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Food Additive

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1. Introduction

Substances which are of little or no nutritive value, but are used in the processing or storage of foods or animal feed, especially in the developed countries; includes antioxidants; food preservatives; food coloring agents; flavoring agents; anti-infective agents; vehicles; excipients and other similarly used substances. Many of the same substances are pharmaceuticals aids when added to pharmaceuticals rather than to foods. Food additives are substances added to food to preserve flavor or enhance its taste and appearance. Some additives have been used for centuries; for example, preserving food by pickling with vinegar, salting, as with bacon, preserving sweets or using sulfur dioxide as in some wines. With the advent of processed foods in the second half of the 20th century, many more additives have been introduced, of both natural and artificial origin. It is sometimes wrongly thought that food additives are a recent development, but there has certainly been an increase in public interest in the topic. Not all of this has been well-informed, and there are signs that commercial interests have been influenced by consumer pressure, as well as food producers manipulating the situation by marketing techniques. Various labeling regulations have been put into effect to ensure that contents of processed foods are known to consumers, and to ensure that food is fresh-important in unprocessed foods and probably important even if preservatives are used. In addition, we also need to add some preservatives in order to prevent the food from spoiling. Direct additives are intentionally added to foods for a particular purpose. Indirect additives are added to the food during its processing, packaging and storage. Food Preservatives are the additives that are used to inhibit the growth of bacteria, molds and yeasts in the food. Some of the additives are manufactured from the natural sources such as corn, beet and soybean, while some are artificial, man-made additives. Most people tend to eat the ready-made food available in the market, rather than preparing it at home. Such foods contain some kind of additives and preservatives, so that their quality and flavor is maintained and they are not spoiled by bacteria and yeasts. More than 3000 additives and preservatives are available in the market, which are used as antioxidants and anti-microbial agents. Salt and sugar the most commonly used additives. Some of the commonly used food additives and preservatives are aluminum silicate, amino acid compounds, ammonium carbonates, sodium nitrate, propyl gallate, butylated hydroxytoluene (BHT), butylated hydroxyanisole (BHA), monosodium glutamate, white sugar, potassium bromate, potassium sorbate, sodium benzoate, etc. Some artificial colors are also added to the foods to give them an appealing

look. These coloring substances are erythrosine (red), cantaxanthin (orange), amaranth (Azoic red), tartrazine (Azoic yellow) and annatto bixine (yellow orange). When the food is to be stored for a prolonged period, use of additives and preservatives is essential in order to maintain its quality and flavor. The excess water in the foods can cause the growth of bacteria, fungi and yeasts. Use of additives and preservatives prevents spoiling of the foods due to the growth of bacteria and fungi. Additives and preservatives maintain the quality and consistency of the foods. They also maintain palatability and wholesomeness of the food, improve or maintain its nutritional value, control appropriate pH, provide leavening and color, and enhance its flavor. There are even foods products that are made entirely from chemicals. Coffee creamers, sugar substitutes, and candies consist almost completely of artificial ingredients. Such manipulation of our food can have a profound effect on our body's unique biochemical balance. When we need to store any food for a longer time, it should be properly processed. During this processing, some substances and chemicals, known as additives, are added to the food. Additives consistently maintain the high quality of foods.

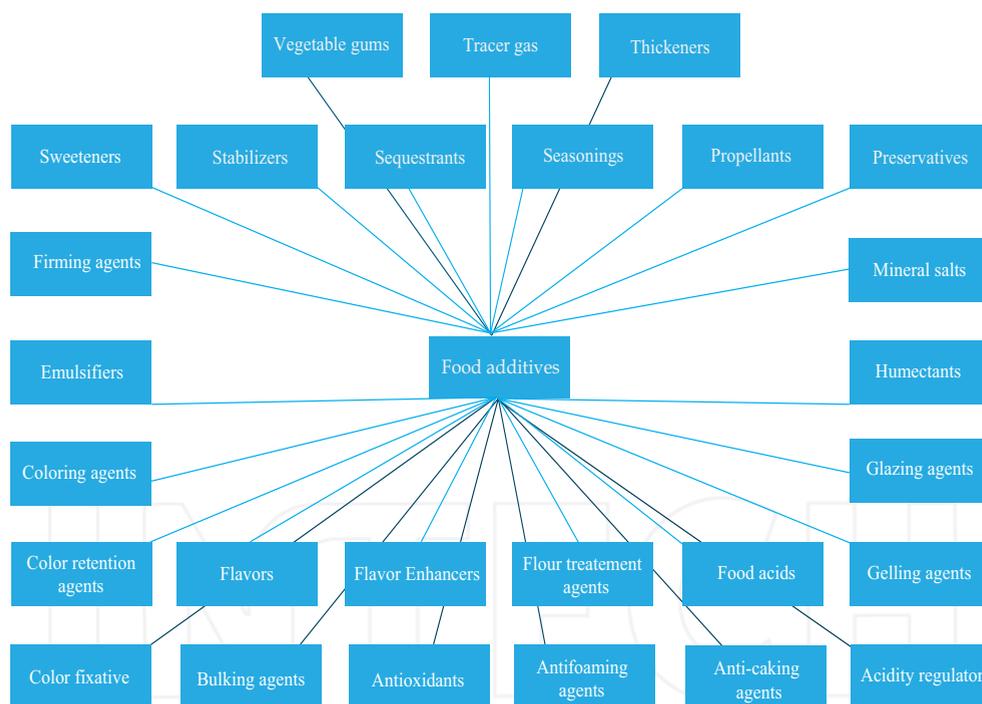


Fig. 1. Showing classification of food additives

2. Classification of food additives

Additives are classified as antimicrobial agents, antioxidants, artificial colors, artificial flavors and flavor enhancers, chelating agents and thickening and stabilizing agents (Fig. 1). Antimicrobial agents such as salt, vinegar, sorbic acid and calcium propionate are used

in the products such as salad dressings, baked goods, margarine, cheese and pickled foods. Antioxidants including vitamin C, E, BHT and BHA are used in the foods containing high fats. Chelating agents such as malic acid, citric acid and tartaric acid are used to prevent the flavor changes, discoloration and rancidity of the foods. These are very important in food manufacturing companies. The food Additives is used to retard spoilage, enhance food flavors, replace nutrient lost in processing and makes the food more visually appealing.

2.1 Acidity regulator

Acidity regulators are used to change or otherwise control the acidity and alkalinity of foods.

Types of acidity regulator

- i. acid
- ii. acidifier
- iii. acidity regulator
- iv. alkali
- v. base
- vi. buffer
- vii. buffering agent
- viii. pH adjusting agent

2.2 Anti-caking agents

Anti caking agents, prevents the formation of lumps making these products manageable for packaging, transport, and for use by end consumer. Anticaking Agent is the food additive that prevents agglomeration in certain solids, permitting a free-flowing condition. It reduces the tendency of particles of food to adhere to one another.

Types of anti-caking agent

- i. Anti-caking agent
- ii. Anti-stick agent
- iii. Drying agent
- iv. Dusting agent

Anti-caking agents consist of such substances as starch, magnesium carbonate, and silica and are added to fine-particle solids, such as food products like table salt, flours, coffee, and sugar. Some of the common examples of foods that contain anti-caking agents include:

- i. Vending machine powders (coffee, cocoa, soup)
- ii. Milk and cream powders
- iii. Grated cheese
- iv. Icing sugar
- v. Baking powder
- vi. Cake mixes
- vii. Instant soup powders
- viii. Drinking chocolate
- ix. Table salt

2.3 Antifoaming agents

Antifoaming agents reduce or prevent foaming in foods.

Types of anti-foaming agent

- i. Antifoaming agent
- ii. Defoaming agent

2.4 Antioxidants

A food additive, which prolongs the shelf-life of foods by protecting against deterioration caused by oxidation. Antioxidants are used to preserve food for a longer period of time. Antioxidants act as oxygen scavengers as the presence of oxygen in the food helps the bacteria to grow that ultimately harm the food. In the absence of antioxidant food additive oxidation of unsaturated fats takes place rendering to foul smell and discoloration of food. Different kinds of antioxidants foods act in a different ways but the end result is to delay or minimize the process of oxidation in food. Some antioxidants foods additives combine with oxygen to prevent oxidation and other prevent the oxygen from reacting with the food leading to its spoilage.

Types of anti-oxidant agent

- i. Anti-browning agent
- ii. Antioxidant
- iii. Antioxidant synergist

Some popular antioxidant foods

Antioxidant vitamins

a) Ascorbic acid- E300

Antioxidant vitamins include Ascorbic acid (vitamin C) this antioxidant vitamin is used in beers, cut fruits, dried potatoes and jams. The antioxidant vitamins in these foods helps in preventing the discoloration of food by preventing the oxidation. It can also act as a substitute of vitamin C in potatoes that is lost during processing.

b) Citric acid - E330

It is used in biscuits, jams, tinned fruits, alcoholic drinks, cheese and dried soup. It has many uses like it prevents the discoloration of food, increases the anti-oxidant effect of other substances and regulates pH in jams and jellies.

c) Tocopherols - E307

(307a, d-alpha-Tocopherol; 307b, Tocopherol concentrate and 307c, dl-alpha-Tocopherol)

This antioxidant food additive is used in the meat pies and oils to reduce the oxidation of fatty acids and vitamins.

d) Butylated hydroxyanisole (BHA) - E320

It is used in margarine, oils, crisps and cheese. This antioxidant helps in preventing the reactions leading to the breakdown of fats.

Antioxidants benefits

There are many benefits of using antioxidant food additives. Antioxidants prevent the blockage of arteries with fatty deposits that prevents the heart-attacks. Also these are associated with the prevention of certain types of cancers, arthritis and more conditions of these kinds.

2.5 Bulking agents

A food additive, which contributes to the bulk of a food without contributing significantly to its available energy value. Bulking agents such as starch are additives that increase the bulk of a food without affecting its nutritional value.

Types of bulking agents

- i. Bulking agent
- ii. Filler

2.6 Color retention agents

A food additive, which stabilizes, retains or intensifies the colour of a food. In contrast to colorings, color retention agents are used to preserve a food's existing color.

Types of color retention agents

- i. Color adjunct
- ii. Colour fixative
- iii. Colour retention agent
- iv. Colour stabilizer

2.7 Coloring

A food additive, which adds or restores colour in a food. Colorings are added to food to replace colors lost during preparation, or to make food look more attractive, more visually appealing.

Types of coloring agents

- i. Colour
- ii. Decorative pigment
- iii. Surface colorant

Beta carotene, Caramel, Carrot oil, Citrus red # 1, Dehydrated beets, FD&C colors: Blue # 1, 2; Red # 3, 40; Yellow # 5, 6 - used in processed foods, especially sweets and products marketed for children, soft drinks, baked goods, frosting, jams, and margarine.

Though there is a growing realization that the color additives should be used to the minimum, the fact is that the food doesn't even look presentable at times without it and appears inedible.

2.8 Emulsifiers

A food additive, which forms or maintains a uniform emulsion of two or more phases in a food. Emulsifiers allow water and oils to remain mixed together in an emulsion, as in mayonnaise, ice cream, and homogenized milk. It stops fats from clotting together.

Types of emulsifiers

- i. Clouding agent
- ii. Crystallization inhibitor
- iii. Density adjustment agent (flavouring oils in beverages)
- iv. Dispersing agent
- v. Emulsifier
- vi. Plasticizer
- vii. Surface active agent
- viii. Suspension agent

2.9 Emulsifying salt

A food additive, which, in the manufacture of processed food, rearranges proteins in order to prevent fat separation.

Types of emulsifying salt

- i. Emulsifying salt
- ii. Melding salt

2.10 Firming agents

A food additive, which makes or keeps tissues of fruit or vegetables firm and crisp, or interacts with gelling agents to produce or strengthen a gel.

2.11 Flavors

Flavors are additives that give food a particular taste or smell, and may be derived from natural ingredients or created artificially.

2.12 Flavor enhancers

Flavor enhancers enhance a food's existing flavors. They may be extracted from natural sources (through distillation, solvent extraction, maceration, among other methods) or created artificially.

Types of flavor enhancing agents

- i. Flavour enhancer
- ii. Flavour synergist

Some flavor enhancers are as follows:

- a) Dioctyl sodium-sulfosuccinate - used in processed foods.
- b) Disodium guanylate - used in canned meats, meat based foods.

- c) Hydrolyzed vegetable - used in mixes, stock, processed meats.
- d) Monosodium glutamate (MSG) - used in Chinese food, dry mixes, stock cubes, and canned, processed, and frozen meats.

2.13 Flour treatment agents

A food additive, which is added to flour or dough to improve its baking quality or colour.

Types of flour treatment agent

- i. Dough conditioner
- ii. Dough strengthening agent
- iii. Flour bleaching agent
- iv. Flour improver
- v. Flour treatment agent

2.14 Food acids

Food acids are added to make flavors "sharper", and also act as preservatives and antioxidants. Common food acids include vinegar, citric acid, tartaric acid, malic acid, fumaric acid, and lactic acid.

2.15 Gelling agents

Gelling agents are food additives used to thicken and stabilize various foods, like jellies, desserts and candies. The agents provide the foods with texture through formation of a gel. Some stabilizers and thickening agents are gelling agents.

2.16 Glazing agents

A food additive, which when applied to the external surface of a food, imparts a shiny appearance or provides a protective coating. Glazing agents provide a shiny appearance or protective coating to foods.

Types of glazing agent

- i. Coating agent
- ii. Film forming agent
- iii. Glazing agent
- iv. Polishing agent
- v. Sealing agent
- vi. Surface-finishing agent

2.17 Humectants

A food additive, which prevents food from drying out by counteracting the effect of a dry atmosphere.

Types of humectants

- i. Humectant
- ii. Moisture/water retention agent
- iii. Wetting agent

2.18 Mineral salts

Mineral salts are added as nutritional additives though they may have other properties like an anti-oxidant or a preservative. Many of them are essentials that need to be included in our daily diets, as they are the source of important nutrients required for the body. The important natural mineral salts that should be consumed are sodium, phosphorus, potassium, chlorine, sulphur and calcium. While the above mentioned happen to be the macro elements of the natural mineral salts, the micro elements are the ones that are essential nutrients for the human body. The micro elements in the minerals salts consist of iodine, iron, fluoride and zinc.

2.19 Preservatives

A food additive, which prolongs the shelf-life of a food by protecting against deterioration caused by microorganisms. It prevents or inhibits spoilage of food due to fungi, bacteria and other microorganisms. It stops microbes from multiplying and spoiling the food.

Types of preservatives

- i. Antimicrobial preservative
- ii. Antimicrobial synergist
- iii. Antimould and antirope agent
- iv. Antimycotic agent
- v. Bacteriophage control agent
- vi. Fungistatic agent
- vii. Preservative

Some preservatives are:

- a) Benzoic acid and benzoates - are found in soft-drinks, beer, margarine and acidic foods. They are use to extend shelf life and protect food from fungi and bacteria.
- b) Nitrites and nitrates - are found in processed meats, such as sausages, hot dogs, bacon, ham, and luncheon meats, smoked fish. They are used to extend shelf life and protect food from fungi and bacteria; preserve color in meats and dried fruits.
- c) Sulfites - are found in dried fruits, shredded coconut, fruit based pie fillings. They are used to extend shelf life and protect food from fungi and bacteria.

2.20 Propellants

It helps propel food from a container.

2.21 Seasonings

Seasoning is the process of imparting flavor to, or improving the flavor of food.

2.22 Sequestrants

A sequestrant is a food additive whose role is to improve the quality and stability of the food products. Sequestrants form chelate complexes with polyvalent metal ions, especially copper, iron and nickel, which serve as catalysts in the oxidation of the fats in the food. Sequestrants are a kind of preservative.

2.23 Stabilizers

A food additive, which makes it possible to maintain a uniform dispersion of two or more components. Stabilizers, like agar or pectin (used in jam for example) give foods a firmer texture. While they are not true emulsifiers, they help to stabilize emulsions.

- i. Colloidal stabilizer
- ii. Emulsion stabilizer
- iii. Foam stabilizer
- iv. Stabilizer

2.24 Sweeteners

Sweeteners are added to foods for flavoring. Sweeteners other than sugar are added to keep the food energy (calories) low, or because they have beneficial effects for diabetes mellitus and tooth decay and diarrhea. These are the substances that sweeten food, beverages, medications, etc., such as sugar, saccharine or other low-calorie synthetic products. They in general can be termed as sweetening agents. They all are called artificial sweeteners as they are usually not a component of the product they are added to. As per the source, these substances can be classified as natural and artificial sweeteners. Natural sweeteners are obtained from the natural sources like sugarcane and sugar beet and from fruits (fructose) and the artificial ones have a chemical origin. Artificial sweeteners are further of two type namely non-caloric sweeteners and sugar alcohols. Noncaloric sweeteners do not add calories to foods. They are used in snack foods and drinks. Sweeteners like saccharine and aspartame fall under this category. Sugar alcohols are used in chewing gums and hard candies and have almost same calories as sugar. Examples of sugar alcohols are sorbitol and mannitol.

Commonly used sweeteners

- a) Acesulfame K - It is a 0 calorie sweetener, 130- 200 times sweeter than sucrose. It is not metabolized by the body. The only limitation it has is that if used in large quantities, it has an after taste. It is used in fruit preserves, dairy products and all types of beverages. It is used to reduce the calories of the products. It is heat resistant and enhances flavors.
- b) Aspartame - It is a low calorie sweetener about 200% more sweet than the sugar. It is disintegrated into aspartic acid, phenylalanine and methanol in the body on digestion. It's taste is similar to sugar only more sweet. It is used in all types of foods and beverages and medicines. It is found naturally in protein rich foods.
- c) Cyclamate - This is a calorie free sweetener 30-50 times sweeter than sugar. It is metabolized in the gut by few individuals and generally expelled as such. It is generally used in combination with other sweeteners. It has a pleasant taste, and is stable at high temperatures and is economical.
- d) Saccharin - It is one of the earliest low calorie sweeteners that is 300-500 times more sweet than sugar. It doesn't metabolize and absorption is slow. Owing to this it is expelled as such from the body. Saccharin is the most widely used sweetener. It was earlier banned in certain countries but now is used quite commonly. There are other sweeteners like Stevioside, Alitame, Thaumatin, Sucralose, Neohesperidine DC and Aspartame-Acesulfame Salt. All artificial sweeteners have been approved by the U.S. Food and Drug Administration (FDA). They are considered harmless if taken in limited quantities.

2.25 Thickeners

Thickeners are substances which, when added to the mixture, increase its viscosity without substantially modifying its other properties.

Types of thickeners

- i. Binder
- ii. Bodying agent
- iii. Texturizing agent
- iv. Thickener

2.26 Tracer gas

Tracer gas allows for package integrity testing preventing foods from being exposed to atmosphere, thus guaranteeing shelf life.

2.27 Vegetable gums

Vegetable gums come from the varied sources that can be on land or in sea. Some of the seaweeds are the excellent sources of food gums in which comes the carrageenan and alginates. Whereas guar, locust bean gum, pectin are obtained from the plants. Xanthan gum is obtained by the process of microbial fermentation. The source of gelatin is animal tissue. Vegetable gums are the polysaccharides that have the natural origin and used to increase the viscosity of the solution or food even if used in a very small concentration. Major Vegetable Gums are:

- a. Cellulose Gum
- b. Xanthan Gum
- c. Locust Bean Gum
- d. Pectin

3. 'E' numbering

To regulate these additives, and inform consumers, each additive is assigned a unique number, termed as "E numbers", which is used in Europe for all approved additives. This numbering scheme has now been adopted and extended by the Codex Alimentarius Commission to internationally identify all additives, regardless of whether they are approved for use.

E numbers are all prefixed by "E", but countries outside Europe use only the number, whether the additive is approved in Europe or not. For example, acetic acid is written as E260 on products sold in Europe, but is simply known as additive 260 in some countries. Additive 103, alkanet, is not approved for use in Europe so does not have an E number, although it is approved for use in Australia and New Zealand. Since 1987, Australia has had an approved system of labelling for additives in packaged foods. Each food additive has to be named or numbered. The numbers are the same as in Europe, but without the prefix 'E'.

The United States Food and Drug Administration listed these items as "Generally recognized as safe" or GRAS; they are listed under both their Chemical Abstract Services number and Fukda regulation under the US Code of Federal Regulations.

4. Dangers of food additives and preservatives

Although additives and preservatives are essential for food storage, they can give rise to certain health problems. They can cause different allergies and conditions such as hyperactivity and Attention Deficit Disorder in the some people who are sensitive to specific chemicals. The foods containing additives can cause asthma, hay fever and certain reactions such as rashes, vomiting, headache, tight chest, hives and worsening of eczema. Some of the known dangers of food additives and preservatives are as follows:

- Benzoates can trigger the allergies such as skin rashes and asthma as well as believed to be causing brain damage.
- Bromates destroy the nutrients in the foods. It can give rise to nausea and diarrhea.
- Butylates are responsible for high blood cholesterol levels as well as impaired liver and kidney function.
- Caffeine is a colorant and flavorant that has diuretic, stimulant properties. It can cause nervousness, heart palpitations and occasionally heart defects.
- Saccharin causes toxic reactions and allergic response, affecting skin, gastrointestinal tract and heart. It may also cause tumors and bladder cancer.
- Red Dye 40 is suspected to cause certain birth defects and possibly cancer.
- Mono and di-glycerides can cause birth defects, genetic changes and cancer.
- Caramel is a famous flavoring and coloring agent that can cause vitamin B6 deficiencies. It can cause certain genetic defects and even cancer.
- Sodium chloride can lead to high blood pressure, kidney failure, stroke and heart attack.

To minimize the risk of developing health problems due to food additives and preservatives, you should avoid the foods containing additives and preservatives. Before purchasing the canned food, you must check its ingredients. You should buy organic foods, which are free from artificial additives. Try to eat the freshly prepared foods as much as possible rather than processed or canned foods.

5. Effects of food additives

Avoiding or minimizing toxins in your diet is an important step toward enhancing your health and lowering your risk of disease. Foods, amongst other things (cosmetics & medications), represent a source of these toxins. Effects of food additives may be immediate or may be harmful in the long run if you have constant exposure. Immediate effects may include headaches, change in energy level, and alterations in mental concentration, behavior, or immune response. Long-term effects may increase your risk of cancer, cardiovascular disease and other degenerative conditions. Although it may seem difficult to change habits and find substitutes for foods you enjoy, remind yourself that you will be adding to your diet some new wholesome foods that you will come to enjoy even more. Look for foods that are not packaged and processed, but enjoy nature's own bounty of fresh fruits, vegetables, grains, beans, nuts and seeds. Find foods that resemble what they looked like when they were originally grown.

6. Cytotoxic effects of food additives

Exposure to non-nutritional food additives during the critical development window has been implicated in the induction and severity of behavioral disorders such as attention

deficit hyperactivity disorder (ADHD). Although the use of single food additives at their regulated concentrations is believed to be relatively safe in terms of neuronal development, their combined effects remain unclear. The neurotoxic effects of four common food additives in combinations of two (Brilliant Blue and L-glutamic acid, Quinoline Yellow and aspartame) has been assessed for potential interactions. Mouse NB2a neuroblastoma cells were induced to differentiate and grow neurites in the presence of additives. After 24 h, cells were fixed and stained and neurite length measured by light microscopy with computerized image analysis. Neurotoxicity was measured as an inhibition of neurite outgrowth. Two independent models were used to analyze combination effects: effect additivity and dose additivity. Significant synergy was observed between combinations of Brilliant Blue with L-glutamic acid, and Quinoline Yellow with aspartame, in both models. Involvement of N-methyl-D-aspartate (NMDA) receptors in food additive-induced neurite inhibition was assessed with a NMDA antagonist, CNS-1102. L-glutamic acid- and aspartame induced neurotoxicity was reduced in the presence of CNS-1102; however, the antagonist did not prevent food color-induced neurotoxicity. Theoretical exposure to additives was calculated based on analysis of content in foodstuff, and estimated percentage absorption from the gut. Inhibition of neurite outgrowth was found at concentrations of additives theoretically achievable in plasma by ingestion of a typical snack and drink. In addition, Trypan Blue dye exclusion was used to evaluate the cellular toxicity of food additives on cell viability of NB2a cells; both combinations had a straightforward additive effect on cytotoxicity. These data have implications for the cellular effects of common chemical entities ingested individually and in combination. (Lau *et al.*, 2006)

Gallic acid is added to foods to prevent oxygen-induced lipid peroxidation and can be obtained by the hydrolysis of tannic acid which can be found in tea, coffee, red wine, and immature fruits. Tannic acid has also been used as a food additive. The effect of gallic acid on mouse spermatogonia, mouse spermatocytes, and mouse Sertoli cells *in vitro* was investigated. First, each cell line was cultured with predetermined concentrations of gallic acid for 3 h to assess the effects of gallic acid on *in vitro* growth of testicular cells and MTT cytotoxicity assay was used to measure cell viability. Secondly, intracellular levels of hydrogen peroxide in mouse spermatogonia, mouse spermatocytes, and mouse Sertoli cells treated with gallic acid were analyzed using dihydrorhodamine 123 as a probe to evaluate the pro-oxidative property of gallic acid. The results obtained indicate that gallic acid inhibits the growth and proliferation of testicular cells in a dose-dependent manner and increases the intracellular level of hydrogen peroxide in mouse spermatogonia significantly ($p < 0.05$). It can be suggested that gallic acid exerts cytotoxic effects on testicular cells by its pro-oxidative activity. In conclusion, gallic acid-induced cytotoxicity in mouse spermatogonia, mouse spermatocytes, and mouse Sertoli cells *in vitro* may be of toxicological research interest considering the testicular toxic potential of gallic acid. (Park *et al.*, 2008)

In recent years, the use of carthami flos (the flowers of *Carthamus tinctorius*) as a colouring and flavouring agent in foods has increased in Iran. In order to evaluate its safety, the teratogenic effects of carthami flos on central nervous system development in mice were investigated. Furthermore, its cytotoxic effect on a rat nerve cell culture was studied to complete safety evaluations. For teratogenic studies, after natural mating, pregnant mice were divided into test and control groups. The groups were treated with different dosage

regimens of aqueous carthami flos extract during 0-8 days of gestation. Embryos were then isolated at the 13th day of gestation and evaluated for macroscopic, microscopic and morphometric characteristics. The results showed that at higher doses (1.6 and 2 mg/kg/day) the embryos were absorbed, whereas at a lower dose (1.2 mg/kg/day) changes in external, internal and longitudinal diameters, open neuropore, changes in cellular orientation and cellular degeneration were observed. The results obtained from the cytotoxic assay also demonstrated a concentration-dependent cytotoxic effect of carthami flos extract. It is concluded that the use of carthami flos as a food additive should be reconsidered. (Nobakht *et al.*, 2000)

The cytotoxicity of 11 dyes, used as food dyes in Japan, on cultured fetal rat hepatocytes was studied. Xanthene dyes containing halogen atoms in their molecules such as phloxin, rose bengal, and erythrosine were more toxic than other groups of food dyes. The effect of food dyes on the cell growth of hepatocytes was also examined. Phloxin was especially toxic to the cell growth and a dose-response relation was observed between the concentration of phloxin and the cell growth of hepatocytes when the dye was added 3 days after plating. (Sako *et al.*, 1980)

The synergistic effect of food additives or food colors on the toxicity of 3-amino-1,4-dimethyl-5H-pyrido[4,3-b]indole (Trp-P-1) was investigated using primary cultured rat hepatocytes. When hepatocytes from rats fed a standard diet were treated with a mixture of four major food additives (sorbitol, sodium 1.(+)-glutamate, benzoic acid, and propylene glycol) or a mixture of six typical artificial food colors (erythrosine, allura red, new cocchine, brilliant blue, tertrazine, and fast green), the *in vitro* treated food-color mixture itself showed cytotoxicity: the reduction of cell viability and decreases in the activities of gluconeogenesis and ureogenesis. The food-color mixture enhanced cytotoxicity of Trp-P-1 obviously. The effects of *in vivo*-dosed food additives or food colors on Trp-P-1-caused toxicity. Hepatocytes were isolated and cultured from rats fed a diet containing a mixture of food additives or a mixture of food colors with half the amount of their respective acceptable daily intake for 4 wk. Trp-P-1 was administered to the hepatocytes at various concentrations for 12 h. Synergistic effects of *in vivo*-dosed food additives and food colors were not observed on Trp-P-1-caused cytotoxicity as estimated by a loss of cell viability and the reductions of DNA and protein syntheses. On the contrary, it was observed that *in vivo* administered food colors synergistically facilitated to reduce the activities of gluconeogenesis and ureogenesis in Trp-P-1-treated hepatocytes. These results suggest that the daily intake of artificial food colors may impair hepatic functions such as gluconeogenesis and ureogenesis, when dietary carcinogens are exposed to the liver cells. (Ashida *et al.*, 2000)

Study was conducted to investigate the impact of food additives like boric acid, citric acid and sodium metabisulphite individually, in different concentrations, on root tips of *Vicia faba* L. Cytological studies revealed significant decrease in mitotic index with an increase in concentration of the food additives. Most frequent cytological abnormalities observed are fragments, disturbed metaphase, C-mitosis, laggards, bridges, stickiness, precocious movement of chromosomes, unequal and late separation of chromosomes. Bridges and fragments were more frequent at anaphase. The percentage of chromosomal aberrations at mitosis increased with an increase in concentration of the food additives. (Pandey and Upadhyay, 2007)

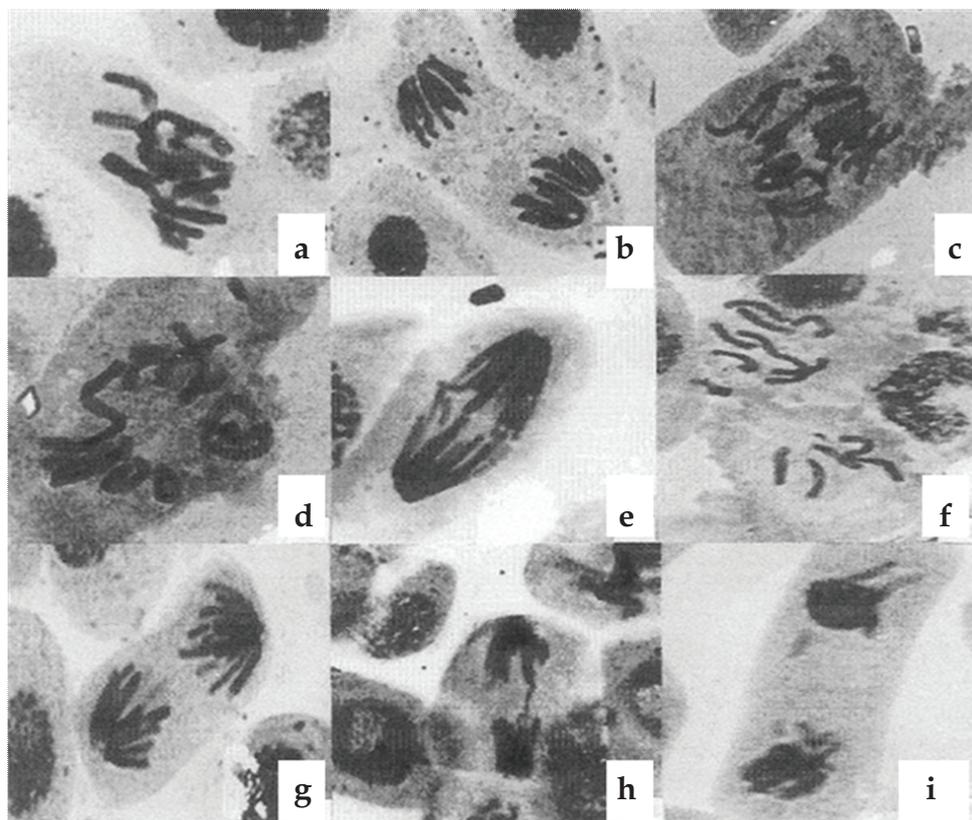


Fig. 2. a-i — Showing cytological effects of food additives in *Vicia faba* L., a. Normal metaphase, b. Normal anaphase, c. Disturbed metaphase, d. C-mitosis, e. Late separation at anaphase, f. Unequal separation, g. Fragmentation at anaphase, h. Chromatid bridge, i. Stickiness and Laggard at anaphase

Clastogenic properties of the food additive citric acid, commonly used as an antioxidant, were analysed in human peripheral blood lymphocytes. Citric acid induced a significant increase of chromosomal aberrations (CAs) at all the concentrations and treatment periods tested. Citric acid significantly decreased mitotic index (MI) at 100 and 200 $\mu\text{g ml}^{-1}$ concentrations at 24 h, and in all concentrations at 48 h. However, it did not decrease the replication index (RI) significantly. Citric acid also significantly increased sister chromatid exchanges (SCEs) at 100 and 200 $\mu\text{g ml}^{-1}$ concentrations at 24 h, and in all concentrations at 48 h. This chemical significantly increased the micronuclei frequency (MN) compared to the negative control. It also decreased the cytokinesis-block proliferation index (CBPI), but this result was not statistically significant. (Serkan et al., 2008)

Ester gum (EG) is used in citrus oil-based beverage flavourings as a weighting or colouring agent. In this study, concentrations of 50, 100 and 150 mg/kg body weight were administered orally to male Swiss albino mice, and sister chromatid exchange and chromosomal aberration were used as the cytogenetic endpoints to determine the genotoxic

and clastogenic potential of the food additive. Although EG was weakly clastogenic and could induce a marginal increase in sister chromatid exchange frequencies, it was not a potential health hazard at the doses tested. (Mukherjee *et al.*, 1992)

Acesulfame-K, a sweetening agent, was evaluated *in vivo* for its genotoxic and clastogenic potentials. Swiss albino male mice were exposed to the compound by gavage. Bone marrow cells isolated from femora were analysed for chromosome aberrations. Doses of 15, 30, 60, 450, 1500 and 2250 mg of acesulfame-K/kg body weight induced a positive dose-dependent significant clastogenicity (trend test $\alpha < 0.05$). These doses were within the no-toxic-effect levels (1.5-3 g/kg body weight in rats) reported by the Joint Expert Committee for Food Additives of the World Health Organization and the Food and Agriculture Organization of the United Nations. In view of the present significant *in vivo* mammalian genotoxicity data, acesulfame-K should be used with caution. (Mukherjee and Chakrabarti, 1997)

Aspartame and acesulfame-K, non-nutritive sweeteners, are permitted individually in diets and beverages. These sweeteners of different classes, used in combination, have been found to possess a synergistic sweetening effect. Whether they also have a synergistic genotoxic effect is unknown. Swiss Albino male mice were exposed to blends of aspartame (3.5, 35, 350 mg/kg body weight) and acesulfame-K (1.5, 15 and 150 mg/kg body weight) by gavage. Bone marrow cells isolated from femora were analyzed for chromosome aberrations. Statistical analysis of the results show that aspartame in combination with acesulfame-K is not significantly genotoxic. (Mukhopadhyay *et al.*, 2000)

This work aimed to study some blood indices of rats as affected by saccharin and the therapeutic action of vitamins C and E. The used adult female *Rattus norvegicus* albino rats in the present study were weighing 100–120 g. Administration of saccharin at a dose of 35 mg kg⁻¹ body weight (b.wt.) day⁻¹ for 35 days significantly decreased serum glucose, triglycerides, cholesterol, total protein and albumin values. These decrements were by 20.16%, 22.76%, 44.92%, 20.16% and 40.44%, respectively, compared to control level (p value < 0.01). But it increased levels of kidney function indices. The effect of saccharin was more pronounced on creatinine. Activities of Alanine aminotransferase (ALT), aspartate aminotransferase (AST) and Alkaline phosphatase (ALP) increased significantly following saccharin treatment to rats. Concerning hematological parameters, the more obvious changes were observed in the increment of white blood cell (WBC), mean corpuscular volume (MCV) and platelets (PLT) and the decrease in hematocrit, hemoglobin (Hb) and red blood cells (RBCs) count in response to the administration of saccharin. In general, vitamin C or E (150 mg kg⁻¹ b.wt. day⁻¹ for 35 days) was able to reduce the effects of saccharin intake. Both vitamins, however, generally have beneficial effects in reducing the changes in the studied parameters. (Abdelaziz *et al.*, 2011)

Monosodium phosphate (MSP - E339i), disodium phosphate (DSP - E339ii), and trisodium phosphate (TSPE339iii) are used as antimicrobials, pH control agents (buffers), boiler water additives, cleaners, coagulants, dispersants, leavening agents, stabilizers, emulsifiers, sequestrants, texturizers, nutrients, and dietary supplements. The effects of these have been studied on root tips of *Allium cepa* L. Roots of *A. cepa* were treated with a series of concentrations, ranging from 300 to 500 ppm for 24, 48 and 72 h. The results indicated that these food preservatives reduced mitotic division in *A. cepa* when compared with the respective control. Mitotic index values were generally decreased with increasing concentrations and longer treatment times. Additionally, variations in the percentage of

mitotic stages were observed. The total percentage of aberrations generally increased with increasing concentrations of these chemicals and longer period of treatment. Different abnormal mitotic figures were observed in all mitotic phases. Among these abnormalities were stickiness, anaphase bridges, C-mitosis and micronuclei. These food additives remarkably depressed the DNA content in the root meristems of *A. cepa*. The interphase nuclear volume (INV) also varied between the untreated (controls) and the treated plants. (Turkoglu Sifa, 2009)

Citric acid is used widely as an acidulant, pH regulator, flavour enhancer, preservative and antioxidant synergist in many foods, like soft drinks, jelly sweet, baked nutrients, jam, marmalade, candy, tinned vegetable and fruit food. Clastogenic properties of the food additive citric acid, commonly used as an antioxidant, were analysed in human peripheral blood lymphocytes. Citric acid induced a significant increase of chromosomal aberrations (CAs) at all the concentrations and treatment periods tested. Citric acid significantly decreased mitotic index (MI) at 100 and 200 $\mu\text{g ml}^{-1}$ concentrations at 24 h, and in all concentrations at 48 h. However, it did not decrease the replication index (RI) significantly. Citric acid also significantly increased sister chromatid exchanges (SCEs) at 100 and 200 $\mu\text{g ml}^{-1}$ concentrations at 24 h, and in all concentrations at 48 h. This chemical significantly increased the micronuclei frequency (MN) compared to the negative control. It also decreased the cytokinesis-block proliferation index (CBPI), but this result was not statistically significant. (Serkan Yılmaz *et al.*, 2008)

7. Food additives and safety

With the increasing use of processed foods since the 19th century, there has been a great increase in the use of food additives of varying levels of safety. This has led to legislation in many countries regulating their use. For example, boric acid was widely used as a food preservative from the 1870s to the 1920s, but was banned after World War I due to its toxicity, as demonstrated in animal and human studies. During World War II the urgent need for cheap, available food preservatives led to it being used again, but it was finally banned in the 1950s.^[2] Such cases led to a general mistrust of food additives, and an application of the precautionary principle led to the conclusion that only additives that are known to be safe should be used in foods. In the USA, this led to the adoption of the Delaney clause, an amendment to the Federal Food, Drug, and Cosmetic Act of 1938, stating that no carcinogenic substances may be used as food additives. However, after the banning of cyclamates in the USA and Britain in 1969, saccharin, the only remaining legal artificial sweetener at the time, was found to cause cancer in rats. Widespread public outcry in the USA, partly communicated to Congress by postage-paid postcards supplied in the packaging of sweetened soft drinks, led to the retention of saccharin despite its violation of the Delaney clause.

In September 2007, research financed by Britain's Food Standards Agency and published online by the British medical journal *The Lancet*, presented evidence that a mix of additives commonly found in children's foods increases the mean level of hyperactivity. The team of researchers concluded that "the finding lends strong support for the case that food additives exacerbate hyperactive behaviors (inattention, impulsivity and overactivity) at least into middle childhood." That study examined the effect of artificial colors and a sodium benzoate preservative, and found both to be problematic for some

Colour	Status worldwide:	Where found:	Possible negative effects:	References
Erythrosine FD&C Red No. 3	Banned for use in cosmetics and external drug, but not food and ingested drugs in the U.S.	Cocktail, canned fruits salads confections dairy products snack foods.	Cancer	<i>The Washington Post</i> , February 7, 1990 CBS News, June 3, 2008
Tartrazine (E102) FD&C Yellow No. 5,	Banned in Norway and Austria.	Ice cream Carbonated drinks Fish sticks	Hyperactivity, asthma, skin rashes, and migraine headaches.	UK Food Guide. http://www.ukfoodguide.net/e102.htm . Retrieved 2007 FDA, 2007
Quinoline yellow (E104)	* Banned in Australia, Japan, Norway and the U.S. Restricted to max. permitted levels in U.K.	Soft drinks Ice creams Candies Cosmetics medications	Asthma, rashes and hyperactivity. Potential carcinogen in animals: implicated in bladder and liver cancer. Altered reproduction in animals.	efsa.europa.eu - EFSA updates safety advice on six food colours 091112
Sunset yellow (E110)* Yellow FCF Orange Yellow S	Banned in Norway, Sweden and Finland. Restricted to maximum permitted levels in U.K.	Sweets Snack foods Ice-creams, Yoghurts Drinks	AVOID in allergies & asthma. Cancer - DNA damage, increases tumors in animals. Growth retardation and severe weight loss in animals.	091113 efsa.europa.eu doi:10.1016/S0140-6736(07)
Carmosine (E122)*	Banned in Canada, Japan, Norway, Austria, Sweden and the U.S. Restricted to maximum permitted levels in U.K.	Yoghurts Sweets	DNA damage and tumours in animals.	Food additives <i>CBC News</i> . 29 September 2008
Allura red (E129)* FD&C Red No. 3	Banned in Denmark, Belgium, France, Germany, Switzerland, Sweden, Austria and Norway	Carbonated drinks Bubble gum, snacks, Sauces, preserves, Soups, wine, cider, etc.	May worsen or induce asthma, rhinitis (including hayfever), or urticaria (hives).	<i>UK Food Guide</i> , a British food additives website. Last retrieved 20 May 2007
Ponceau 4R (E124)* Conchineal	Banned in US, Canada, Norway, Sweden and Japan. Restricted to maximum permitted levels in the UK	Carbonated drinks Ice-creams Confectioneries Desserts	Cancer - DNA damage and tumours in animals. Can produce bad reactions in asthmatics	Food And Drug Administration Compliance Program Guidance Manual p.10
Amaranth (E123) Wine	Banned in the U.S.	Alcoholic drinks Fish roe	May worsen or induce asthma, allergies or hives.	FDA/CFSAN Food Compliance Program: Domestic Food Safety Program
Indigo Carmine (E132)*	Banned in the US, Japan, Australia and Norway. UK use restricted to maximum permitted levels	Ice-creams Sweets Baked goods Confectionery items Biscuits	May cause nausea, vomiting, skin rashes, and brain tumors. DNA damage and tumors in animals.	United States Food and Drug Administration
Brilliant Blue (E133)*	Banned in Austria, Belgium, France, Norway, Sweden, Switzerland and Germany. Restricted to maximum permitted levels in U.K.	Dairy products Sweets Drinks	Hyperactivity and skin rashes. Listed as human carcinogen by the US EPA. Causes DNA damage and tumors in animals	FDA, 1993

Table 1. Colour additives to avoid

children. Further studies are needed to find out whether there are other additives that could have a similar effect, and it is unclear whether some disturbances can also occur in mood and concentration in some adults. In the February 2008 issue of its publication, *AAP Grand Rounds*, the American Academy of Pediatrics concluded that a low-additive diet is a valid intervention for children with ADHD: "Although quite complicated, this was a carefully conducted study in which the investigators went to great lengths to eliminate bias and to rigorously measure outcomes. The results are hard to follow and somewhat inconsistent. For many of the assessments there were small but statistically significant differences of measured behaviors in children who consumed the food additives compared with those who did not. In each case increased hyperactive behaviors were associated with consuming the additives. For those comparisons in which no statistically significant differences were found, there was a trend for more hyperactive behaviors associated with the food additive drink in virtually every assessment. Thus, the overall findings of the study are clear and require that even we skeptics, who have long doubted parental claims of the effects of various foods on the behavior of their children, admit we might have been wrong."

In 2007, Food Standards Australia New Zealand published an official shoppers' guidance with which the concerns of food additives and their labeling are mediated.

There has been significant controversy associated with the risks and benefits of food additives. Some artificial food additives have been linked with cancer, digestive problems, neurological conditions, ADHD, heart disease or obesity. Natural additives may be similarly harmful or be the cause of allergic reactions in certain individuals. For example, safrole was used to flavor root beer until it was shown to be carcinogenic. Due to the application of the Delaney clause, it may not be added to foods, even though it occurs naturally in sassafras and sweet basil.

Blue 1, Blue 2, Red 3, and Yellow 6 are among the food colorings that have been linked to various health risks. Blue 1 is used to color candy, soft drinks, and pastries and there has been some evidence that it may cause cancer. Blue 2 can be found in pet food, soft drinks, and pastries, and has shown to cause brain tumors in mice. Red 3, mainly used in cherries for cocktails has been correlated with thyroid tumors in rats and humans as well. Yellow 6, used in sausages, gelatin, and candy can lead to the attribution of gland and kidney tumors and contains carcinogens, but in minimal amounts.

Some studies have linked some food additives to hyperactivity in children. A recent British study found that children without a history of any hyperactive disorder showed varying degrees of hyperactivity after consuming fruit drinks with various levels of additives. Among those that were studied were: Sodium benzoate (E211), Tartrazine (E102), quinoline yellow (E104), Sunset yellow (E110), Carmosine (E122), Allura red (E129). See tables below for more information.

8. Joint FAO/WHO Expert Committee on Food Additives (JECFA)

The Joint FAO/WHO Expert Committee on Food Additives (JECFA) is an international scientific expert committee that is administered jointly by the Food and Agriculture Organization of the United Nations FAO and the World Health Organization WHO. It has been meeting since 1956, initially to evaluate the safety of food additives. Its work now also includes the evaluation of contaminants, naturally occurring toxicants and residues of veterinary drugs in food.

ii) Food preservatives to avoid:

Sodium benzoate (E211)*		Carbonated drinks Pickles Sauces Certain medicines (even some "natural and homeopathic" medications for kids)	Aggravates asthma and suspected to be a neurotoxin and carcinogen, may cause fetal abnormalities. Worsens hyperactivity	Food Standards Agency issues revised advice on certain artificial colours, 2007
Sulphur Dioxide (E220)*	Not banned anywhere.	Carbonated drinks Dried fruit Juices Cordials Potato products	May induce gastric irritation, nausea, diarrhea, asthma attacks, skin rashes. Destroys vitamin B1. Causes fetal abnormalities and DNA damage in animals.	International Chemical Safety Card 0074
Sodium metabisulphite		Preservative and antioxidant.	May provoke life threatening asthma	http://www.fedupwithfoodadditives.info/factsheets/Factsafeadditives.htm
Potassium nitrate (E249)	Not banned anywhere	Cured meats and canned meat products.	May lower oxygen carrying capacity of blood; may combine with other substances to form nitrosamines that are carcinogens; may negatively effect the adrenal gland.	International Chemical Safety Card 1069
Calcium benzoate (E213)	Not banned anywhere	Drinks, low-sugar products, cereals, meat products.	May temporarily inhibit digestive enzyme function and may deplete levels of the amino acid glycine. AVOID with allergies, hives, & asthma.	http://www.fedupwithfoodadditives.info/factsheets/Factsafeadditives.htm
Calcium sulphite (E226)	In the U.S., sulphites are banned from many foods, including meat	In a vast array of foods- from burgers to biscuits, from frozen mushrooms to horseradish. Used to make old produce look fresh.	May cause bronchial problems, flushing, low blood pressure, tingling, and anaphylactic shock. Avoid them if you suffer from bronchial asthma, cardiovascular or respiratory problems and emphysema.	http://www.fedupwithfoodadditives.info/factsheets/Factsafeadditives.htm
Butylated Hydroxy-anisole (E320) BHA/BHT		Particularly in fat containing foods, confectionery, meats.	BHA/BHT is may be carcinogenic to humans. BHA also interacts with nitrites to form chemicals known to cause changes in the DNA of cells.	doi:10.1021/jm00191a020
Benzoic acid (E210)		Drinks, low sugar products, cereals, meat products.	May temporarily inhibit digestive enzyme function. May deplete glycine levels. AVOID in asthma, or allergies.	International Chemical Safety Card 0103

Table 2. Food preservatives to avoid

iii) Flavourings & sweeteners to avoid:

Monosodium Gluamate MSG (E621)* **	Not banned anywhere	Processed foods & drinks, soup mixes.	Destroys nerve cells in brain and linked with aggravating or accelerating Huntington's, Alzheimer's and Parkinson's diseases. Causes cancer, DNA damage and fetal abnormalities in animals. Increases hyperactivity.	doi:10.1111/j.1365-2222.2009.03221.x
Aspartame (E951)*	US Air Force pilots are banned from drinking soft drinks containing aspartame.	200 times sweeter than sugar	May cause neurological damage, especially in younger children where brain is still developing. Breaks down in the body to phenylalanine (neurotoxin - may cause seizures), aspartic acid (damages developing brain) and methanol (converts to formaldehyde). Crosses the placental barrier from mother to baby, even in small doses. Implicated in diseases such as MS and Non-Hodgkin's Lymphoma. May contribute to obesity.	FDA Consumer Magazine, 1999
Acesulphame K (E950)*	Not banned anywhere.	200 times sweeter than sugar	Causes cancer in animals. Linked to hypoglycemia, lung tumours, increased cholesterol and leukemia. May contribute to obesity	British Pharmacopoeia Commission Secretariat, 2009
Saccharine (E954)*	Banned in Germany, Spain, Portugal, Hungary, France, Malaysia, Zimbabwe, Fiji, Peru, Israel, Taiwan.	350 times sweeter than sugar	May interfere with blood coagulation, blood sugar levels and digestive function. Causes cancer of the bladder, uterus, ovaries, skin and blood vessels in animals. Linked to DNA damage and congenital abnormalities in animals. May contribute to Obesity.	USDA, 1972
High Fructose Corn Syrup (HFCS)	Not banned anywhere	Carbonated drinks other sweetened drinks (juices) baked goods candies canned fruits jams & jellies dairy products	Obesity Accelerated aging Insulin resistance Diabetes mellitus Complications of diabetes Fatty liver Increased triglycerides Increased uric acid Chronic diarrhea Irritable bowel syndrome Hives	The American Medical Association, 2007

*All of these additives are considered the "Dirty Dozen Food Additives" and are prohibited in the UK for foods marketed for children less than 36 months.

**MSG-intolerant people can develop MSG symptom complex, which is characterized by one or more of the following:

- A burning sensation in the back of the neck, forearms and chest.
- Numbness in the back of the neck, radiating to the arms and back.
- A tingling, warmth and weakness in the face, temples, upper back, neck and arms.
- Facial pressure or tightness, swelling of lips/face
- Chest pain, rapid heartbeat
- Headache, nausea, drowsiness
- Bronchospasm (difficulty breathing) in MSG-intolerant people with asthma.

Table 3. Flavourings & sweeteners to avoid

JECFA has evaluated more than 1500 food additives, approximately 40 contaminants and naturally occurring toxicants, and residues of approximately 90 veterinary drugs. The Committee has also developed principles for the safety assessment of chemicals in food that are consistent with current thinking on risk assessment and take account of recent developments in toxicology and other relevant sciences.

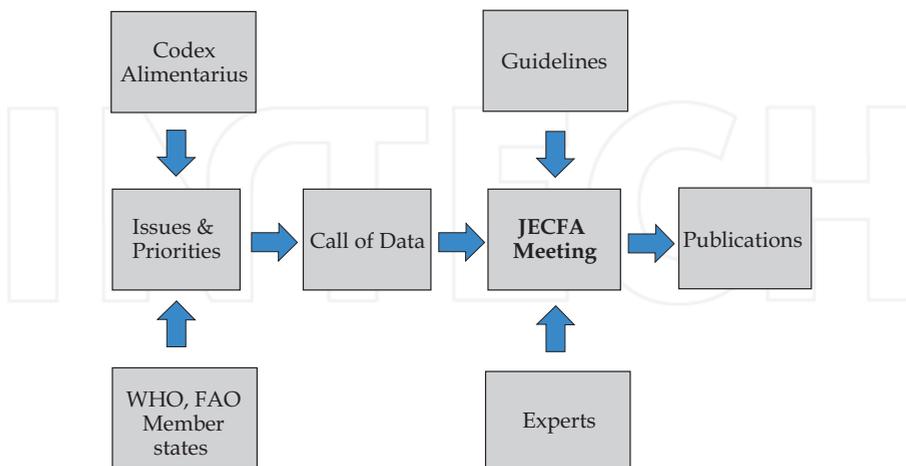


Fig. 3. Showing flow chart which shows the process flow for JECFA

The above flow chart shows the process flow for JECFA.

A brief summary of the purpose, history, and workings of the Joint FAO/WHO Expert Committee on Food Additives.

9. Sites related to JECFA

- JMPR
The Joint FAO/WHO Meeting on Pesticide Residues is the related expert committee for pesticide residues in food. It is responsible for reviewing and evaluating toxicological residue and analytical aspects of the pesticides under consideration.
- Codex Alimentarius
The Codex Alimentarius Commission was created in 1963 by FAO and WHO to develop food standards, guidelines and related texts such as codes of practice under the Joint FAO/WHO Food Standards Programme. The main purposes of this Programme are protecting health of the consumers and ensuring fair trade practices in the food trade, and promoting coordination of all food standards work undertaken by international governmental and non-governmental organizations. Codex standards are based on scientific advice as provided by JECFA and JMPR.

10. General information related to chemical risks in food

Chemicals are the building blocks of life and are important for many, if not all, aspect of human metabolism. However, human exposure to chemicals at toxic levels, as well as

nutritional imbalances, are known or suspected to be involved in causing cancer, cardiovascular disease, kidney and liver dysfunction, hormonal imbalance, reproductive disorders, birth defects, premature births, immune system suppression, musculoskeletal disease, impeded nervous and sensory system development, mental health problems, urogenital disease, old-age dementia, and learning disabilities. Possibly a significant part of these disorders and diseases can be attributed to chemical exposure, and for many (environmental) chemicals food is the main source of human exposure. Consequently, the protection of our diet from these hazards must be considered one of the essential public health functions of any country.

Under the World Trade Organization's Agreement on Sanitary and Phytosanitary Measures, food traded internationally must comply with Codex Standards that are established to protect health of consumers on basis of a sound risk assessment. Such independent international risk assessments are performed by Joint FAO/WHO Expert Committee on Food Additives (JECFA) and Joint FAO/WHO Meeting on Pesticide Residues (JMPR) as well as ad hoc expert meetings to address specific and emerging issues. The experts estimate a safe level of exposure (acceptable or tolerable daily intake ADI, TDI) and estimate the exposure to chemicals from the diet and from specific foods. Such exposure assessments often are based on national data or international data from the WHO Global Environment Monitoring System - Food Contamination Monitoring and Assessment Programme (GEMS/Food).

Based on the risk assessments provided through these expert meetings, the Codex Alimentarius Commission can recommend specific measures, such as maximum limits in foods to assure that exposure do not exceed the acceptable/tolerable level of intake. Other measure can be the development of 'Codes of Practices' to reduce levels of contaminants in food. Also, levels of use for food additives can be recommended or maximum residue levels for pesticides or veterinary drug residues when applied in accordance with good practices. The scientific advice provided through these expert meetings also often serves directly as the basis for national food safety standards.

11. Conclusion

Food additives preserve the freshness and appeal of food between the times it is manufactured and when it finally reaches the market. Additives may also improve nutritional value of foods and improve their taste, texture, consistency or color. All food additives approved for use in the United States are carefully regulated by federal authorities to ensure that foods are safe to eat and are accurately labeled. Food additives have been used by man since earliest times. Today, food and color additives are more strictly regulated than at any time in history. Additives may be incorporated in foods to maintain product consistency, improve or maintain nutritional value, maintain palatability and wholesomeness provide leavening or control acidity/alkalinity, and/or enhance flavor or impart desired color. The Food and Agriculture Organization (FAO), however, recognizes additives as any substance whose intended use will affect, or may reasonably be expected to affect, the characteristics of any food. FAO law prohibits the use of any additive that has been found to cause cancer in humans or animals. To market a new food or color additive, a manufacturer must first petition the FAO for its approval. FAO regulations require evidence

that each substance is safe at its intended levels of use before it may be added to foods. In deciding whether an additive should be approved, the agency considers the composition and properties of the substance, the amount likely to be consumed, its probable long-term effects and various safety factors. Some food additives like boric acid, citric acid and sodium metabisulphite showed mitotoxicity and genotoxicity having potential risks for human health. Thus, all additives are subject to ongoing safety review as scientific understanding and methods of testing continue to improve.

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13. References

- Added use level data, SPET calculations and indication of food categories with highest SPET as used in exposure estimations of flavourings at the 73rd JECFA meeting (2010), Complete Table
- Ashida H., Hashimoto T., Tsuji S., Kanazawa K., Dasno G.I. (2000) Synergistic effects of food colors on the toxicity of 3-amino-1,4-dimethyl-5h-pyrido[4,3-b]indole (Trp-P-1) in primary cultured rat hepatocytes. *Journal of nutritional science and vitaminology* vol. 46, no3, pp. 130-136
- Assessment of technologies for determining cancer risks from the environment. Darby, PA, USA: DIANE publishing. 1981. pp. 177. ISBN 142892437X.
- Bucci, Luke (1995). *Nutrition applied to injury rehabilitation and sports medicine*. Boca Raton: CRC Press. pp. 151. ISBN 0-8493-7913-X.
- Codex Alimentarius. "Class Names and the International Numbering System for Food Additives."
http://www.codexalimentarius.net/download/standards/7/CXG_036e.pdf.
- Evaluation of the carcinogenic hazards of food additives (Fifth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 220, 1961 (out of print).
- Evaluation of the toxicity of a number of antimicrobials and antioxidants (Sixth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 228, 1962 (out of print).
- Evaluation of food additives: specifications for the identity and purity of food additives and their toxicological evaluation: some extraction solvents and certain other substances; and a review of the technological efficacy of some antimicrobial agents. (Fourteenth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 462, 1971 (out of print).
- Evaluation of food additives: some enzymes, modified starches, and certain other substances: Toxicological evaluations and specifications and a review of the technological efficacy of some antioxidants (Fifteenth report of the Joint

- FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 488, 1972.
- Evaluation of certain food additives and the contaminants mercury, lead, and cadmium (Sixteenth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 505, 1972, and corrigendum (out of print).
- Evaluation of certain food additives (Eighteenth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 557, 1974, and corrigendum (out of print).
- Evaluation of certain food additives: some food colours, thickening agents, smoke condensates, and certain other substances. (Nineteenth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 576, 1975 (out of print).
- Evaluation of certain food additives (Twentieth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 599, 1976. English français español
- Evaluation of certain food additives (Twenty-first report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 617, 1978.
- Evaluation of certain food additives and contaminants (Twenty-second report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 631, 1978 (out of print).
- Evaluation of certain food additives (Twenty-third report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 648, 1980, and corrigenda.
- Evaluation of certain food additives (Twenty-fourth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 653, 1980.
- Evaluation of certain food additives (Twenty-fifth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 669, 1981.
- Evaluation of certain food additives and contaminants (Twenty-sixth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 683, 1982.
- Evaluation of certain food additives and contaminants (Twenty-seventh report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 696, 1983, and corrigenda (out of print).
- Evaluation of certain food additives and contaminants (Twenty-eighth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 710, 1984, and corrigendum.
- Evaluation of certain food additives and contaminants (Twenty-ninth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 733, 1986, and corrigendum.
- Evaluation of certain food additives and contaminants (Thirtieth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 751, 1987.
- Evaluation of certain food additives and contaminants (Thirty-first report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 759, 1987, and corrigendum.

- Evaluation of certain veterinary drug residues in food (Thirty-second report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 763, 1988.
- Evaluation of certain food additives and contaminants (Thirty-third report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 776, 1989.
- Evaluation of certain veterinary drug residues in food (Thirty-fourth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 788, 1989.
- Evaluation of certain food additives and contaminants (Thirty-fifth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 789, 1990, and corrigenda.
- Evaluation of certain veterinary drug residues in food (Thirty-sixth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 799, 1990.
- Evaluation of certain food additives and contaminants (Thirty-seventh report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 806, 1991, and corrigenda.
- Evaluation of certain veterinary drug residues in food (Thirty-eighth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 815, 1991.
- Evaluation of certain food additives and naturally occurring toxicants (Thirty-ninth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series No. 828, 1992.
- Evaluation of certain veterinary drug residues in food (Fortieth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 832, 1993.
- Evaluation of certain food additives and contaminants (Forty-first report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 837, 1993.
- Evaluation of certain veterinary drug residues in food (Forty-second report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 851, 1995.
- Evaluation of certain veterinary drug residues in food (Forty-third report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 855, 1995, and corrigendum.
- Evaluation of certain food additives and contaminants (Forty-fourth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 859, 1995.
- Evaluation of certain veterinary drug residues in food (Forty-fifth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 864, 1996.
- Evaluation of certain food additives and contaminants (Forty-sixth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 868, 1997.

- Evaluation of certain veterinary drug residues in food (Forty-seventh report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 876, 1998.
- Evaluation of certain veterinary drug residues in food (Forty-eighth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 879, 1998.
- Evaluation of certain food additives and contaminants (Forty-ninth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 884, 1999.
- Evaluation of certain veterinary drug residues in food (Fiftieth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 888, 1999.
- Evaluation of certain food additives (Fifty-first report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 891, 2000.
- Evaluation of certain veterinary drug residues in food (Fifty-second report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 893, 2000.
- Evaluation of certain food additives and contaminants (Fifty-third report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 896, 2000.
- Evaluation of certain veterinary drug residues in food (Fifty-fourth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 900, 2001.
- Evaluation of certain food additives and contaminants (Fifty-fifth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 901, 2001.
- Evaluation of certain mycotoxins (Fifty-sixth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 906, 2002.
- Evaluation of certain food additives and contaminants (Fifty-seventh report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 909, 2002.
- Evaluation of certain veterinary drug residues in food (Fifty-eighth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 911, 2002.
- Evaluation of certain food additives (Fifty-ninth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 913, 2002.
- Evaluation of certain veterinary drug residues in food (Sixtieth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series No. 918, 2003.
- Evaluation of certain food additives and contaminants (Sixty-first report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 922, 2004.

- Evaluation of certain veterinary drug residues in food (Sixty-second report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 925, 2004.
- Evaluation of certain food additives (Sixty-third report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 928, 2005.
- Evaluation of certain food contaminants (Sixty-fourth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 930, 2006.
- Evaluation of certain food additives (Sixty-fifth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 934, 2006.
- Evaluation of certain veterinary drug residues in food (Sixty-sixth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 939, 2006.
- Evaluation of certain food additives and contaminants (Sixty-seventh report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 940, 2007.
- Evaluation of certain food additives and contaminants (Sixty-eighth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 947, 2007.
- Evaluation of certain food additives (Sixty-ninth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 952, 2009.
- Evaluation of certain veterinary drug residues in food (Seventieth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 954, 2009.
- Evaluation of certain food additives (Seventy-first report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 956, 2010
- Evaluation of certain contaminants in food (Seventy-second report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 959, 2011
- Evaluation of certain food additives and contaminants (Seventy-third report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 960, 2011
- Fennema, Owen R. (1996). Food chemistry. New York, N.Y: Marcel Dekker. pp. 827. ISBN 0-8247-9691-8.
- Fumiyo Sako, Noriko Kobayashi, Hiroyuki Watabe and Naoyuki Taniguchi (1980) Cytotoxicity of food dyes on cultured fetal rat hepatocytes Toxicology and Applied Pharmacology Volume 54, Issue 2, Pages 285-292
- General principles governing the use of food additives (First report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 129, 1957 (out of print).
- International Organization for Standardization. "67.220: Spices and condiments. Food additives".

- Ismael Abdelaziz, Abd El Rahiem, A Ashour (2011) Effect of saccharin on albino rats' blood indices and the therapeutic action of vitamins C and E. *Hum Exp Toxicol* vol. 30 no. 2 129-137)
- Karen Lau, W. Graham McLean, Dominic P. Williams, and C. Vyvyan Howard (2006) Synergistic Interactions between Commonly Used Food Additives in a Developmental Neurotoxicity Test. *TOXICOLOGICAL SCIENCES* 90(1), 178-187
- McCann, D; Barrett, A; Cooper, A; Crumpler, D; Dalen, L; Grimshaw, K; Kitchin, E; Lok, K et al. (2007). "Food additives and hyperactive behaviour in 3-year-old and 8/9-year-old children in the community: a randomised, double-blinded, placebo-controlled trial.". *Lancet* 370 (9598): pp. 1560-7. doi:10.1016/S0140-6736(07)61306-3. PMID 17825405.
- Mukherjee A., K. Agarwal and J. Chakrabarti (1992) Genotoxicity studies of the food additive ester gum. *Food and Chemical Toxicology* Volume 30, Issue 7, Pages 627-630
- Mukherjee A. and J. Chakrabarti (1997) In vivo cytogenetic studies on mice exposed to acesulfame-K – A non-nutritive sweetener. *Food and Chemical Toxicology* Volume 35, Issue 12, Pages 1177-1179
- Mukhopadhyay K M., A. Mukherjee and J. Chakrabarti (2000) In vivo cytogenetic studies on blends of aspartame and acesulfame Food and Chemical Toxicology Volume 38, Issue 1, Pages 75-77
- Nobakht, M., Fattahi, M., Hoormand, M., Milanian, I., Rahbar, N., Mahmoudian (2000) A study on the teratogenic and cytotoxic effects of safflower extract. *M. Journal of Ethnopharmacology* Vol. 73 No. 3 pp. 453-459
- Pandey Ram Milan and Santosh Upadhyay, (2007) Impact of Food Additives on Mitotic Chromosomes of *Vicia faba* L. *CARYOLOGIA* Vol. 60, no. 4: 309-314
- Procedures for the testing of intentional food additives to establish their safety for use (Second report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 144, 1958 (out of print).
- Rev. Lyman Abbott (Ed.) (1900). *The Outlook* (Vol. 64). Outlook Co. pp. 403.
- Serkan Yılmaz, Fatma Ünal, Deniz Yüzbaşıoğlu and Hüseyin Aksoy (2008) Clastogenic effects of food additive citric acid in human peripheral lymphocytes. *Cytotechnology* 56:137-144)
- Specifications for identity and purity of food additives (antimicrobial preservatives and antioxidants) (Third report of the Joint FAO/WHO Expert Committee on Food Additives). These specifications were subsequently revised and published as Specifications for identity and purity of food additives, Vol. I. Antimicrobial preservatives and antioxidants, Rome, Food and Agriculture Organization of the United Nations, 1962 (out of print).
- Specifications for identity and purity of food additives (food colours) (Fourth report of the Joint FAO/WHO Expert Committee on Food Additives). These specifications were subsequently revised and published as Specifications for identity and purity of food additives, Vol. II. Food colours, Rome, Food and Agriculture Organization of the United Nations, 1963 (out of print).

- Specifications for the identity and purity of food additives and their toxicological evaluation: emulsifiers, stabilizers, bleaching and maturing agents (Seventh report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 281, 1964 (out of print). English, pp. 1-100; English, pp. 101-189;
- Specifications for the identity and purity of food additives and their toxicological evaluation: food colours and some antimicrobials and antioxidants (Eighth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 309, 1965 (out of print).
- Specifications for the identity and purity of food additives and their toxicological evaluation: some antimicrobials, antioxidants, emulsifiers, stabilizers, flour-treatment agents, acids, and bases (Ninth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 339, 1966 (out of print).
- Specifications for the identity and purity of food additives and their toxicological evaluation: some emulsifiers and stabilizers and certain other substances (Tenth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 373, 1967 (out of print).
- Specifications for the identity and purity of food additives and their toxicological evaluation: some flavouring substances and non-nutritive sweetening agents (Eleventh report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 383, 1968 (out of print).
- Specifications for the identity and purity of food additives and their toxicological evaluation: some antibiotics (Twelfth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 430, 1969 (out of print).
- Specifications for the identity and purity of food additives and their toxicological evaluation: some food colours, emulsifiers, stabilizers, anticaking agents, and certain other substances (Thirteenth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 445, 1970 (out of print).
- Toxicological evaluation of certain food additives with a review of general principles and of specifications (Seventeenth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 539, 1974, and corrigendum (out of print).
- Turkoglu Si. fa (2009) Genotoxic effects of mono-, di-, and trisodium phosphate on mitotic activity, DNA content, and nuclear volume in *Allium cepa* L. CARYOLOGIA Vol. 62, no. 3: 171-179
- U.S. Food and Drug Administration. (1993). Everything Added to Food in the United States. Boca Raton, FL: C.K. Smoley (c/o CRC Press, Inc.).
- Wansu Park, Mun Seog Chang, Hocheol Kim, Ho Young Choi, Woong Mo Yang, Do Rim Kim, Eun Hwa Park and Seong Kyu Park (2008) Cytotoxic effect of gallic acid on testicular cell lines with increasing H₂O₂ level in GC-1 spg cells. Toxicology in Vitro Volume 22, Issue 1, Pages 159-163

Online References

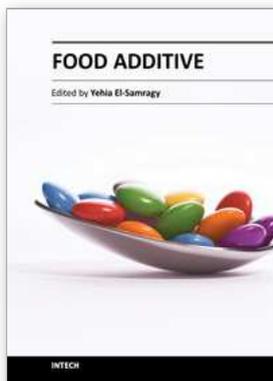
http://www.ncbi.nlm.nih.gov/pubmed/17825405?ordinalpos=7&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DefaultReportPanel.Pubmed_RVDocSum.

<http://www.foodstandards.gov.au/newsroom/publications/choosingtherightstuff/>.

<http://www.webmd.com/diet/features/the-truth-about-seven-common-food-additives>

<http://www.sixwise.com/newsletters/06/04/05/12-dangerous-food-additives-the-dirty-dozen-food-additives-you-really-need-to-be-aware-of.htm>

http://www.iso.org/iso/iso_catalogue/catalogue_ics/catalogue_ics_browse.htm?ICS1=67&ICS2=220.



Food Additive

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A food additive is defined as a substance not normally consumed as a food in itself and not normally used as a characteristic ingredient of food whether or not it has nutritive value. Food additives are natural or manufactured substances, which are added to food to restore colors lost during processing. They provide sweetness, prevent deterioration during storage and guard against food poisoning (preservatives). This book provides a review of traditional and non-traditional food preservation approaches and ingredients used as food additives. It also provides detailed knowledge for the evaluation of the agro-industrial wastes based on their great potential for the production of industrially relevant food additives. Furthermore the assessment of potential reproductive and developmental toxicity perspectives of some newly synthesized food additives on market has been covered. Finally, the identification of the areas relevant for future research has been pointed out indicating that there is more and more information needed to explore the possibility of the implementation of some other materials to be used as food additives.

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