

Chemical Preservatives and Additives

Food Preservation

- **Preservation of Food is the process of treating and handling food to stop or slow down spoilage caused by micro-organisms**
- **Preservation also includes prevention of loss of quality and to maintain edibility and nutritive value**
- **It also includes processes used to inhibit natural ageing and discolouration that can occur during food preparation**

Preservatives

- **These are substances which either delay the growth of microorganisms without necessarily destroying them or prevent deterioration of quality during manufacture and distribution**
- **These are naturally occurring or synthetic substance that is added to products to prevent decomposition by microbial growth or by undesirable chemical changes.**
- **These substances are added in very low quantities (up to 0.2%) which do not alter the organoleptic and physicochemical properties of the foods**

The method of food preservation is based on

- The activity of several additives – combined or synergistic**
- The intrinsic product parameters – food composition, acidity, water activity**
- The extrinsic factors – processing temperature, storage atmosphere and temperature**

The mechanism of action mainly based on action as -

- Antioxidants – compounds that delay or prevent the deterioration of foods by oxidative mechanisms**
- Antimicrobials – agents inhibit the growth of spoilage and pathogenic microorganisms**

Chemical Preservatives

- **Chemicals that function to preserve the food are generally added after the food has been processed and before it is packaged**
- **The purpose of using a chemical agent as a preservative is to retard food spoilage caused by microorganisms**

Characters of Chemical Preservatives

- **Interfere with the cell membranes of microorganisms**
- **Obstruct the enzyme activity of microbes**
- **Alter the genetic mechanisms of microbes**
- **Act as antioxidants**
- **Act as stabilizers,**
- **As firming agents**
- **Act as moisture retainers**

Chemical Preservatives

- 1. Traditional chemical food preservatives - Sugar and Salt**
- 2. Acidulants - Benzoic acid, Sorbic acid and Lactic acid**
- 3. Gaseous chemical food preservatives/ leavening agents - Sulphur dioxide and sulphites, Carbondioxide**
- 4. Antioxidants - Butylated Hydroxy Anisole (BHA), Butylated Hydroxy Toluence (BHT), Propyl Gallate, Natural/Synthetic Tocophelos (Vitamin E, Ascorbic Acid (vitamin C) and Lecithin**
- 5. Colour additives**
- 6. Flavour additives**
- 7. Sweeteners**
- 8. Emulsifiers**

1. Table Sugar and salt:

- Increase osmotic pressure and prevent microorganism development**
- Salt also cause dehydration by drawing out and tying up water from the tissue of the food**
- Salt added to food also ionizes, yielding the chlorine ion, which is harmful to micro organisms and interferes with the action of proteolytic enzymes**
- The concentrations of 60% in the finished product assures food preservation**

2. Benzoic acid:

- Yeasts are inhibited by benzoate to a greater extent than are moulds and bacteria. Sorbic acid**
- Sorbic acid and its salts are practically tasteless and odourless in foods, when used at reasonable levels (< 0.3 %) and their antimicrobial activity is generally adequate.**
- It is considered non toxic and is metabolized**
- Sorbates are used for mould and yeast inhibition in a variety of foods including fruits and vegetables, fruit juices, pickles, sauerkraut, syrups, jellies, jams, preserves, high moisture dehydrated fruits, etc.**

3. Gaseous chemical food preservatives:

A. Sulphites -

- SO₂ and sulphites may be added to such foods as dived fruits, fruit pulp and juices, and molasses**
 - They conserve colour, act as antioxidants and control microbial growth**
 - Sulphur dioxide and its various sulphites dissolve in water, and at low pH levels yield sulphurous acid, bisulphite and sulphite ions**
 - Sulphur inhibits enzymatic browning and keeps plant tissue fresh longer**
- (But this practice has been banned by the FDA because there were over 100 reported cases of adverse reactions including death)**

B. Carbon dioxide:

- Carbon dioxide is used as a solid (dry ice) in many countries as a means of lowtemperature storage and transportation of food products.**
- The gaseous CO₂ inhibits growth of psychrotrophic micro-organisms and prevents spoilage of the food (fruits and vegetables, etc.)**
- Carbon dioxide is used as a direct additive in the storage of fruits and vegetables, it delays respiration and ripening as well as retarding mould and yeast growth**

C. Nitrates and Nitrites:

- Nitrites prevent the growth Clostridium botulinum, micro organisms that secrete a deadly toxin these micro organisms grow in anaerobic condition readily found in the interior of ham or in meat that has been vacuum package**

4. Antioxidants:

- Antioxidants are beneficial in preventing rancidity in fats and foods containing fats**
- Fats exposed to light, moisture, heat or heavy metal ions become activated and oxidize (react with available oxygen) to peroxides**
- The most used antioxidants are Butylated Hydroxy Anisole (BHA), Butylated Hydroxy Toluene (BHT), Propyl Gallate, Natural/Synthetic Tocopherols (Vitamin E) Ascorbic Acid (vitamin C) and Lecithin**
- BHA + BHT are frequently used in variety of products because they are relatively stable to heat and maintain their effect in cooked products**

5. Colour Additives

- The acceptance of food products is determined largely by its appearance, consumers become accustomed to standardized colours in familiar foods and base their purchasing habits/decisions on past experiences.**
- The colour of foods colorants are added to carbonated beverages, frozen desserts some dairy and baked products**

6. Flavour additives

- Natural food flavours are expensive, not uniform in flavour quality or chemical composition and available seasonally**
- Suppose that a manufacturer wanted to produce banana ice-cream, it will take 5 tons of bananas to extract ½ litre of banana oil. • Hence if the demand for flavouring agents in our food supply is to be met, artificial flavourings become a necessity. • The flavouring agents commonly used are Esters C pentylacetate responsible for banana flavour, aldehyde like benzaldehyde with cherry flavour.**

7. Sweeteners

- Nutritive sweeteners contain calories because they are metabolized by the body to produce energy**

Examples of nutritive sweetener include sucrose, glucose (dextrose, fructose and invert sugar. High fructose corn syrup)

- Non nutritive sweeteners, such as saccharin do not provide calories because they are not metabolized. Aspartame is classified as a non nutritive sweeter even though it is metabolized to two amino acids (phenylalamine and aspartic acid) because the level of aspartame used is extremely small only of aspartame is weeded to produce a sweetness that is equivalent to sucrose.**

8.Emulsifiers

- Emulsifiers allows molecule that are mutually antagonistic (water and oil) to mix together**
- They also improve the texture, volume and body of baked goods by maintaining an even distribution of ingredients.**
- One of the most used emulsifiers is lecithin found naturally in milk, eggs and soybeans**

FOOD ADDITIVES

- Substance or mixture of substance, other than a basic foodstuff which is present in food as result of any aspect of production, processing, storage or packaging
- This does not include any chemicals that are contaminants pesticides, colour additives or new animal drugs

Qualities of a good additive –

1. Additives should be used only:

- To maintain the nutritional quality of food
- To improve appearance of food

2. An additive is not justified:

- ✓ if it reduces the nutritive value of a food
- ✓ if it disguise faulty quality or processing and handling that is not allowed
- ✓ if it deceive the customer or if the desired effect can be obtained by other manufacturing practices that are economically and technologically satisfactory

- 3. It should be used in smallest amount and produce the desired effect under good manufacturing practices**
- 4. The additive used must conform to a standard purity**
- 5. Additives should be subjected to adequate toxicological evaluation**
- 6. The approval of an additive should be limited to specific foods for specific purposes under specific conditions**

• **Conclusion**

Preservatives and Additives are used in foods for five main reasons:

- i) To maintain product consistency (Emulsifiers give products a consistent texture and prevent them from separating, Stabilizers and thickeners give smooth uniform texture, Anti-caking agents help substances such as salt to flow freely)**
- ii) To improve or maintain nutritional value (Vitamins and minerals are added to many common foods such as milk, flour, cereal and margarine to make up person's diet)**
- iii) To maintain palatability and wholesomeness (Preservatives retard product spoilage caused by mold, air, bacteria, fungi or yeast, Antioxidants are preservatives that prevent fats and oils in baked goods and other foods from becoming rancid or developing an off-flavor)**

iv) To control acidity/alkalinity (Leavening agents that release acids when heated can react with baking soda to help cakes, biscuits and other baked goods to rise during baking, Other additives help to modify the acidity and alkalinity of foods for proper flavor, taste and color)

v) To enhance flavor or impact desired color (Many spices, natural and synthetic flavors enhance the taste of foods, Colors, likewise, enhance the appearance of certain foods to meet consumer expectations)

Chemical Preservatives

Mechanism of action of Antioxidants

Ascorbic acid	oxygen scavenger
Butylated hydroxyanisole (BHA)	free radical scavenger
Butylated hydroxytoluene (BHT)	free radical scavenger
Citric acid	enzyme inhibitor/metal chelator
Sulfites	enzyme inhibitor/oxygen scavenger
Tertiary butylhydroquinone (TBHQ)	free radical scavenger
Tocopherols	free radical scavenger

E number	Chemical compound	Comment
E300-304	ascorbic acid, sodium ascorbate	cheese, chips
E321	butylated hydroxytoluene, butylated hydroxyanisole	also used in food packaging
E310-312	gallic acid and sodium gallate	oxygen scavenger
E220 – E227	sulfur dioxide and sulfites	beverages, wine
E306 – E309	tocopherols	vitamin E activity

Mechanism of Action of Antimicrobials

Acetic acid	disrupts cell membrane function (bacteria, yeasts, some molds)
Benzoic acid	disrupts cell membrane function/inhibits enzymes (molds, yeasts, some bacteria)
Natamycin	binds sterol groups in fungal cell membrane (molds, yeasts)
Nisin	disrupts cell membrane function (gram-positive bacteria, lactic acid-producing bacteria)
Nitrates, nitrites	inhibits enzymes/disrupts cell membrane function (bacteria, primarily <i>Clostridium botulinum</i>)
Propionic acid	disrupts cell membrane function (molds, some bacteria)
Sorbic acid	disrupts cell membrane function/inhibits enzymes/inhibits bacterial spore germination (yeasts, molds, some bacteria)
Sulfites and sulfur dioxide	inhibits enzymes/forms addition compounds (bacteria, yeasts, molds)

Antimicrobial Preservatives

E number	Chemical compound	Comment
E200 – E203	sorbic acid, sodium sorbate and sorbates	common for cheese, wine, baked goods, personal care products
E210 – E213	benzoic acid and benzoates	used in acidic foods such as jams, salad dressing, juices, pickles, carbonated drinks, soy sauce
E214 – E219	parabens	stable at a broad pH range, personal care products
E220 – E228	sulfur dioxide and sulfites	common for fruits, wine
E249 – E250	nitrites	used in meats to prevent botulism toxin
E251 – E252	nitrites	used in meats
E280 – E283	propionic acid and propionates	baked goods

Natural food colorants				
Chemical class	Colour	Plant source	Pigment	Products
Anthocyanins	red	strawberry (<i>Fragaria</i> species)	pelargonidin 3-glucoside	beverages, confections, preserves, fruit products
	blue	grape (<i>Vitis</i> species)	malvidin 3-glucoside	beverages
Betacyanins	red	beetroot (<i>Beta vulgaris</i>)	betanin	dairy products, desserts, icings
Carotenoids	yellow/orange	annatto (<i>Bixa orellana</i>)	bixin	dairy products, margarine
	yellow	saffron (<i>Crocus sativus</i>)	crocin	rice dishes, bakery products
	red/orange	paprika (<i>Capsicum annuum</i>)	capsanthin	soups, sauces
	orange	carrot (<i>Daucus carota</i>)	beta-carotene	bakery products, confections
	red	mushroom (<i>Cantharellus cinnabarinus</i>)	canthaxanthin	sauces, soups, dressings
Phenolics	orange/yellow	turmeric (<i>Curcuma longa</i>)	curcumin	dairy products, confections

Synthetic food colorants

Common name	United States	European Union	Products
Allura red AC	FD&C red no. 40	...	gelatin, puddings, dairy products, confections, beverages
Brilliant blue FCF	FD&C blue no. 1	E133	beverages, confections, icings, syrups, dairy products
Erythrosine	FD&C red no. 3	E127	maraschino cherries
Fast green FCF	FD&C green no. 3	...	beverages, puddings, ice cream, sherbet, confections
Indigo carmine	FD&C blue no. 2	E132	confections, ice cream, bakery products
Sunset yellow FCF	FD&C yellow no. 6	E110	bakery products, ice cream, sauces, cereals, beverages
Tartrazine	FD&C yellow no. 5	E102	beverages, cereals, bakery products, ice cream, sauces