SPOILAGE OF CANNED PRODUCTS - BIOCHEMICAL, ENZYMATIC AND MICROBIAL SPOILAGE

SPOILAGE OF CANNED PRODUCTS

Enzymatic spoilage

Many reactions in plant and animal tissues are activated by enzymes. The changes in foods during storage can be produced both by enzymes present in the food or by enzymes from microorganisms that contaminate the food. A good example of the former is the ripening of banana due to the enzymes present which hasten the ripening process. After some time the fruit become too soft and unfit to eat. If there is a bruised spot on the fruit, yeasts can grow and produce enzymes which spoil the fruit.

Enzymes convert starch into sugars, protein into amino acids, and pectin into pectic acids and thus change the constituents of food. Some fruits and vegetables turn brown when damaged or when their cut surfaces are exposed to air due to the presence of the enzymes phenolase, peroxidase and polyphenol oxidase. Their actions can be easily controlled by regulating the temperature and excluding moisture and air. Enzyme can act between zero and 60^{o}C. the optimum temperature of reaction is usually 37^{o}C, the rate varying directly with temperature. All enzymes are inactivated at 80^{o}C.

Microbial spoilage

Bacteria, yeasts and moulds may infect food after harvesting, during its handling, processing and storage. But not all microorganisms cause spoilage, e.g., lactic acid bacteria are used in the making of cheese and other fermented dairy products, yeasts for the production of wine and beer and *Acetobacter* bacteria for vinegar production. Spoilage organisms are present everywhere- in soil, air, water and even in the raw and processed food.

(i) Bacteria

These are unicellular microorganisms that are classed as plants though they do not contain chlorophyll. A bacterial cell is about I □m in length

Bacteria are classified according to their shape. Cocci are spherical, bacilli are cylindrical and spirilla and vibrios are spiral. Bacterial spores are more resistant than yeast or mould spores to most processing conditions. Bacteria, with a few exceptions, cannot grow in acid media in which yeasts and moulds thrive. They multiply by ‘fission’ or division of cells. When a bacterium becomes mature it divides into two, these two become four and so on. The growth of bacteria is very rapid and depends upon the nature of the food material, moisture, temperature and air. Some bacteria do not grow in air but temperature plays a major role in their growth, the optimum being generally 37^{o}C.

Some bacteria produce spores which can be destroyed by heating at 121°C for 30-40 minutes. Bacteria are very sensitive to acids and are destroyed in their presence even at the temperature of boiling water. Hence, most fruits being acidic can be easily sterilized at 100°C whereas vegetables being non-acidic require a higher temperature of 116°C. The important groups of bacteria are:

(a) Bacillus: rod-shaped;

(b) Coccus: spherical;

(c) Coccobacillus: oval-shaped;

(d) Aerobes :require atmospheric oxygen for growth, e.g., *Acetobacter aceti;*

(e) Facultative anaerobes: can grow with or without atmospheric oxygen;

(f) Obligate anaerobes: do not grow in atmospheric oxygen;

(g) Mesophiles: require a temperature below 38°C for growth;

(h) Obligate thermophiles: grow between 38 and 82°C;

(i) Facultative thermophiles: grow over the whole range of temperature covered by mesophiles and obligate thermophiles and below; and

(j) Psychrotrophs: grow fairly well at refrigeration temperatures and some can even grow slowly at temperature below freezing.

Important Food Spoilage Bacteria

Group	**Genus**
Acetics	**Acetobacter and Gluconobacter**
Lactics	*Lactobacillus, Leuconostoc, Pediococcus, Streptococcus*
Butyrics	*Clostridium*
Propionics	*Propionobacterium*
Proteol Gytics	*Bacillus, Pseudomonas, Clostridium, Proteus* etc.

Some useful bacteria

The following bacteria are of great importance in the food processing industry.

Acetobacter sp.

These bacteria, also known as “Vinegar bacteria”, cause significant spoilage in the wine industry but are necessary for vinegar production. The important species are *Acetobacter aceti,* A. *orleansis* and A. *Schutzenbachi.* They are very small, usually non-motile and generally do not form spores. These bacteria are aerobes and in the presence of oxygen convert ethyl alcohol to acetic acid. They are of two types-one type forms a tough shiny film on the surface of wine and the growth is known as “vinegar mother”, while the other grows throughout the wine without forming “vinegar mother”. These bacteria can be easily destroyed by heating to 65°C.

Lactobacillus sp.

Different organisms of this group, also known as "lactic acid bacteria", have different properties but all of them produce lactic acid from carbohydrates. Those which are used in distilling and brewing industries are facultative thermophiles (heat-tolerants) which grow abundantly at 50 to 55^{o}C and produce much lactic acid. Mesophiles are used in the preparation of pickles. *Lactobacillus plantarum* is generally found in pickles and olives. The other important species are *Pediococcus cerevisiae, Leuconostoc mesenteroides, Streptococcus faecalis* and *Lactobacillus brevis.* These bacteria cause "lactic souring" and spoil wines, which can be easily prevented by maintaining a sulphur dioxide concentration of 0.007 per cent in wine.

(ii) Yeasts

Yeasts are unicellular fungi which are widely distributed in nature. They are somewhat larger than bacteria. The cell length is about 10 □m and the c

Most yeasts are spherical or ellipsoidal. Yeasts that multiply by means of 'budding' are known as 'true yeasts'. The bud when it becomes mature separates from the mother cell and functions like an independent organism. Yeasts grow luxuriantly at a moderate temperature in a solution of sugar in plenty of water. Under suitable conditions the sugar is converted into alcohol and carbon dioxide gas is evolved.

Yeast + Sugar ⟶ Alcohol + Carbon dioxide

This is the reason that carbon dioxide is evolved from food materials spoiled by yeasts and pushes out corks from bottles with great force. Active fermentation can be easily recognized by the formation of carbon dioxide foams or bubbles. Yeasts prefer a low concentration of sugar for their growth. Most of them do not develop in media containing more than 66% sugar or 0.5% acetic acid. Boiling destroys the yeast cells and spores completely. Some of the yeasts which grow on fruits are *Saccharomyces, Candida* and *Brettanomyces.*

Pseudo-yeasts

These are like true yeasts but do not form spores. All the members of this group are particularly unsuitable for fermentation purposes as they produce off-flavours and cloudiness.

Yeasts causing food spoilage

Yeast	**Product spoiled**
Saccharomyces	Low-sugar products
Candida	High-acid foods, salty foods, butter
Brettanomyces	Beers, wines
Zygosaccharomyces (osmophilic)	Honey, syrups, molasses, wines, soy sauce

Pichia	Wines
Hansenula	Beers
Debaryomyces	Meat brine, cheese, sausages, etc.
Hanseniospora	Fruit juices
Torulopsis	Milk products, fruit juices, acid foods
Rhodotorula	Meat, sauerkraut
Trichosporon	Chilled beer

(iii) Moulds

Moulds are multicellular, filamentous fungi belonging to the division Thallophyta but are devoid of chlorophyll. They are larger than yeasts. They are strict aerobes and require oxygen for growth and multiplication and tend to grow more slowly than bacteria.

The principal parts of a mould are a web-like structure known as mycelium and the spore. The mycelium is often white and cottony and penetrates into the attacked foodstuff. After fixing itself the mould produces viable spores which resist the unfavourable conditions after dispersal and germinate when they get favourable conditions. They thrive best in closed, damp and dark situations with an adequate supply of warm, moist air but require less free moisture than yeasts and bacteria. They prefer sugar-containing substances and may spoil jams, jellies, preserves and other sugar-based products. Acid medium favours their growth and, therefore, they grow well in pickles, juices, etc. This is the main reason that fruits and fruit products are attacked by moulds which not only consume nutrients present in the food thereby lowering its food value but also spoil the flavour, texture and appearance of the product. They may grow even on moist leather but do not thrive in an alkaline medium. Moulds are sensitive to heat; boiling quickly destroys both moulds and their spores. The most important moulds are;

a) *Penicillium* sp. (Blue moulds),
b) *Aspergillus* sp. (Black moulds),
c) *Mucor* sp. (Gray moulds), and
d) *Byssochlamys fulva*

a. Penicillium sp.

These are also known as blue moulds. In the initial stage of growth they have a cottony appearance but later when the spores or conidia are formed, their appearance becomes powdery and the colour becomes blue, brown or pink according to age. The spoiled materials have a ‘mouldy’ odour and flavour.

b. Aspergillus sp.

In the initial stages of growth it is white and cottony like *Penicillium* but later with the formation of spores, it becomes black and is hence known as “black mould”. Unlike *Penicillium* it does not produce off-odour and flavour. They generally attacks grapes and bael.

(c) Mucor sp.

It is gray in colour and hence is known as ‘gray mould’. It is also known as ‘pin mould’ or bread mould’ because if frequently grows on moist bread. Although *Mucor* attacks fruits, in the preservation of fruits and vegetables it does not pose a serious problem like blue and black moulds.

(d) Byssochlamys fulva

This mould causes spoilage of canned fruits. The infected fruits disintegrate and sometimes carbon dioxide gas is also produced. It can grow under reduced oxygen tension and the ascospores posses high resistance to heat. For destroying spores heating of the cans at 88 to 90^{o}C is essential.

Although the organism is not as resistant as some of the thermophiles, its control in canned foods is difficult. Canned products which cannot withstand prolonged heating without deterioration are ultimately spoiled. Association of this mould with fruit in the field has been observed. Hence the emphasis should be on eliminating the organism from the raw material itself instead of processing to destroy it in the can.

A small number of moulds produce toxic substances, known as mycotoxins, in food. *Aspergillus flavus* produces aflatoxins in harvested crops, such as groundnut, which are stored in the field without drying properly.