold spoilage, if not stored under appropriate conditions. Edible nuts are also rich in oil and give similar microbiological problems as oil-seeds. Seeds rich in oil have lower water content at a particular water activity than cereals *e.g.* groundnuts with 7.2 % water content have a water activity of about 0.65-0.70 at 25 °C. Apart from the problem of mycotoxin formation in molded oil-seeds, several mold species have strong lipolytic activity leading to the contamination of the extracted oil with FFA, which may inturn undergo oxidation to form products contributing to rancidity. The most lipolytic molds are species of *Aspergillus* such as *A. niger* and *A. tamarii, Penicillium* and *Paecilomyces* while at higher water activities species of *Rhizopus* may be important. If oil-seeds are harvested with as little damage as possible and dried to an appropriate water content, it should be possible to store them for a considerable long time, so long as they are not exposed to excessive temperature abuse during

storage. The problem may arise when large storage facilities such as silos are not carefully designed to avoid temperature differentials. Migration of water in these circumstances can result in germination of fungal spores and the growth of mycelium creating a localized region of fungal activity releasing further water of respiration into the region. Thus, a commodity initially going into store at safe water content goes moldy over a period of time. Dry oil-seeds are not susceptible to direct microbiological spoilage, but the activity of insects and rodents lead to secondary invasion and thus can cause mold spoilage.

Sources of biological hazards: Among the various hazards, the biological hazards are very important and their sources are as follows

i. **Insect pests:** Some of the insect pests are carrier of microbiological contamination and when they come in contact with food they leave the food contaminated.

ii. **Water:** Water is a carrier of biological contamination. When such water is used for processing, it contaminates the food. Also, when such water is used for cleaning food contact surfaces, it contaminates foods. Contaminated water carries mainly *Coliform, Salmonella, Listeria* and *Shigella* bacteria.

iii. **Environmental hygiene:** Bioburden in the environment is the potential source of contamination of food. *Listeria* grows as biofilms in floor drains in processing plants.

iv. **Personnel hygiene:** The food handlers are the main sources of microbiological contamination. There are two routes of such contamination – one through pathogenic microorganisms carried through persons and another unhygienic practices indulged in by the workers. Poor personal hygiene among food handlers is the chief contributing factors for *Shigella* contamination.

v. **Cleaning of equipment and food contact surfaces:** Inadequate cleaning practices and cleaning agents used impart contamination to foods being processed.

Prevention of biological hazards:

i. **Pest control system:** Inspection and auditing of pest control protocol are important. The facility should be insect-pest protected. Breeding and harbouring places for insects such as mosquitoes and flies should be eliminated.

ii. **Swab analysis of hands of food handlers:** Swab analysis of the sample taken from the hands of food handlers and judging the level of hygiene should be done. High count in the swab also indicates ineffective hand washing facility.

iii. **Microbiological analysis of food contact surfaces:** Evaluation of samples taken from food handling equipment and food contact surfaces has shown effectiveness of cleaning practices and cleaning as well as sanitizing agents.

iv. **Evaluation of aerial load:** Periodic evaluation of aerial counts for microorganisms, which may contaminate food being processed under such environment, is essential. This should include inside environment and that immediately outside the facility.

v. **Control of process:** Evaluation of control systems for heat treatment and drying which are designed to control microbiological contamination should be done.

Processes that are aimed at prevention of growth include:

- Irradiation
- Refrigeration

- Freezing
- Drying
- Control of water activity (addition of salt, sugars, polyols, and so forth)

Processes that are aimed at minimizing organisms include:

- Pasteurization
- Sterilization (canning)
- Cleaning and sanitizing
- Membrane processing

Further, a method of processing that is aimed at the control of undesirable microflora is the deliberate addition of microorganisms and the use of fermentation.

Safety from a chemical viewpoint generally relates to keeping undesirable chemicals, such as pesticides, insecticides, and antibiotics, out of reach of the food supply chain. Making sure that food products are free from extraneous matter (metal, glass, wood, etc.) is another facet of food safety.

Today, we want food products that are convenient to use and still have all the qualities of a fresh product.

Check Your Progress 1

Note: a) Use the space given below for your answers.
b) Check your answers with those given at the end of unit.

1. List the three components of reflected light used to define colors.

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2. Name instruments used to measure texture.

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3. What is flavour and how it is influenced ?

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4. The study of the science of the deformation of matter is called.

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5. How do fats or lipids affect the texture of food?

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13.6 QUALITY STANDARDS FOR PROCESSED FOODS

Food quality as distinct from food safety is the extent to which all the established requirements relating to the characteristics of a food are met. Common examples of quality characteristics of food are:

- Identity of a food in relation to a standard (*e.g.*, standardized food)
- Declared gross or net quantity (*e.g.*, weight or volume) of a unit of the food or net-fill of a food container
- Declared or claimed amount of one or more stated components of a food
- Appearance (*e.g.*, size, shape, colour)
- Flavour
- Aroma
- Texture
- Viscosity
- Shelf-life stability
- Fitness for use as human food
- Wholesomeness
- Adulteration
- Packaging
- Labelling

In today's race for market growth and market share, organizations have realized the need to focus on meeting and exceeding customer needs and expectations. Successful organizations are seeking to achieve more than just customer satisfaction. They are targeting to achieve customer delight. They believe that by focusing on the customer, and supplying defect-free products, backed by effective delivery and after-sales service they survive competition and move on to gain a position of leadership in their respective markets.

Many effective management tools are now available and are continually being developed to enable organizations to achieve these objectives. Some of these are in the form of International Quality Standards and other related Standards, which can be used by organizations big and small, manufacturing or service-oriented to identity areas for improvement and implement changes in products, processes and organizational culture to enable meet the challenges of competition. These standards give guidelines on the principles to be adopted by organizations. They do not prescribe the method to be used to implement the principles. This is left to the concerned organization, which leaves it a lot of freedom for adopting practices and procedures that are most suitable for its operations. This refutes the myth that the standards need an organization to adopt rigid and unchangeable and prescriptive

procedures and practices. When clearly understood and correctly interpreted these standards are a pleasure to adopt and implement. As one senior executive in an organization exclaimed after the organization was recommended for certification "I used to struggle a lot before we adopted this management system. Now I am more relaxed at work. I do no work, the system works.

A quality system standard is a document that describes the requirements of a quality system. The ISO 9001:2000 quality management system standard is the recognized international quality system standard. Many countries have formally adopted this international standard as their national quality system standard. Prior to the adoption of the international quality system standard, some countries had developed their own national quality system standards. In addition, some industry sectors have developed sector-specific quality system standards.

Here are some of these tools for organizations to pick from:

1. ISO 9001, ISO 9002 and ISO 9003:1994

First published in 1987, the ISO 9000 series of standards enable an organization to set up a quality management system and supply products and services that are free of non-conformities and aim to achieve customer satisfaction.

2. ISO 9001:2000

Implementation of this standard will enable an organization to demonstrate its ability to consistently provide products that meet customer and to meet applicable regulatory requirements. It aims to enhance customer satisfaction through the effective application of the system, including processes for continual improvement of the system and the assurance to conformity to customer and applicable regulatory requirements. The stress is more on continual improvement of the quality management system rather than the adoption of numerous procedures. It incorporates eight excellent management principles within the standard and has only six mandatory procedures. It leaves more freedom to the organization, than the 1994 version, as to which processes it should document.

The eight principles adopted are titled as follows: Customer focused organization, Leadership, Involvement of people, Process approach, Systems approach to management, Continual improvement, Factual approach to decision making, and Mutually beneficial supplier relationships. These principles are expressed throughout the standard in each of its "clauses".

3. HACCP for Food Industry

The Hazard Analysis and Critical Control Points (HACCP) system, which is science based and systematic, identifies specific hazards and measures for their control to ensure the safety of food. HACCP is a tool to assess hazard and establish control systems that focus on prevention rather than relying mainly on end product testing.

HACCP can be applied throughout the food chain from the primary producer to final consumer and its implementation should be guided by scientific evidence of risks to human health. Besides enhancing food safety, implementation of HACCP can provide other significant benefits. The application of HACCP system can aid inspection by regulatory authorities and promote international trade by increasing confidence in food safety.

The application of HACCP is compatible with the implementation of quality

management systems, such as the ISO 9000 series and is a system of choice in the management of food safety within such systems.

4. SA 8000 Social Accountability Standard

This Standard specifies requirements for social accountability to enable an organization to:

a) Develop, Maintain and Enforce policies and procedures in order to manage those issues which it can control or influence;

b) Demonstrate to interested parties that policies, procedures and practices are in conformity with the requirements of this Standard. The requirements of this Standard apply universally with regard to geographic location, industry sector and company size.

5. ISO 17025 for Laboratory Certification

ISO 17025, which replaces the previous Guide 25 accreditation, is a document prescribing the "General requirements for the competence of a calibration and testing laboratories". Its aims are to:

a. Provide a basis for use by accreditation bodies in assessing competence of laboratories;

b. Establish general requirements for demonstrating laboratory compliance to carry out specific calibrations or tests; and

c. Assist in the development and implementation of a laboratory's quality system.

Quality control or quality assurance

Quality assurance systems in the food industry are much more extensive in scope than quality control programs. They include the inspection, testing and monitoring activities of quality control programs, along with additional activities that are devoted to prevention of food safety hazards and quality defects. The activities are integrated and interrelated to form a system. Quality assurance systems are intended to provide confidence to a food company capable of meeting the food quality and food safety requirements. These quality systems include documents that describe operations and activities that directly relate to food quality and safety.

Controlling quality may be achieved by:

- Inspections of raw materials to ensure that no poor quality ingredients are used.
- Carrying out checks on the process to ensure that the weights of the ingredients, temperature and time of baking (for example) are correct.
- Inspecting the final product to ensure that no poor quality products are sent to the consumer.

However, this quality control approach is focused on the process whereas the problems that customers may face can also occur elsewhere in the production and distribution chain.

Raw material inspection for quality control

Cereals and oilseeds

When grain is delivered to the flour or rice mill, take a sample from the batch and inspect it. Most often the grain is delivered in sacks to small-scale millers and a sample should be taken from the sacks using a 'Thief Sampler'. The sample should be carefully examined for the following quality characteristics:

i) Correct type of grain.
ii) Presence/amount of other seeds.
iii) Presence/amount and type of contaminants such as chaff, soil, dust, insects, rat hairs or excreta etc.
iv) Damaged grains (cracked grains or insect damage).
v) Moisture content.
vi) Colour of the grains/any discolouration.
vii) Maturity (over-ripe or under-ripe).
viii) Visible mold.
ix) Presence of flour mites.

Except for moisture determination, these checks may be carried out without specialised quality control equipment. Operators involved in raw material inspection should be fully trained and some form of incentive scheme to reward careful inspection may also be appropriate. The results of the examination and the amount in each batch should be recorded in an Incoming Materials Test Book, noting the number of the batch and the name of the supplier.

Fruits and Vegetables

Once the fruit has been transported to the processing unit, it is within the control of the manufacturer and more systematic quality assurance procedures can be adopted. As resources for quality assurance are usually limited they should be focused on the parts of the process that are most effective in ensuring that the products meet customer specifications. The HACCP approach should be used as a means of achieving maximum results from the resources available for quality control. Examples include regular monitoring of the cleanliness of the production area and checking to ensure that there is no animal or insect infestation, maintaining good operator hygiene by regular inspection and training, making sure that wastes are disposed of properly and regularly.

When raw materials arrive, each batch should be recorded in an Incoming Materials Test Book, noting the number of the batch, the name of the supplier and useful observations. This information should also be recorded for other ingredients and packaging materials used in the process.

The first series of checks are made on the raw materials as they arrive at the processing unit. These usually involve spreading the fruits on sorting tables and inspecting them for quality and suitability for processing. Maturity of raw materials is usually assessed by looking at the fruit or sometimes by handling them, as there are few objective tests that can be applied to incoming fruit in small processing plants. Similarly, other ingredients should be checked to make sure that they are of the right type and have not been adulterated. Packaging should be inspected on arrival to make sure it is the correct type and is not damaged in any way.

Checks on incoming raw material should include the following:

i) Colour
ii) Size
iii) Maturity (over-ripe or under-ripe)
iv) Visible mold or rots

v) Serious bruising or cuts

vi) Presence of foreign material

vii) Percentage of rejects

Any material which do not meet the required standards are removed together with foreign matter such as leaves, stones, etc. and taken outside to a disposal site well away from the processing room. Regular removal is important to prevent the waste from attracting flies to the processing area and to avoid the risk of contaminating good quality fruit.

Careful inspections at this stage save a lot of time and money later in the process. Good training for inspection staff is important and possibly a bonus scheme should be considered, as proper sorting is one of the most cost-effective ways of improving the value of a raw material. It should be remembered that it is not possible to improve the quality of a raw material by processing it. Poor quality raw materials produce poor quality finished products.

Check Your Progress 2

Note: a) Use the space given below for your answers.
b) Check your answers with those given at the end of unit.

1. What qualities do consumers expect of their food?

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13.7 IMPORTANCE OF PACKAGING AND LABELLING

A variety of packages, packaging materials and package liners and inserts can be used to protect the quality of produce during post-harvest handling, storage, transport and marketing. In addition to protection, packaging allows quick handling throughout distribution and marketing and can minimize impacts of rough handling. If produce is packed for ease of handling, heavily waxed cartons, wooden crates or rigid plastic containers are preferred over bags or open baskets since stacking cannot be done in the latter. Sometimes, locally constructed sturdy baskets or crates can be lined to provide added protection to produce. Wooden crates and plastic containers, while more expensive, are reusable and can be used for hydro-cooling and package icing.

Advances in food packaging

Modified atmosphere packages, made possible through the unique properties of plastics, are used in packaging fruits, vegetables, baked goods, fresh and processed meats, and cooked poultry. Through this process, fresh produce and other food products can be packaged in controlled atmosphere that maintain the carbon dioxide/oxygen ratio at its optimum level, thus greatly extending the shelf life of these foods.

The advent of new technology (*e.g.*, multilayer package applications) is allowing high-barrier food and beverage bottles, pouches and containers to prolong the shelf life of products such as beer, ketchup, juice and milk. Retortable pouches have made it possible to supply ready-to-eat traditional foods in a more convenient way.

Advances in packaging technology have spawned oxygen scavengers, antimicrobial films and gas permeable packages, while controlled packaging has led to modified atmosphere packaging, moisture absorbers and other hybrid forms of packages to keep foods fresh.

The use of plastics in aseptic packaging significantly increases the non-refrigerated shelf life and availability of many perishable products making them more readily available in the hot, humid climate of the developing world and dramatically improving the diets of the people who live there.

The reuse of plastics bottles is a common commercial practice such as polycarbonate baby bottles, polyethylene tetraphthalate (PET) beverage bottles for soft drinks, carbonated beverages and ready-to-serve beverages. Despite the possible inhibiting effects of the forthcoming legislation, the proportion of food packaging held by plastics is expected to increase rapidly. At present, almost 90 % of plastics packaging is employed in food and drink application. Based on survey of Stratton (1998) the product safety food packaging will be most important issues in food packaging over the next few years to come.

Plastics

Some popular plastics include cellophane, cellulose, acetate, nylon, mylar, saran, and polyvinyl chloride. Copolymer plastics extend the range of useful food-packaging applications. Ionomer (ionic bonds) plastic materials are improved food-handling materials that function under greater oil, grease, solvent resistance, and they have a higher melting strength. Newer plastic materials contain cornstarch, which makes them more biodegradable.

Flexible plastic films

Flexible packaging describes any type of material that is not rigid, but the term ‘flexible’ film is usually reserved for non-fibrous plastics polymers, which are less than 0.25 mm thick (Fellow, 2005). The ability to shape plastics is due to long polymers formed by addition reactions or by condensation reactions to form long polymer molecules. Thermoplastic materials are able to undergo repeated softening on heating and hardening again on cooling, whereas thermoplastics cross-link the long molecules when heated with chemicals and they do not soften

Single films

Most polymer films are made by extrusion, in which pellets of the polymer are melted and extruded under pressure as a sheet or tube. Other methods are calendaring, where the polymer is passed through heated rollers until the required thickness is achieved, and casting, in which the extruded polymer is cooled on chilled rollers.

Cellulose films

Mixing suitable sulphite paper pulp with caustic soda to dissolve it produces these and it is allowed to ‘ripen’ for 2-3 days to reduce the length of polymer chains and form sodium cellulose. This is then converted to cellulose xanthate by treatment with carbon disulphide, ripened for 4-5 days to form ‘viscose’ and then cellulose is regenerated by extrusion or casting into an acid-salt bath to form cellulose hydrate. Glycerol is added as a softener and the film is then dried on heated rollers. Higher quantities of softeners and longer residence time in the acid-salt bath produce more flexible and more permeable films.

Polyethylene tetraphthalate (PET)

PET is a very strong, transparent, glossy film, which has good moisture and grease barrier properties. It is flexible at temperatures from – 70 ^{0}C to 135 ^{0}C and undergoes little shrinkage with variations in temperature or humidity.

Laminated films

Lamination of two or more films improves the appearance, barrier properties and mechanical strength of a package. Not all polymer films can be successfully laminated; the two films should have similar characteristics and the film tension, adhesive application and drying conditions should be accurately controlled to prevent the laminate from blocking (not unwinding smoothly), curling (edges of the roll curl up) or delaminating (separation of the layers). Commonly used laminates are polyvinylidene chloride coated polypropylene, polyvinylidene chloride-coated polypropylene-polyethylene, polypropylene-ethylene vinyl acetate, biaxially-oriented polypropylene-nylon-polyethylene, nylon-PVDC-LDPE and nylon-EVOH-LDPE etc.

The most versatile method of lamination is adhesive laminating (or dry bonding) in which an adhesive is first applied to the surface of one film and dried. Synthetic adhesives are mostly aqueous dispersions or suspensions of polyvinyl acetate with other compounds e.g., poly vinyl alcohol, 2- hydroxycellulose ether to give a wide range of properties. Two-part urethane adhesives, containing a polyester or polyether resin with an isocyanate cross-linking agent, are also widely used. Co-polymerised vinyl acetate and ethylene or acrylic esters give improved adhesion to plastics, to produce laminated films, and are also used for case sealing, spiral tube winding, pressure sensitive coatings and labelling of plastic bottles. Solvent based systems have a number of problems including environmental considerations, clean air regulations, higher cost, safety from fire hazards, toxicity and production difficulties, which mean that these are now being used only when other systems are not suitable and are likely to be phased out altogether.

Coextruded films

Coextrusion is the simultaneous extrusion of two or more layers of different polymers to form a single film. Co-extruded films have very high barrier properties. They are thinner than laminates and the layers cannot separate. To achieve strong adhesion, the copolymers used are olefins like low/high density PE, styrene or PVC polymers.

Blown-film coextrusions

These are suitable for high speed form-fill-seal and pouch or sachet equipment used for confectionary, snack foods, cereals and dry mixes. Typically a three layer co-extrusion has an outside presentation layer, which has gloss and printability, a middle bulk layer which provides stiffness, strength and spilt resistance, and an inner layer which is suitable for heat sealing. A five layer co-extrusion can be used to replace metalized polyesters for bag-in-box applications.

Edible and biodegradable films

Concern over environmental pollution from packaging materials has lead to research into edible or biodegradable films for general food packaging and films that can be used to coat fresh fruit to control the rate of respiration. Development of novel polymers that biodegrade slowly has focused on thermoplastic polyesters, á-amino acids and polymides and co-polymerization of lactams and lactones, as each has a low glass transition and low melting point

The food industry uses four basic packaging materials: metal, plant matter (paper and wood), glass, and plastic. A number of basic packaging materials are often combined to give a suitable package. The fruit drink box is an example where plastic, paper, and metal are combined in a laminate to give an ideal package. Another example is a peanut butter jar. The main package containing the food (primary package) is made of glass (or plastic); the lid is made of metal lined with plastic; and the label is made of paper.

Sausage casings are an example of an edible film. By spraying gelatin, gum arabic, starch, monoglycerides, proteins, or other edible materials, a thin protective coating can be formed around food particles. For example, raisins in breakfast cereals are sprayed to prevent them from moistening the cereal in the box, and nuts are coated to protect them from oxidative rancidity. An edible wax film is used to coat the surface of vegetables to reduce moisture loss and provide increased resistance to the growth of molds.

Cans

Cans are formed at the food processing factory or shipped with their bottom attached with separate can lids. Lids are seamed onto the cans. The outside of the steel can is protected from rust by a thin layer of tin (.025 per cent by weight). A thin layer of tin or baked-on enamel protects the inside of the can. Tin-free steel and thermoplastic adhesive-bonded seams have become more common. These do away with the need for solder, which can contribute to traces of lead in food. Factory equipment allows hermetically sealed sanitary steel cans to be manufactured and later sealed at the rate of 1,000 units per minute. Rigid aluminum, tin plate, and tin free containers also can be readily formed without side seams or bottom end seams by pressure extrusion. Aluminum is used as a packaging metal because of its lightweight, low levels of corrosion (rust), recyclability, and ease of shipping. However, aluminum has less structural strength than metal cans. This limitation has been overcome by the injection of a small amount of liquid nitrogen into the can prior to closure. This gas provides for internal pressure that adds rigidity.

Glass

Glass provides a chemically inert and noncorrosive recyclable food packaging material. Glass breaks, and it is too heavy for some processing uses. Also, recycling is not easy, except in the case of home canning use.

Paper

Paper used as a primary container must be treated, coated, or laminated. Paper from wood pulp and reprocessed waste paper is bleached and coated or impregnated with waxes, resins, lacquers, plastics, and laminations of aluminum to improve its water strength and gas impermeability, flexibility, tear resistance, burst strength, wet strength, grease resistance, sealability, appearance, and printability of advertising or labels. Papers treated for primary contact with food are reduced in their ability to be recycled. Paper that comes in contact with foods must meet FDA standards for chemical purity. Paper used for milk cartons must come from sanitary virgin pulp. The major safety concern is with the puncturability or tearability that will allow for the outside environment to enter and contaminate the food.

Retortable pouches

Twenty years of development went into the technology to ensure that the materials used in the production of retortable pouches would protect the food and not contribute harmful extratries (chemical interaction with foods) to foods. The three

layers consist of an outer layer of polyester film for strength, temperature resistance, and printability; a middle layer of aluminum film for barrier properties; and an inner layer of polypropylene film that provides for a heat-seal.

Each basic packaging material has advantages and disadvantages. Metal is strong and a good overall barrier, but it is heavy and prone to corrosion. Paper is economical and has good printing properties; however, it is not strong, and it absorbs water. Because paper absorbs water, it gains moisture from the milk, gets weaker, and fails. Glass is transparent allowing the consumer to see the product, but it is breakable. Plastics are versatile but often expensive. Paper makes a good economical material and provides a good printing surface. Overall, the requirements, functions, and considerations of food containers include:

1. Non-toxic and compatibility with food
2. Sanitary protection
3. Moisture protection
4. Resistance to impact
5. Light protection
6. Gas and odour protection
7. Ease of opening and closing
8. Tamper-resistance and tamper evident
9. Pouring features
10. Size, shape, and weight limitations
11. Reseal features
12. Ease of disposal
13. Appearance and printability
14. Transparency
15. Affordability

Food Labelling

Food labelling for most of the food products sold must have the product name, the manufacturer's name and address, the amount of the product in the package, and the product ingredients. The ingredients are listed in descending order, based on their weight.

In 1975, the Food and Drug Administration (FDA) established "nutrition labelling" or guidelines for labelling the nutrient and caloric content of food products. Nutrition labelling is mandatory only for those foods that have nutrients added or make a nutritional claim. Manufacturers are encouraged, but not required, to provide nutrition labelling of other food products.

General labelling requirements

In most circumstances, foods for retail sale or for catering purposes are required to bear a label setting out all the information prescribed in the new Code. Foods for catering purposes means those foods for use in restaurants, canteens, schools, caterers or self catering institutions, where food is offered for immediate consumption. The label on a package of food for retail sale or for catering purposes generally must include the following core information.

1. Prescribed name or, where no name is prescribed, a name or a description of the food sufficient to indicate the true nature of the food.

2. Lot identification.
3. Name and business address of the supplier.
4. Mandatory warning and advisory statements and declarations specified in standard and any other warning and advisory statements specified elsewhere.
5. Ingredient listing.
6. Date marking.
7. Nutrition information panel.
8. Percentage labelling (characterising ingredient/s and component/s).
9. Directions for use or storage where, for reasons of public health and safety, consumers need appropriate directions for use or storage of the food.
10. Country of origin must be stated on products made and sold in country other than manufactured one.

Name or description of the food

The label on a package of food must include a name or a description of the food. If there is a prescribed name for the food, it must be included on the label. If there is no prescribed name for a food, the label must include a name or description of the food sufficient to indicate the true nature of the food. The name or description chosen should be specific enough to differentiate it from other foods. There is no specific requirement for where this information should appear on the label. There are a few prescribed names in the new Code. A prescribed name is a name by which a food is defined or described in a standard and is declared to be a prescribed name in that Standard. Examples include 'honey', 'formulated supplementary food' and 'formulated supplementary food for young children'. In accordance with food law and fair trading law, manufacturers must not represent foods in a false, misleading or deceptive manner.

Lot identification

Lot identification is required on packaged food to assist in the rare event of a food recall. A lot mark clearly identifies the 'lot' a food comes from as well as the premises where the food was packed or prepared. A date mark and the supplier's address details can help satisfy the requirements of a lot mark. There are some specific exemptions from lot identification. These exemptions cover individual portions of ice cream and food in small packages when the bulk packages and bulk container in which the food is stored or displayed for sale includes lot identification.

Name and business address of supplier

A supplier's name and address details are required on the label on a package of food to assist in the rare event of a food recall. This makes the identification and notification process easier. The term 'supplier' includes the packer, manufacturer, vendor or importer of the food. A business address means the location of the premises from which a business is being operated, and includes the street number, the street name, the town or suburb and the state or territory. A post office box address is not sufficient.

Basic labelling requirements

Basic information required by law to appear on labels of most pre-packed foods includes the following.

Name of the food

The name should be sufficiently precise to inform the purchaser of the true nature of the food. It may be necessary to add a qualifying statement to clarify the name, example "Vegetable *Samosa* - a spicy vegetable filled pastry parcel."

If there is a name prescribed by law, it must be used *e.g.* "prawns". Reserved names may only be used for foods meeting specific compositional criteria e.g. coffee, chocolate, and jam. Customary names that have become accepted in the UK without further explanation may also be used example "Cream Crackers" or "Muesli".

List of Ingredients

All the ingredients of the food, headed by the word "Ingredients" (or a phrase including that word), must be listed in descending order of weight.

Certain categories of ingredients such as additives must be identified by category name, *e.g.* "Preservative", and then identified by a specific (chemical) name or serial number, *e.g.* serial number, *e.g.* "sodium nitrate" or "E250".

Claims - Nutritional Information

Some claims are prohibited, example claims that food can prevent, treat or cure diseases or other "adverse conditions."

Nutritional claims about food such as "reduced energy", "rich in vitamins" etc., can only be made if the food meets set compositional standards. Such claims also require the provision of nutritional information. All nutritional information must be given in the form specified in the Regulations.

Date Marking

There are two types:

1. Use by-followed by Day and Month or Day, Month and Year for perishable foods that usually need to be kept cold to maintain safety - example: meat, fish, dairy products, ready to eat salads.
2. Best Before - date until which the food will maintain its optimum quality, *e.g;* foods that become stale or develop off-flavours, such as biscuits, crisps, or soft drinks. Expressed as:
    - Best Before + Day, Month for foods with up to 3 months life, *e.g;* "Best Before 31 March";
    - Best Before End + Month, Year for food with more than 3 months shelf-life, example "Best Before End March 99";
    - Best before End + Year for food with more than 18 months shelf-life, *e.g;* "Best Before End 2004".

Storage Conditions

Any special storage conditions must be described *e.g;* storage temperature for perishable foods.

Instructions for Use

Instructions for use are required if it would be difficult to use the food without them, example. "How to make a cake from cake mix".

Check Your Progress 3

Note: a) Use the space given below for your answers.
b) Check your answers with those given at the end of unit.

1. Name the three general type of food packaging.

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2. Explain requirements, functions, and considerations of food containers.

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3. Discuss general labelling requirements for food.

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13.8 LET US SUM UP

Consumers expect certain qualities from their food. These include color, flavor, texture, and even size. When these are missing or different than expected, the food is rejected. Food science determines and uses methods to measure food-quality factors. These methods ensure a consistent, reliable product. Some evaluation methods use chemical and mechanical techniques. Others are completely human, such as taste panels. Also, in cooperation with industry, we can develop and maintain commercial item descriptions for hundreds of items.

Recent changes in the food label provide consumers with more accurate and more useful nutritional information. This information is provided on the nutrition panel. Some of the components of the food label are mandatory and some are voluntary. Additionally, label regulations address how and when certain health claims can be made for foods. Finally, food-labelling requirements also address ingredient labeling.

For a successful food-processing sector in India, various aspects such as quality control, quality system and quality assurance, the constituents of total quality management, should function in a horizontal fashion for total success. These are vital today, if one has to reach the world market and at the same time realizing that India itself is one of the big markets. The process of quality control starts from raw materials, process design, product composition, packaging, storage, distribution, consumer preparation and feedback.

13.9 KEY WORDS

Colour : The property of a material in which specific visual wavelengths of the electromagnetic radiation are absorbed and/or reflected.

Flavour : A blend of taste, smell and general touch sensation evoked by the presence of a substance in the mouth.

Food labelling : Labels have the product name, manufacturers' name and address, the amount of the product in the package and the product ingredients.

Quality : It includes size, colour, shape, texture, cleanness, freedom from defects, and other more permanent physical properties of a product, which can affect its market value.

Texture : The arrangement of particles of a food material that gives it its characteristic structure.

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13.11 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1. In order to maintain quality, the colour of food products must be measured and standardized. If a food is transparent, like a juice or a coloured extract, colourimeters or spectrophotometers can be used for colour measurement. The colour of liquid or solid foods can be measured by comparing their reflected colour to defined (standardized) color tiles or chips. Three components of reflected light used to define colours are value, hue and chroma. The colour of a food can be precisely defined with numbers for these three components with tri-stimulus colourimetry. Instruments such as the Hunterlab Colour and Colour Difference Meter measure the value, hue, and chroma of foods for comparisons.
2. Texture is a mechanical behavior of foods measured by sensory (physiological/ psychological) or physical (rheology) means. Texture testing in foods is based upon the action of stress and strain. Many of the methods are based upon compression, shearing, shear-pressure, cutting, or tensile strength.

   The compressimeter is used to determine the compressibility of cakes and other "spongelike" products. The penetrometer has been used to measure gel strength. The Warner-Bratzler shear apparatus has been the standard method of evaluating meat tenderness. The Instron has adapted many of the historical texture measuring instruments for measuring elasticity. The Brookfield viscometer will measure the viscosity in terms of Brookfield units.
3. Food flavour includes taste sensations perceived by the tongue-sweet, salty, sour, and bitter-and smells perceived by the nose. Food flavour is a combination of taste and smell, and it is very subjective and difficult to measure. Depending on the food, flavour can also be influenced by bacteria, yeasts, moulds, enzymes, heat/cold, moisture/dryness, light, time, and additives used in the preparation of food.
4. Rheology a characteristics of food, which explains science of flow ability under pressure.
5. Changes in texture are often due to water status. Fresh fruits and vegetables become soggy as cells break down and lose water. On the other hand if dried fruits take on water, their texture changes. Bread and cake lose water as they become stale. If crackers, cookies, and pretzels take up water, they become soft and undesirable.

   Various methods are used to control the texture of processed foods. Lipids are softeners and lubricants used in cakes. Starch and gums are used as thickeners. Protein can also be a thickener, or if coagulated as in baked bread, it can form a rigid structure. Depending on its concentration in a product, sugar can add body as in soft drinks or in other products add chewiness, or in greater concentrations it can thicken and add chewiness or brittleness.

Check Your Progress 2

1. Food quality as distinct from food safety is the extent to which all the established requirements relating to the characteristics of a food are met. Consumers are looking for the following qualities of food:

- Identity of a food in relation to a standard (*e.g;* standardized food)
- Declared gross or net quantity (*e.g;* weight or volume) of a unit of the food or net fill of a food container

- Declared or claimed amount of one or more stated components of a food
- Appearance (*e.g;* size, shape, colour)
- Flavour, aroma, texture, viscosity
- Shelf-life stability, fitness for use as human food, wholesomeness
- Free from adulteration, good packaging and labelling of the product.

Check Your Progress 3

1. Three commonly used packaging material are:

   a) Plastics

   Some popular plastics include cellophane, cellulose, acetate, nylon, mylar, saran, and polyvinyl chloride. Copolymer plastics extend the range of useful food-packaging applications. Newer plastic materials contain cornstarch, which makes them more biodegradable.

   b) Cans

   Cans are formed at the food processing factory or shipped with their bottom attached with separate can lids. Lids are seamed onto the cans. The outside of the steel can is protected from rust by a thin layer of tin (.025 per cent by weight). A thin layer of tin or baked-on enamel protects the inside of the can. Rigid aluminum, tin plate, and tin free containers also can be readily formed without side seams or bottom end seams by pressure extrusion. Aluminum is used as a packaging metal because of its lightweight, low levels of corrosion (rust), recyclability, and ease of shipping. However, aluminum has less structural strength than metal cans. This limitation has been overcome by the injection of a small amount of liquid nitrogen into the can prior to closure.

   c) Paper

   Paper used as a primary container must be treated, coated, or laminated. Paper from wood pulp and reprocessed waste paper is bleached and coated or impregnated with waxes, resins, lacquers, plastics, and laminations of aluminum to improve its water strength and gas impermeability, flexibility, tear resistance, burst strength, wet strength, grease resistance, sealability, appearance, and printability of advertising or labels.

2. The requirements, functions, and considerations for food containers include:

   i) Non-toxic and compatibility with food

   ii) Sanitary protection

   iii) Moisture protection

   iv) Resistance to impact

   v) Light protection

   vi) Gas and odour protection

   vii) Ease of opening and closing

   viii) Tamper-resistance and tamper evident

   ix) Pouring features

   x) Size, shape, and weight limitations

   xi) Reseal features

   xii) Ease of disposal

xiii) Appearance and printability

xiv) Transparency

xv) Affordability

3. Food labelling for most of the food products sold must have the product name, the manufacturer's name and address, the amount of the product in the package, and the product ingredients. The ingredients are listed in descending order, based on their weight. It should also mention lot identification, name and business address of the supplier. Mandatory warning and advisory statements and declarations specified in standard and any other warning and advisory statements specified elsewhere should be mentioned. Ingredient listing, date marking, nutrition information panel, directions for use or storage where, for reasons of public health and safety should also be written on the packets.