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Food preservative chemistry: Effects and side effects†

Debashree Mandal

Department of Chemistry, Tarakeswar Degree College, Tarakeswar, Hooghly-712 410, West Bengal, India

E-mail: debashree1981@gmail.com

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Food is accumulated by approximately each individual society. But it undergoes spoilage due to microbial, chemical or physical actions. So food storage is important industrially as well as traditional domestic skill also. Every company includes food preservatives to the foodstuff during processing. After adding this additive, the color, texture, flavor display, feel and noise (cackle) etc. of the food remain intact for a long time. Although the food preservatives are useful for food storage, but its effect of their hazards as "slow poisons" will enhance the risk of disease or early death. Food preservative needs to add to the food in little quantity. People should aware of the preservatives, their amount and avoid as much as possible.

Keywords: Food preservatives, natural, chemical, side-effects, E-numbers.

Introduction

Human first discovered fire and then invented how to cook their food and the awareness that salt could result in preservation of that food without cooking. In prehistoric times, the first preservative agent was probably smoke, then salt and further vinegar, honey, oil etc. used by Ancient Egyptians. In ancient Assyria, Greece, and China first used SO_2 (sulfur dioxide) as a fumigant. Biological foods or non biological foods are decomposing due to time, temperature and enzymic action. Not in India but also in abroad for last ten years, the dead biological substances with preservatives have been consumed by people. After adding food preservatives, the color, texture, smell etc. of the food remain intact for a long time. But it has both effects and side effects on human or non-human species. Every manufacturer now adds food preservatives to the food during processing. In the present era, packaged food industry has been serving as one of the fastest growing network. All of we must aware of the food preservatives as well as chemistry of food. Food chemistry is the education of chemical method of all biological and non-biological mechanism of foods. It deals with carbohydrates (empirical formula $C_nH_{2n}O_n$), proteins (composed of amino acids) and lipids (fats, oils, waxes, and cholesterol). Proteins are vital components of food. Every cell needs protein for structure and function. Our body has more or less 20 amino acids among which eight are essential. We cannot produce these amino acids in large amount for growth and repair of our cells, so they must be ingest in our diet from outside. Fat which is obtained from milk related products, eggs, seafood, oils (from plants-nuts, olives and seeds), animal meat acts as a source of energy of the cell.

Food preservatives are mostly considered safe, but several of them have life-threatening side effects[1]. There are certain criteria and quantity for each individual preservative. A chemical additive must satisfy the criteria like nontoxic, readily soluble, must not convey off-flavors when applied at stages effective in scheming microbial growth, exhibit antimicrobial properties over the pH range of each particular food, must be economical and practical to apply. This may cause hyper activity on over usage. There are two types of food preservatives: natural[2] and chemical.

(i) Natural food preservation: Boiling, freezing and refrigeration, pasteurizing, dehydrating, smoking, pickling are the natural ways of preserving food. Customized wrapping method like vacuum packing and hypobaric packing also acts as food preservatives. Sugar, salt, alcohol, vinegar are often applied as food preservatives in bulk amount. Sugar facilitated to stop or slow the growth of bacteria, moulds and yeast in jams. It also helps to make longer the shelf life of many foods by maintaining and stabilising the water content in

†Review.

foods. Salt (NaCl) is one of the earliest preservatives which leads to high osmotic pressure and because of these bacteria cannot survive or reproduce. Ethanol can protect a specimen from bacterial or fungal degradation while at the same time protecting color patterns and external morphology.

(ii) Chemical food preservations: Vinegar (acetic acid-CH_3CO_2H), lactic acid, citric acid (Fig. 1), and their salts applied to food to decrease the pH to levels unfavorable for growth of spoilage organisms and as flavorants. These or-

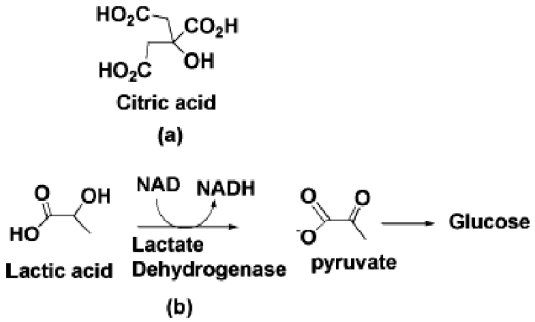

Fig. 1. (a) Structures of citric acid and (b) lactic acid conversion reaction.

ganic acids are most effective against bacterial content and maintaining the nutritional value of the feed as well as improving nutrient digestibility. They are soluble, hygroscopic and have the abilities of buffering and chelation. Lactic acid is the main product of many food fermentations (Fig. 2). Propionic acid (CH_3CH_2COOH) is employed also as inhibitor in bread dough. Its calcium and sodium salts are permitted in breads, cakes, certain cheese, and other foods, primarily as a mold inhibitor.

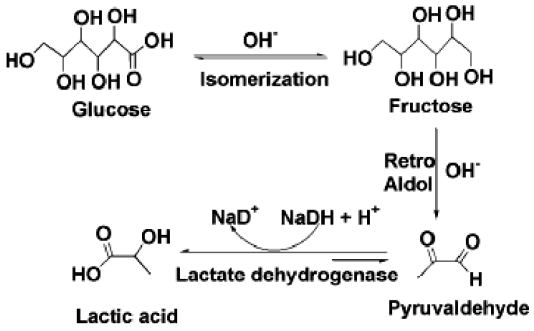

Fig. 2. Fermentation shows lactic acid as end product.

Different chemical food preservatives (Fig. 3) (see also Table 2) can be added to the food or sprayed on the food for the preservation purpose which is described below.

(a) Antimicrobial agents: Benzoic acid (C_6H_5COOH) and sodium benzoate[3] (Fig. 4) are common preservative in acidified foods such as fruit juices, syrups, jams, sauces, jellies, pickles, fruit cocktails, tea, coffee, etc. Benzoic acid is used as antimicrobial agents in edible coatings and fungistatic. Sodium benzoate is used as a preservative hugely in the soft drink, as a result of the demand for high-fructose corn syrup in carbonated beverages. It also applied in pharmaceuticals for preservation purposes and for therapeutic treatment of patients with urea cycle enzymopathies. A new application of sodium benzoate is improving strength and clarity of plastics such as polypropylene. Now-a-days sodium benzoate is acted as a stabilizer in photographic baths/processing[4]. Benzoate contained foods are strictly neglected

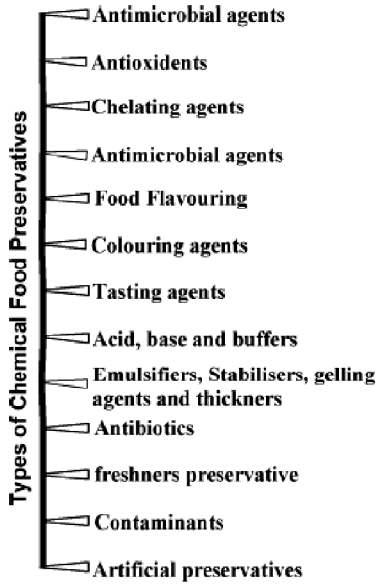

Fig. 3. Types of chemical food preservatives.

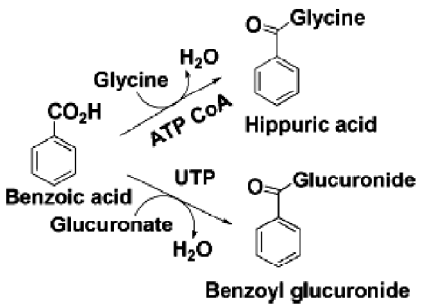

Fig. 4. Metabolism of benzoic acid of humans.

by asthma patients because it degeneration the condition (Fig. 5). It is reported that benzoates can cause brain damage and cancer. Esters of *p*-hydroxybenzoic acid (parabens) used in deodorants, lotions, lipsticks, shampoos, scrubs, and cosmetic industry to prevent bacteria. It has been banned in Russia because of its role in triggering allergies, asthma and skin rashes for reaction with urine[5] (Fig. 6).

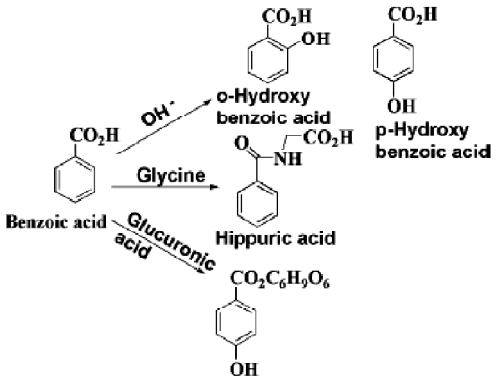

Fig. 5. Breakdown pathways of benzoic acid.

to the body. The salts used for meats because they stabilize red meat color, inhibit a little spoilage and food poisoning organisms and give to flavor improvement.

Sorbic acid (E200) (*trans,trans*-2,4-hexadienoic acid) and its potassium, sodium and calcium salts are used as preservatives in a wide range of foods, such as cheese, pickles, sauces, vegetables, fruit juices, pickles, sauerkraut, syrups, jellies, jams, preserves, high moisture dehydrated fruits, in medicines, cosmetics and wine. It has proposed as a partial replacement for nitrite in meat curing as it inhibits *Clostridium botulinum* growth and yeasts and has antibacterial activity. But in presence of nitrite, it reacts to yield certain mutagenic products. The main mutagens seem to be 1,4-dinitro-2-methylpyrrole (NMP) and ethylnitrolic acid (ENA)[7] (Fig. 8). It prolongs the shelf life of foods by stopping the growth of mold, yeast and fungi. It can cause urticarial and contact dermatitis in some cases.

In general cut fruits and vegetables are dipped in a solution of sulphites. Sulphur dioxide (SO_2)(E220) and sodium and potassium salts of sulfite (SO_3^{2-}), bisulfate (HSO_3^-) and

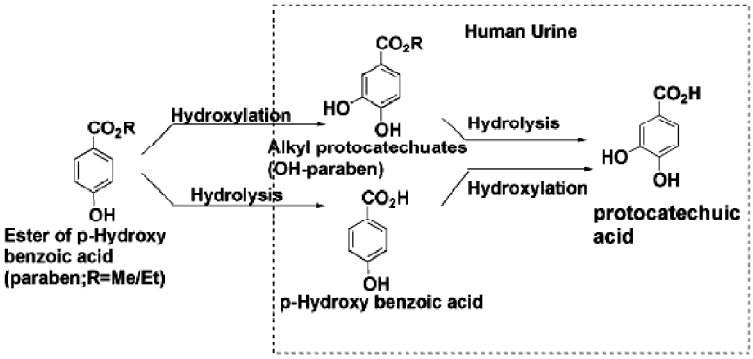

Fig. 6. Reaction of parabens with human urine on exposure.

Sodium nitrate ($NaNO_3$) and sodium nitrite ($NaNO_2$) are commonly used as preservative for meat products, which gets readily converted into nitrous acid (3HONO) under acidic conditions (e.g. in the human stomach) which further decomposes to yield nitric oxide (NO), when react with hemoglobin to produce met-hemoglobin (Fig. 7) or nitrosamines, a powerful carcinogens that can cause loss of consciousness and death, especially in infants and is suspected of stomach cancer for living system[6]. Nitrosamines reduce *Clostridium botulinum* growth. The above Na-salts can also interfere with the thyroid, as well as with the blood's ability to transport oxygen

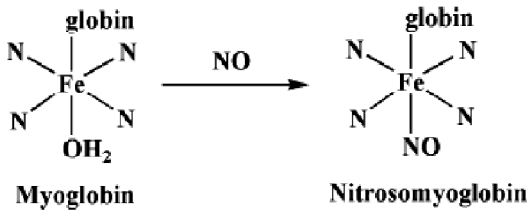

Fig. 7. Effect of $NaNO_3$/$NaNO_2$ in myoglobin.

metabisulfite ($S_2O_5^{2-}$) conserve colour, act as antioxidants, control microbial growth. Because of the above cause, it

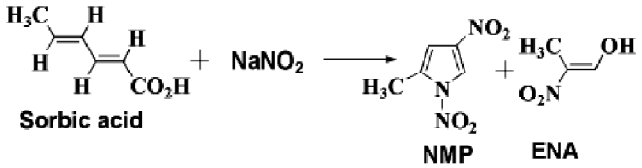

Fig. 8. Reaction of sorbic acid with $NaNO_2$.

maintains the appearance of fruits and prevents rotting. It is used for dried fruits as an antibrowning agent. The main reason for the reactivity of sulfites with food is the nucleophilicity of the sulfite ion (SO_3^{2-}). It has been found that uracil undergoes a facile addition of bisulfate (Fig. 9). The S=S bond of free cystine can be cut by sulfites leading to the formation of thiol and sulfonates. It has a particular attraction for reactions with aldehydes and ketones of reducing sugar. The sulfonated carbonyls formed by reaction of sulfites with unsaturated carbonyl are stable and their formation is very fast and irreversible. Acetaldehyde is the primary sulfite reactive substance in wines and ciders and converted to acetaldehyde hydroxysulfonate which is stable. D-Glucose may react irreversibly with sulfites to form a stable sulfonic acid derivative. Sulfites can react with a broad range of vitamins including thiamine (Vitamin B_1), ascorbic acid (Vitamin C), folic acid (Vitamin B_9), cobalamin (Vitamin B_{12}) and Vitamin K destroying β-carotene, a precursor of vitamin. Thiamine in foods is inactivated by sulfating agents. Sulfites can induce oxidation of unsaturated fatty acids. Anthocyanins and phenols that are present as pigments in wines can react with sulfites forming colourless anthocynin-4-bisulfites[8]. A major problem with this preservative is that its measured concentration falls with time as a outcome of reactions with food components and as a result of autoxidation after packaged foods are opened and exposed to air. Samples must be analyzed without delay and exposure to air minimized[9]. Asthmatics (~5–11%) are sensitive to sulphates and experience symptoms such as headaches, nausea, abdominal pains and dizziness.

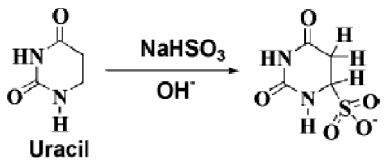

Fig. 9. Formation of β-D-ribofuranosyl from uracil.

Any of the above antimicrobial agents are not permitted in the baby food.

(b) Antioxidants: Chemicals that prevent oxidation where food is spoiled by reacting oxygen are known as antioxidants. Oxidation causes them to turn rancid in order to discoloring and unpleasant tastes like metallic or sulfurous. Antioxidants work as free radical scavengers (Fig. 10). It prevents the browning of cut fruit, vegetables and fruit juices. Vitamin C (E300) is one of the most widely used antioxidant. Vitamin E (α-tocopherol), Vitamin C (Fig. 10), pine bark extract, grape seed extract and apple extract tea are all natural antioxidant. Natural vegetable oils are not readily oxidized due to the

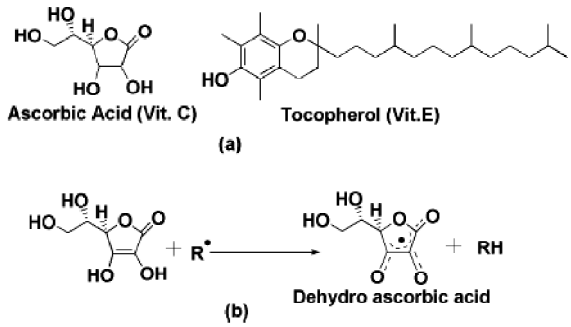

Fig. 10. (a) Structure of Vitamin C and Vitamin E. (b) Formation of dehydro ascorbic acid by radical mechanism.

presence of Vitamin E. During refining processes, this vitamin may be removed from oils; and therefore, refined vegetable oils can become unstable toward oxidation. Butylated hydroxyl toluene (BHT)(E321), butylated hydroxyl anisole (BHA)(E320) (Fig. 11) are the common chemical antioxidant which used in fruits, dried fruits, canned olives, peppers, corn syrup, cornstarch, wine vinegar, butter, meats, cereals, chewing gum, baked goods, snacks, beer, animal feed, food packaging, cosmetics, rubber products, petroleum products, cosmetics and pharmaceuticals. BHA is generally used to maintain fats from becoming rancid and as a yeast de-foaming agent. Oxygen reacts preferentially with BHA or BHT rather than oxidizing fats or oils, thereby protecting them from spoilage (Fig. 11) and therefore, maintains food odor, color and flavor. The side effects arise in form of headaches, joint pain, heart palpitations, allergies, behavior changes and cancer. The oxidative chemistry of BHA and BHT may give to carcinogenicity/tumorigenicity. Yet, BHA and BHT have antiviral

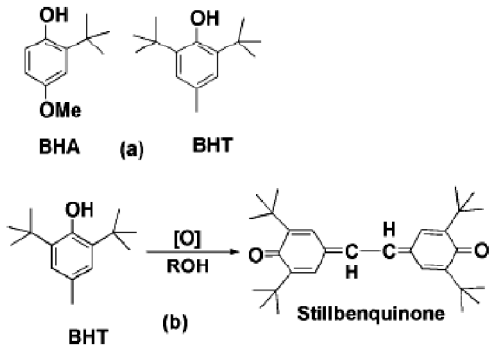

Fig. 11. (a) Structure of BHA and BHT. (b) Oxidation chemistry of BHT.

and antimicrobial activities. Research is going on the use of BHT in the treatment of herpes and AIDS.

Sodium erythorbate, sodium diacetate, sodium succinate, sodium dehydro acetate, duccinic acid, erythorbic acid and proplyphenols etc. are also used as antioxidant.

(c) Chelating agent: Chelating agents works on enzymes and interrupt their metabolism leading to the preservation. Disodium ethylenediaminetetraacetic acid (EDTA), is commonly used for packaged foods. EDTA is thought to have several mechanisms in dealing with coronary heart disease, including binding to calcium as an element in atheromatous plaques (Fig. 12), as an antioxidant to prevent lipid oxidation, reduce iron reserves in the body, and arterial[10]. Though use in a lot of food products and cosmetics it is known to cause asthma problems and kidney damage[11]. Besides EDTA, polyphosphates, citric acid and ascorbic acid also acts as chelating agents.

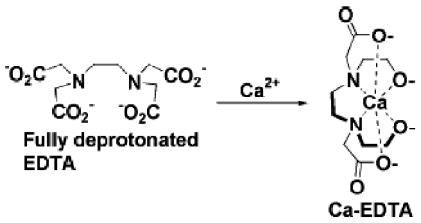

Fig. 12. Formation of Ca-EDTA cmplex.

(d) Food flavorings: Food flavours always boost the acceptability of food. Monosodium glutamate (MSG), disodium guanylate, disodium inosinate is one of the most dangerous chemicals which are used for artificial food flavour enhancers in salad dressings and spices. MSG (E612) is usually mixed to processed foods like soups, sauces, noodles and sausages. It produces the potential toxicity of a quantity of free glutamate ingested at once. It became controversial because of its association with the so-called Chinese restaurant syndrome. Symptoms of this syndrome are headache and drowsiness. Because of these concerns, both the acute and chronic toxicity of MSG (Fig. 13) have been widely studied. It does not create any risk of lasting injury.

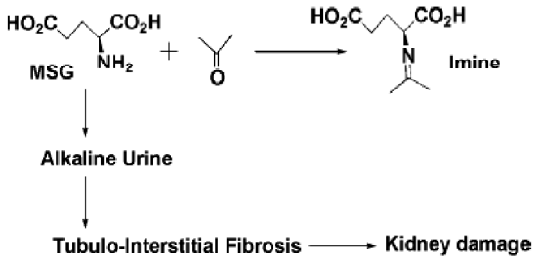

Fig. 13. Formation of imine from MSG.

Esters C pentylacetate is responsible for banana flavour, aldehyde like benzylaldehyde with cherry flavor. All these are known to cause kidney stones, nausea, headaches, obesity and burning sensations in the stomach.

(e) Colouring agents: Colors are added in the product for children. It is added to carbonated beverages, soft drinks, sweets, ice cream, spices, vegetables, cosmetics, candies, pastries, pharmaceutical preparations, frozen desserts, some dairy products, baked products etc. because this preservative restores colour lost during storage. It gives colour to foods which otherwise would be colourless (e.g. soft drinks) and so make them more attractive. Consumers decline orange juice or any fresh ripe fruit and vegetables unless it is strongly colored, even if it is identical in taste and nutritional value. The natural colors of many foods are unstable in heat or oxidation. Thus storage/processing can lead to variations in color even when the nutritional value remains unchanged. The use of food colors can resolve the problem for retailers and manufacturers. Then attention has given to -N=N- (azo group) of dye. Two kinds of azo dye presents, those which are water-soluble and those which are not. Water-soluble azo dyes are less toxic because they are more readily excreted from the body and can be reduced to form the toxic amino group ($-NH_2$), in the body in conjunction with the ac-

tion of microorganisms such as *Streptococcus, Bacillus pyocyaneus* and *Proteus sp*.

Copper sulphate used for colouring peas. Aniline dyes are almost without exception, alone used. Tartrazine (E102), (5-hydroxyl-1-(*p*-sulfophenyl)-4-(*p* sulfophenylazo)pyrazole-3-carboxylic acid) (Fig. 14) is widely used as colourant for yellow food in smoked fish, chewing gum, sweets, beverages, and canned fruit preserves which may cause allergic reactions and asthmatic attacks and has been implicated in ADHD in children. Sunset yellow (E110) (4-dimethylamino-azobenzene) dye was used to color butter and margarine yellow, hence its name "butter yellow". Quinoline yellow (E104) enhance the yellowness of a custard, dairy product like butter, cheese. Red dye 40; *p*-cresidine is assumed to

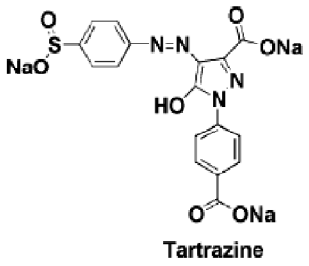

Fig. 14. Structure of tartrazine.

source assured birth defects and possibly cancer. Caramel or carmoisine (E122); 4-methyl-imidazole is a renowned flavoring and coloring agent that can basis of Vitamin B_6 deficiencies. It is also the reason of certain genetic defects and even cancer[12]. Many synthetic coloring agents are toxic and carcinogenic if it is used in enough quantity. Caramel gives a light brown color but it contains carcinogenic benzo[*a*]pyrene in small quantity. Curcumin, gives the yellow color to curry and toxic 15 times higher than tartrazine. Natural coloring agent is not safe for all time.

According to Food and Cosmetics (FD&C) colour naming method, different numbers are used to recognize several colours (Table 1). Red 3 is carcinogenic, banned from cosmetics, externally applied drugs and lakes. Colourings are carcinogen and therefore it is not permitted in fresh nonveg/veg or baby food.

(f) Tasting agents: Aspartame (E951) sweetener is used in snacks, sweets, alcohol, desserts, diet foods, diet soft drinks. Non nutritive sweeteners, such as saccharin (E954)

Table 1. FD and C designation of color

FD and C designation	Name	Molecular formula
Blue no. 1	Brilliant blue FCF	$C_{37}H_{34}N_2Na_2O_9S_3$
Blue no. 2	Indigotine	$C_{16}H_8N_2Na_2O_8S_2$
Green no. 3	Fast green FCF (Turquoise)	$C_{37}H_{34}N_2Na_2O_{10}S_3$
Red no. 3	Erythrosine (Pink)	$C_{20}H_6I_4Na_2O_5$
Red no. 40	Allura red AC	$C_{18}H_{14}N_2Na_2O_8S_2$
Yellow no. 5	Tartrazine (Yellow)	$C_{16}H_9N_4Na_3O_9S_2$
Yellow no. 6	Sunset yellow FCF (Orange)	$C_{16}H_{10}N_2Na_2O_7S_2$

do not provide calories because they are not metabolized. Bulk sweeteners like sorbitol, have a similar sweetness to sugar and are used at similar levels in diabatic food named as sugar free. Recently, these non-nutritive sweeteners received much attention as ingredients in diet soft drinks. The sweeteners supply sweetened foods for diabetics who must limit sugar intake, for those who wish to limit carbohydrate calorie intake, and for those who desire to reduce food-induced dental caries. Saccharin (Fig. 15) is a health hazard and it may cause cancer with overdose. Mannitol (E965) is also used for same purpose (sugar free) but only in chewing gum and ice cream. Current news illustrates the possibility of headaches, blindness, and seizures with continuing high doses of aspartame. Fructose is natural sweetner, permits a smaller amount is to be added especially in the manufacture of soft drinkers.

Fig. 15. Structure of sachharin.

Lipids are added to food for flavor, to cook foods and to improve the texture of foods.

(g) Acid, bases and buffers: Acids, bases and buffers control the acidity or alkalinity of food, for safety and stability of flavour.

(h) Emulsifiers: Emulsifiers permit molecule that are mutually antagonistic (water and oil) to mix together e.g. Leci-

thins (E322) which is most used emulsifiers found naturally in milk, eggs and soybeans and in making mayonnaise, ice cream etc. Emulsifiers and stabilisers both can develop the texture, amount and shape of baked goods by keeping an even allotment of ingredients. Stabilisers prevent ingredients from separating again, e.g. locust bean gum (E410). Thickeners help give food body, example can be found in most sauces.

(i) Antibiotics: Antibiotics are secondary metabolites produced by microorganisms that slow down or damage a wide spectrum of other microorganisms. *Streptomyces* is the most useful bacteria. Three antibiotics have been explored widely as temperature add-on for canned foods: subtilin, tylosin, and nisin. Nisin peptide is an alternate food preservative which is prepared during the food fermentation by *Lactococcu lactis*. It is used for killing bacteria by binding to the cell membrane of bacteria and poking holes in the cell. It is used most widely in cheeses. Chlortetracycline and oxytetracycline were widely studied for their application to fresh foods, whereas natamycin is employed as a food fungistat. Irregular intake of antibiotics build up resistance to antibiotics and new allergies may develop.

(j) Fresheners preservative: Sulfur is used to keep dried fruit fresh. Formaldehyde is used to disinfect frozen vegetables. Maleic hydrazine potatoes are coated with this chemical inhibitor because of their bad habit of sprouting, which has resulted in cancer in laboratory animals. Propylene glycol is used in making ice-cream, the same is used in antifreeze and paint remover. Carboxymethyl cellulose is a stabilizer, used in ice cream, salad dressing, cheese spreads and chocolate milk, has produced tumors in 80% of rats injected.

(k) Contaminants: Substances that enter food unintentionally or illegally at various stages of production which may cause harm.

(1) Heavy metals: It arises from soil, water, containers cooking equipment e.g. lead, cadmium etc.

Lead is used for glazing pottery. It may create stomach cramps, liver damage, kidney damage, immune and nervous system damage.

Mercury cumulates in fish and sea food. It is also can be found in food, fertilized with mercury-organic pesticides.

Cadmium is used as a part of some fertilizers and so is found in plants, some sea creatures accumulate it in great amount.

Copper and zinc are acute carcinogen because they get in the organism if the food has been stored in containers which made of Cu/Zn.

(2) Pesticides: It is used in agriculture to prevent damage to crops. They include insecticides, herbicides, and fungicides. It may occur respiratory problems, heart and circulatory problems, damage to nervous system and even cancer.

(3) Plastic containing food: Plastic chemicals (BPA, thalates etc.) from packaging are very much used now-a-days. Phthalates is seen in plastic packaging, inflatable toys, nail polish, hairsprays, lotions, fragrances. It interferes with male genital development, and also increases the risk of obesity and cardiovascular disease, may cause problems with the immune system and nervous system.

Formaldehyde is used from treated paper packaging.

(l) Artificial preservatives: Now-a-days, the use of high hydrostatic pressures or voltage pulses to inactivate microorganisms in food. Ultrasonic radiation and nuclear radiation is also being used.

Hydrogen peroxide (H_2O_2) has been applied in the dairy industry as a substitute for heat pasteurization in the treatment of milk. It also used as bleaching agent, as a preservative for fish-paste products in Japan.

Perfluoroalkyl chemicals (PFCs) are usually seen in grease-proof paper, cardboard packaging, water-repellent fabric, nonstick pans. It leads to low-birth weight babies, problems with the immune system, the thyroid and fertility.

Perchlorate is also interfering with thyroid function and can disrupt early brain development. In some dry food packaging to decrease static electricity perchlorate is used.

Anti-caking agents (magnesium carbonate) mixed in dried milk/table salt to prevent lump. Anti-foaming agents prevent or disperse frothing, e.g. in the production of fruit juices.

Advantage vs disadvantage of food preservatives

Advantage: Preservatives increase shelf life of food, reduces the risk of food poisoning, prevents wasting of food, makes food more appetising by colouring, improves the taste by flavouring and the texture by pinch amount addition, in-

creases nutritive value, provides wider variety of foods, ensures consistency of food quality.

Disadvantage: Different types of allergies may occur like migraine, hyperactivity, rashes etc. Bulking agents can deceive consumers. Some additives destroy nutrients e.g. sulphur dioxide destroys vit. B12. sweetners can leave bitter after taste e.g. saccharine.

Solution to avoid food preservatives

(a) We shall buy and serve organic fruits and vegetables in season.

(b) We should avoid microwaving food or beverages in plastic containers because heat can cause plastics to leak BPA and phthalates into food.

Table 2. Summary of some (GRAS)[a] chemical food preservatives

Preservatives	Maximum tolerance	Foods
Propionic acid propionates	0.32%	Bread, cakes, some cheeses, rope inhibitor in bread dough
Sorbic acid, sorbates	0.2%	Hard cheeses, figs, syrups, salad dressings, jellies, cakes
Benzoic acid/ benzoates	0.1%	Margarine, pickle relishes, apple cider, soft drinks, tomato catsup, salad dressings
Parabens	0.1%	Bakery products, soft drinks, pickles, salad dressings, lipsticks
SO_2/sulfites	200–300 ppm	Dehydrated fruits, wine making, lemon juice
Ethylene/propylene 700 ppm yeasts, molds, vermin oxides	700 ppm	Fumigant for spices, nuts
Sodium diacetate	0.32%	Bread
Nisin	1%	Certain pasteurized cheese spread
Dehydroacetic acid	65 ppm	Pesticide on strawberries, squash
Sodium nitrite	120 ppm	Meat-curing preparations
Ethyl formate	15–200 ppm	Dried fruits, nuts
Red lead and mercury sulphide		Red cheese
Red lead		Cayenne pepper
Copper salts		Pickles
Sulphuric acid contained tin and lead		Vinegar

[a]GRAS (Generally recognized as safe) per section 201(32)(s) of the U.S. Federal Food, Drug and Cosmetic Act as amended.

(c) Use more glass and stainless steel instead of plastic.

(d) We should avoid plastics with the numbers 3, 6 and 7 on them.

(e) We should avoid food dyes, plastic containers, non-stick pans which is made of perfluorooctanoic acid (PFOA), a carcinogenic chemical. It emits toxic fumes when cooking starts on it.

(f) We shall cut back on canned foods, fast food, processed foods and beverages in general.

(h) We shall buy foods from reputable sources and read the labels where it has written what is in the product you use such as expiry date, ingredient list, calorie etc.

(i) We should buy lotions, creams, soaps and other products that are made naturally and are fragrance-free.

How we can reduce the level of exposure from food additives?

(i) A large number of chemicals food preservatives are allowed to use safe in food products, according to Food and Drug Administration (FDA), an agency of the United States Department of Health and Human Services. In India food safety is taken care by Food Safety and Standards Authority of India (FSSAI). The FDA's Website provides a list of approved preservatives in food products. Those chemical preservatives generally recognized as safe (GRAS) are summarized in Table 3.

To inform consumers, each additive is assigned a specific number, termed as "E-number", which is used in India

Table 3. E-Numbers of food preservatives

E 100-199 Colours	(100-109) yellow; (110-119) orange; (120-129) red; (130-139) blue and violets; 140-149 green; (150-159) brown and black; (160-199) gold
E 200-290 preservatives	(E200) sorbic acid; (E201, E202 and E203, respec tively) sodium, potassium and calcium sorbic acid salts; 210-219 benzoates; (E221-E226 and 224-229) sulphite salts ; 230-239 phenols and formates (methanoates); fungicides used for treatments of citrus fruit surface: (E230) diphenyl; (E231) orthophenylphenol; (E232) sodium salt of orthophenylphenol; (E242) dimethyldicarbonate; (E240-E259) nitrates and nitites; (E249) potassium nitrite; (E250) sodium nitrite; (E251) sodium nitrate; (E52) potassium nitrate; (260-269) acetates (ethanoates); (270-279) lactates; (280-283) propionates (propanoates); (E284) boric acid; (E285) borax
290-299 pH regulators preservatives	(E330) citric acid; (E320) BHA and BHT

Table-3 (contd.)

E 500-599 anti-caking agents	(500-509) mineral acids and bases; (510-519) chlorides and sulphates; 520-529 sulphates and hydroxides; (E221-E226 and 224-229) sodium and potassium salts of sulfite, bisulfate, and metabisulfite (530-549) alkali metal compounds; 550-559 silicates; (570-579) stearates and gluconates; (580-599) substitutes of sulphites; (E586) 4-hexylresorcinol ($C_{12}H_{18}O_2$)
Anti-oxidants	(E300-E305) ascorbates; (E306-E309) tocopherols; (E310-E319) erythorbates; (E320-E329) lactates; (E340-E349) phosphates; (E360-E369) succinates are all effectively used as anti-oxidants for food and beverages; (E301) ascorbic acid
E 600-699 Flavour enhancers	(620-629) glutamates; (MSG/E621) monosodium glutamate; (630-639) inosinates
E 700-799 Antibiotics	(E234) nisin; (E235) natamycin
E 900-999 Miscellaneous	(900-909) waxes; (910-919) synthetic glazes; (920-929) improving agents; (930-949) packaging gases; (950-969) sweeteners; (990-999) foaming agents
E 1100-1599: Additional chemicals	New chemicals that do not fall into standard classification schemes (E1105) lysozyme

(ii) Asthma patients may feel uncomfortable due to some food preservatives like sulphur dioxide and must be aware in choosing food. Medical opinion is necessary when required.

(iii) In 2017 FDA banned BPA (bispheol A)[14] (Fig. 16) which may cause cancer in people, banned the use of some phthalates in child-care product, soda cans, plastics with the number 3 or 7.

(iv) FSSAI recently banned plastic and newspaper in food packaging, stapler pins in tea bags, carbide for artificial ripening of the fruits, 'non-veg' silver leaf in Indian desserts, toluene printing in food packages, business-listing of unregistered FBOs (Food Business Operators) on e-commerce sites, health supplements as medicines. The Kinder surprise, a little colourful egg case is banned in America. Asprin which is a non-steroidal anti-inflammatory drug is used to reduce pain, was banned in 2002 by the US Government drug safety body for children under sixteen year old. A side effect of Disprin was found to cause a rare condition that causes swelling of the liver and brain.

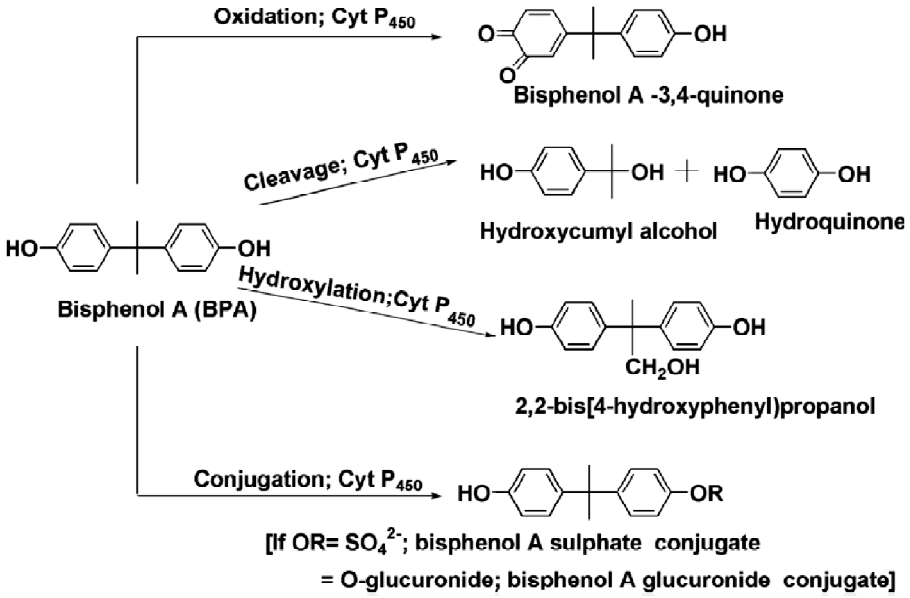

Fig. 16. Conversion of BPA.

as well as in abroad for all approved additives[13]. Europe uses only the numbers not the E-prefix. If anybody finds the label disorder by comparing FDA food product approved preservatives list, a legal step can be taken. People can lodge complains through Website also.

Conclusion

Preservatives are used to keep the quality of food for longer time though it has side effects. The smallest amount of additive should be used that will produce the desired effect under good manufacturing practices. The reaction of

preservatives can be very mild to life-frightening. It is greatest to eat a preservative-free diet if at all possible. Government agencies and medical associations provide dietary recommendations to help patients manage some chronic conditions. With time and growing demands, preservation techniques have been improved and modernized. Irradiation, high pressure food preservation, and pulsed electric field effect are the latest innovations used to increase the life of foods. More research is needed to better understand how artificial food colours impacted on child's behaviour (Attention-deficit/hyperactivity disorder) (ADHD). Although there are certain risks in use of preservatives but its contributions to food industry can't be ignored.

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