Food Additives

M.A.J.Wansapala and I.Wickramasinghe

Food Additives are substances added intentionally to food stuffs to reform to certain technological functions. Different individuals may define these substances differently from different points of view. Hence, it is worth finding a more comprehensive definition of food additives which help us to understand the real role of food additives in the food industry.

Definition of a food additive

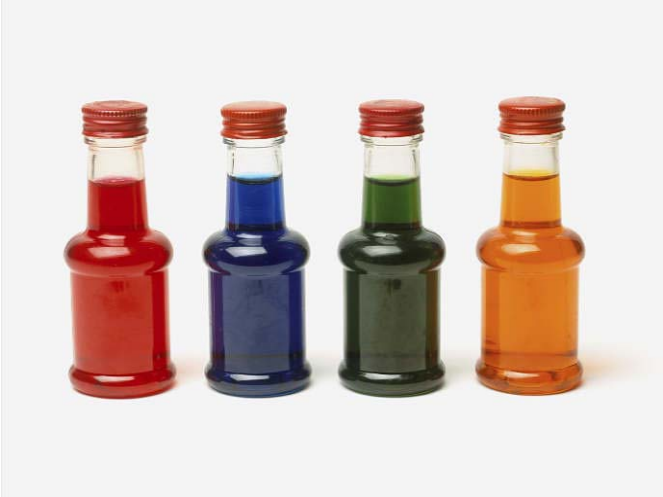
According to food labelling regulation imposed in 1984, food additives are substances, not commonly regarded or used as food, which are added to, or used in or on food at any stage to affect its keeping qualities, texture, consistency, appearance, odour, alkalinity or acidity, or to serve any other technological function in relation to food. This includes processing aids in so far as they are added to or used in or on food as aforesaid, but does not include vitamins and minerals, herbs or spices (when used as seasoning agents), hops, salts, yeast or yeast extract, total products of any hydrolysis or autolysis of food proteins, starter cultures, malt or malt extracts and air or water. Food additives can be categorized into several classes; colouring agents, preservatives, antioxidants, emulsifiers, thickeners, gelling agents, stabilizers, flavours and flavour enhancers, acids and acidity regulators, anti caking agents, modified starch , sweeteners, anti foaming agents firming agents, and enzymes.

Table 1 : Permitted food colours

Colour required	Permitted food colours
Red	Carmosine Fast Red E Ponceau 4R
Blue	Indigo Carmine Brilliant Blue FCF
Yellow	Tatrazine Amaranth Sunset Yellow
Green	Green S Green FCF

Colouring agents

Although 2000 artificial colours are available in the market, only about ten colours are used as food colouring agents. Colour is one of the attributes which tends to improve consumer attraction. Most of the producers tend to earn profits through this additive.



It is reported that all artificial colours, flavours and odours are made from coal tar. These are highly carcinogenic. Foods which have bright colours, strong flavours or odours may have these harmful chemicals. Hence, addition of artificial colours is prohibited for raw and unprocessed meat, poultry, fish, fruits, vegetables, tea, coffee beans, ground coffee, coffee extracts, bread, creams, condensed milk, dried milk, cheese, butter and baby foods.

However the permitted food colours can be identified by their E- coding number. Presently the declaration of the E- coding number or name of the colour is essential for most of the food items and the regulation is governed by the relevant food authorities.

Preservatives

Preservatives are substances added to foods to inhibit the growth of bacteria, yeast and or moulds. Most of them are chemical compounds. Optimum activities of

Table 2 : Important food colours and their E- numbers

E-coding number	Colour	Applications
E-100	Curcumin	Margarine
E-101	Riboflavin	Sauces
E-102	Tatrazine	Soft drinks
E-110	Sunset Yellow FCF	Biscuits
E-120	Cochineal	Alcoholic drinks
E-122	Carmoisine	Jams & Preserves
E-155	Chocolate Brown	Chocolate cakes

E-number range for colours lie between E 100- E 108

certain chemical preservatives are controlled by external factors such as pH, temperature and the salinity of the medium.

Common chemical preservatives can be divided into seven (07) major groups.

(a) Sorbates
(b) Benzoates and para benzoates
(c) Sulphites
(d) Biphenyls
(e) Amines
(f) Nitrite and nitrates
(g) Propionates

Table 3 : Common chemical groups and their applications in

Common chemical group	Application
Sorbates	Dairy products, confectionary
Benzoates and Para Benzoates	Fruit pulp, soft drinks, jam
Sulphites	Fruit juices, dehydrated vegetables
Biphenyls	Surface treatment of citrus fruit
Amines	Surface treatment of banana
Nitrite and Nitrates	Meats and cheese Industry
Propionates	Bakery products

Activity of the sorbates, sulphite, benzoates and propionates is highly dependant on the pH of the medium.

Two types active species of sulphites can be identified at pH 3-5(i.e. HSO^-_4 and SO_3^{-2}). Undissociated skeletons of sorbates, benzoates and propionates are a prerequisite for their optimum activity. Maximum content of their undissociated form is shown at the respective pH values given in the table. Activity of biphenyls, Amines and Nitrate/ Nitrites depends on other parameters except pH.

Table 4 : Optimum pH for certain chemical preservatives

Group of preservative	Optimum pH
Sulphite	3-5
Sorvates	Below 6
Benzoates	4
Propionates	4-4.8

Effect of chemical preservatives on human health

Since preservatives being chemicals, excess amounts may lead to different physiological problems. Therefore the application of chemical preservatives has to be controlled by applying certain standards and limits. However, common limits or standard for all chemical preservatives cannot be applied at a global level. These levels are adjusted by the relevant authority in each country from time to time.

Sulphites and Nitrate/ Nitrites show maximum toxicity relative to others. Excessive amounts of sulphites create problems in the lungs, affect the respiratory system, while excessive amounts of Nitrite/ Nitrate may cause cancer due to its by product of nitrosamines.

However, preservation is an essential operation in order to obtain a good quality food product and maximum profits. But most people are reluctant to buy chemically

preserved food products due to the possible bad effects of preservatives. Therefore products labelled as "Natural" are preferred by consumers.

Certain parameters should be kept constant in order to maintain the natural condition of the food product. Hence a number of chemicals are added at different levels to food products to achieve this objective. Therefore food products with chemical preservatives at standard levels are often safer than the so called "Natural" foods.

Antioxidants

Many food constituents are adversely affected by oxygen in the air. Oil, fat and oil flavour compounds of food components are oxidized by the oxygen. Certain metals such as copper and iron are subjected to this process as catalysts. This is one of the reasons why iron and copper have largely being replaced in food processing equipment by stainless steel.

An antioxidant as the term implies, tend to prevent oxidation. Natural antioxidants present in foods include Vitamin C, Vitamin E, and certain sulphur containing amino acids. However, the most effective antioxidants are synthetic chemicals approved by the Food and Drug Administration for addition to foods.

Table 5 : Anti oxidants and their applications

E-Code	Antioxidant	Application
E -300	L Ascorbic Acid	Fruit drinks
E -307	α tochopherol (Synthetic)	Cereal based baby foods
E -310	Propyl gallate	Vegetable oil
E -320	Butylated Hydroxy Anisole	Cheese spreads
E -321	Butylated Hydroxy Toluene	Chewing gum
E -322	Lecithin	Low fat spreads

Auto – oxidation process of lipids is controlled by antioxidants. This process consists of three major steps; initiation, propagation and termination

Electrons of the free radical at the third level can be absorbed by the antioxidant and delocalised within the electron cloud of the antioxidant, and thereby control the chain reaction.

Effects of oxidation of fat

Market demand, consumer attraction and nutritive quality are highly affected by oxidation. It not only imparts the rancid flavour to the food but lowers the nutritive value of the foodstuff. Low molecular weight fatty acids, alcohols, ketones, and aldehydes, are the major by-products responsible for the objectionable flavour. Muscle proteins can be affected by free radicals which are the active components of the oxidation process, and their water holding capacity may be reduced due to this action. Consequently food becomes hard. The secondary products such as aldehydes react with amino acids forming brown coloured melonidine complexes. These complexes impart additional colour and flavour to the product. Oxidation of fat also badly affects the level of fat soluble vitamins.

There are certain types of chemicals which can help to prevent oxidation of fats and oils . Although they are not categorized as antioxidants they can diminish the rhythm of the reaction, e.g. citric acid, phosphoric acid and their derivatives.

Flavours and flavour enhancers

Flavour is the aggregate of the characteristics of the material that produces the sensation of flavour. It can make food more palatable and attractive. Seven primary flavours can be identified according to the Amoove theory.

All flavours are composed of highly aromatic materials specially selected to contribute the particular flavour and odour profile. They are categorized as follows;

(a) Naturally occurring plant materials

(b) Products derived from natural sources by physical means such as extraction, distillation and expression.

(c) Isolates or pure chemicals prepared from natural sources.

(d) Synthetic chemicals identical with those found in natural products.

Most of the compounds of last category are developed by the reaction between amino acid and simple sugar.

Table 6 : Primary flavours and their chemical equivalence

Primary Odour	Chemical equivalent	Substrate
Campharaceous	Camphor	Moth ball
Musky	Penadecanolactome	Angelica root
Floral	Phenyl ethyl alcohol	Roses
Pepperminty	Menthol	Mint candy
Ethereal	Ethylene dichloride	Dry cleaning fluid
Pungent	Acetic acid	Vinegar
Putrid	Butyl mercaptan	Rotten eggs

Flavour Enhancers

These compounds by themselves do not have the flavouring activity but can intensify or enhance the flavour of food. This property is dependant on the structure of the molecule, and the activity depends on the pH of the medium.

E.g.: Monosodium glutamate (MSG), Tricholonic acid, Ibotenic acid, Inosine 5 monophosphate (IMP)

Activity of a compound like IMP is dependant on the water content as well as the enzymic activities of the medium. Since IMP is a 5 nucleotide it is unstable for irradiation.
Certain compounds like MSG can cause cancer.

Sweeteners

Sweeteners have the notable characteristic of sugar. These compounds which can show the same property at different levels are known as sweeteners. The ideal sweetener would fulfil all the characteristics of sugar, with the exception of two attributes.

(a) Sugar substitute should not be fermentable by the micro-organism in the mouth
(b) It should have a low energy value

Depending on the sweetening capacity, sweeteners can be divided into two major groups.

(a) Intense sweeteners
(b) Bulk sweeteners

Intense sweeteners (e.g. aspartame, saccharin, acsulfame, thaumatin) have a sweetness many times that of sugars and are therefore used in small amounts. Bulk sweeteners have about the same sweetness as sugar and are used at the same sort of levels as sugar (examples of such sweeteners are sorbitol, mannitol, isomalt, hydrogenated glucose syrup and xylitol). However, it has been revealed that long-term use of cyclamates, which is an artificial sweetener, cause cancer in the stomach and other organs in the digestive system.

Modified starch

Starch which has been treated physically or chemically to modify one or more of its key physico- chemical properties is known as modified starch. Seven types of modified starches are available in the market.

Origin of modified starch can be corn, wheat, rice, potato, tapioca, etc.

Anti-caking agents

Anti-caking agents help to keep powders such as milk powder, tea, coffee, sugar, salt etc, flowing freely rather than sticking as lumps.

Starch, magnesium carbonate, silica, calcium silicate, stearic acid and sodiumaluminosilicate are considered as synthetic anti-caking agents while talc and bentonite are considered as natural anti-caking agents. .

Anti-caking agents can affect the physical properties of the food material. It does not act chemically. For example magnesium carbonate is used in icing sugar. They are generally harmless with a flat bland taste. Octadecyl ammonium acetate is used as an anti-caking agent in bakery products.

Thickening agents

These are substances that help to maintain the thickness of the medium. When thickeners are added to beverages they absorb the fluid and thickens the beverages. Breaking down the starches reverses the thickening action and almost all water in the beverage is available as free fluid for absorption by the body. Modified food starch or certain vegetable gums are examples of thickeners. When the thickening agent is a vegetable gum, it will continue to remain as cold water even during digestion. So this may reduce the fluid availability to the body. Commonly

Table 7 : Modified starches and their properties

We can find tartaric acid in grapes, pine apples and potatoes. Without the presence of these acids fruits may taste bland. Also food acids help us in food preservation and for jam and jelly setting. Also these acids have antioxidant and preservation properties.

used thickening agents are pectin, agar agar, lignin, algin and carageenan like gums.

All food gums are polysaccharides. They are odourless and tasteless and may have a nutritional quality besides the primary function. Also they help in digestion and may be used in laxatives.

Food acids

These are the only edible acids. Presence of these acids sharpens the taste of any food. All the fruits have these acids and give the typical taste of the fruit.

The naturally occurring food acids are citric acid, malic acid and tartaric acid. These are also called wholesome acids. Food acids are found in oranges, grape fruits, pineapples peaches and other seeded fruits.

Table 8 : Food acids and their sources

Citric acid is the commonly used food acid. All the other food acids are available naturally except phosphoric acid. Phosphoric acid is used commonly in aerated drinks along with carbon dioxide.

Emulsifiers

When preparing a food item we have to combine the natural components of food into a consistent and pleasing blend. The food components such as carbohydrates, proteins, oils, fat and water have their own properties and sometimes act counter to one another like for instance oil and water. To make the components compatible emulsifiers are used. An emulsifier acts as an interface between the conflicting components.

An emulsifier is a molecule with separate water and oil friendly ends where the oil droplets are surrounded by the emulsifier molecule. The oil core is hidden by the water friendly tails of the emulsifier. Milk is a classic example for an emulsion. Milk is a complex mixture of fat suspended in an aqueous solution. Egg is also commonly used as an emulsifier.

Emulsifiers are used in creams, sauces, and bakery and dairy products. They may be derived from natural products or produced synthetically.

Common emulsifiers are lecithin mono and diglycerides of fatty acids, esters of monoglycerides of fatty acids and phosphated monoglycerides.

M.A.J.Wansapala and I.Wickramasinghe
Department of Food Science and Technology, Faculty of Applied Sciences, University of Sri Jayewardenepura