



Review

## A mini review on food preservatives

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### Abstract

Food additives are not recently discovered, humans used food additives from ancient times. These food additives enhance the color and taste of food but also, kill harmful pathogens and keep food safe for a long time. Ancient people used salting, smoking, jugging and many more techniques to preserve food but in modern times, lifestyles changed, and people used advanced techniques like ultra-sonication, vacuum packing, electro plasmolysis, bio preservation, nanotechnology, etc. There are many natural compounds extracted from plants like caffeine, anthocyanin, turmeric, saffron used as food additives. Similarly, many synthetic additives can be used in food for example ampicillin, benzoic acid, tetrazine and many more. These synthetic additives are more dangerous as compared to natural additives; therefore, many additives are banned in the world. These additives are given E codes (European union numbers) and INS (International numbering system of food), but E code is used more commonly and labelled on all food items like chips, biscuit, pharmaceuticals, cosmetics etc. In this review, we summarize some traditional and modern food preservation techniques and give some most commonly used food additives with E codes.

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**Introduction:** Food is a basic need for all living organisms, gives energy and strength, promotes growth and maintains stability. Food is a complex mixture of carbohydrates, fat, protein, vitamins and minerals. Food Shelf-life of food is limited due to chemicals, environmental and microbial effects that cause the decomposition or oxidation of food. To improve food's shelf-life several natural or synthetic chemicals are used known as preservatives, are added during the process of food storage and transportation. These are added to fruits, vegetables, cosmetics, prepared food and pharmaceuticals to increase their life by delaying degradation caused by microbes, enzymes, additives as well as chemicals used. Synthetic preservative additives are commonly used in food. However, in recent years, synthetic preservatives are not preferred by consumers due to adverse side effects. Therefore, the use of natural preservatives is increasing day-by-day. Food preservation has been used since ancient times but is a common, well-known and widely used technique nowadays. Sun drying is the oldest technique that was used for food preservation, especially for meat and fruits. Around 5000 BC Babylonians used vinegar for food preservation while ancient Egyptians used salt for fish and meat preservation. Honey was used to preserve food by the early Greeks and Romans. Netherlands people used fire in large chimneys for food preservation. Indian used pickling and boiling techniques for meat, cucumber, eggs, fish, fruits and vegetable preservation. These techniques were modified with time like in ancient days' sun radiations were used for drying but now we use ovens and dryers, similarly, fermentation, freezing, canning and curing are the old techniques with modifications <sup>[1]</sup>. Today, for food preservation a lot of techniques are used traditionally as well as modern techniques. These techniques are summarized for better understanding.

**Traditional or Old Techniques:** Each culture preserves food using basic local or traditional techniques. Some widely used traditional techniques are listed below.

**Boiling:** Boiling is the oldest traditional technique for food preservation. Liquids boil that kills all microorganisms and blocks enzymatic activities present in them <sup>[2]</sup>.

**Drying or dehydration:** Drying in sunlight is one of the oldest techniques for meat, fish, grains, plants and vegetables. Sunlight kills the insects, evaporates water and removes moisture to stop the growth of microorganisms <sup>[3,4]</sup>.

**Salting:** Salting reduced the water content, dehydrates the food and is the most common technique used for meat, fish or foods containing high contents of water <sup>[5]</sup>.

**Sugaring or crystallization:** Sugaring is not only used as a food preservative but also to enhance flavor and texture. Fruits like apples, peaches, apricots, blueberries, and citrus foods are preserved by dipping them in concentrated sugar solution or fruit syrup. Sugar provides hypertonic media and draws water from microorganisms. Honey and table sugar are the most common dehydrating reagents while jam and jellies are most common examples <sup>[6]</sup>.

**Pickling:** The process in which food is preserved in a highly acidic solution like vinegar is known as pickling. This method is commonly used for vegetables like olives, garlic, mango, carrot, green chili, onion, lemon, seafood, eggs and animal products. The acidic solution stores the food for several years and enhances the taste, color and texture of food. Instead of vinegar, salt solution, alcohol, beer and wine can also be used for pickling but these cause a sour taste <sup>[7,8]</sup>.

**Banking or Cooling:** Banking is the oldest technique used in ancient Egypt to preserve meat. Food was preserved in deep holes' diggers in the ground, the holes were lined inside with wood, weeds, straws or leaves to make a barrier between the food and the ground. The low temperature of the ground helps to eliminate the growth of microorganisms <sup>[9]</sup>.

**Smoking:** Initially, smoking was used to preserve food and enhance its flavor and aroma. Meat or fish are sometimes dipped in salt solution and hung near the fire, where fire slowly evaporates water, kills microorganisms, stops chemical reactions and preserves food. Rather, this technique was used to enhance the aroma of green chili, lemon, carrots, olives and tomato <sup>[10]</sup>.

**Canning:** Canning was first time introduced in the 1790s that involve the heating and cooling of food in jars or cans. Heating kills the microorganisms while cooling seals the cans by creating a vacuum to prevent the growth of microorganisms <sup>[11]</sup>.

**Freezing:** In the area where the temperature was very low, the freezing technique was used to preserve the food items. Low temperature blocks the growth of microorganisms by decreasing the chemical and enzymatic reactions of food <sup>[12]</sup>.

**Fermenting:** Fermentation was used around 10,000 BEC for milk from sheep, camel, cows and goats to form yogurt. This fermentation process protects food from spoilage and kills harmful pathogens. During fermentation small amount of acid or alcohol was produced that increased the nutritional value of food <sup>[13,14]</sup>. Currently, this technique is used for cheese production.

**Jugging or Potting:** Jugging was the most common method till the 20<sup>th</sup> century for meat, fish, animals, and pork. Food was stored in sealed earthenware jugs that absorb water, the jug was filled with brine, red wine, or animal blood. Due to low temperatures and lack of oxygen the food can easily be stored for many months <sup>[15,16]</sup>.

**Modern techniques for food preservation:** In recent years, many preservation techniques were developed by modification of traditional techniques to kill pathogens, prevent enzymatic and chemical activities. Such techniques were developed which enhance the flavor and color without losing the original shape. Some of the commonly used techniques are listed here.

**Pasteurization:** The basic principle of pasteurization is heating to kill microorganisms, bacteria, yeast and molds but here food is heated below 100°C and immediately cooled at 4°C. This process is widely used nowadays for milk, vegetables, nuts, juices, eggs and baby foods <sup>[1,17]</sup>. Pasteurization was first time introduced by Louis Pasteur in 1862 for preserving beer and wine <sup>[18,19]</sup>. The efficiency of this technique increases with an increase in temperature, high temperature is used to preserve milk, juices, vegetables and shakes but extra heat can damage food, therefore it is classified into different methods like ultrahigh temperature (UHT) and high-temperature short time (HTST).

**Vacuum packing:** Vacuum packing is the modified version of jugging. Food is stored in tight air bags or jars where a vacuum is created by removing air before sealing. This technique is used to store potato chips, nuts, canned foods and packet foods. Food items can be stored easily for up to 24 months or more without damaging food quality <sup>[20]</sup>.

**Pulsed Electric Field Technology or Electropulsation:** It is a non-thermal preservation technique used for juices, milk, vegetables, olives, smoothie, wine, potatoes, liquid foods, and

semi-solid foods since 1975. In this technique, short electric pulses are used for microbial inactivation<sup>[1,21]</sup>.

**High pressure freezing:** High pressure freezing (HPF) is supposed to be a better method for food preservation on a large scale especially used in food industries and was introduced in 1985. Conventional freezing leads large-sized ice crystals to slow the freezing rate and sometimes cause degradation but freezing at very high pressure prevents degradation by the formation of small-sized ice crystals. The food item freezes until pressure is released, and food comes to its original form, texture and flavor without damaging its structure<sup>[22,23]</sup>

**Ultrasonication:** Ultrasonication is a non-thermal, very effective and eco-friendly technique, used to preserve food at very high scale. Ultrasound waves create an antimicrobial effect in food that inactivate microorganisms and enzyme and also prevent food from degrading<sup>[24-26]</sup>

**Ozone treatment:** Since 1997, gaseous ozone sanitizes and preserves all kinds of vegetables while liquid ozone is used to disinfect and increase shelf life of food items<sup>[27]</sup>.

**Nanotechnology:** Nanotechnology eliminates toxin chemicals, improves food taste, increases shelf life, detects bacteria at the packing stage and enhances food color without damaging food<sup>[28-30]</sup>.

**Bio preservation:** Bio preservation is the modern technique used to preserve food and increase its shelf life by using natural or controlled micro bacteria like lactic acid bacteria (LAB), yeast and bacteriophages that inhibit food spoilage<sup>[31]</sup>. Lactic acid bacteria usually produced polycyclic antibacterial peptides called nisin that inhibit microorganism's growth whereas, bacteriophages are the phages or viruses that attack DNA and block the growth of microorganisms<sup>[31,32]</sup>.

**Food Additives:** Today a large number of chemicals are added as food preservatives that inhibit the growth of microorganisms, reduced oxidation, enhance flavor and aroma like sodium nitrate, sodium benzoate, potassium hydrogen sulfite etc. Such chemicals are called artificial food additives. These are used in all kinds of food from potato chips to canned food or restaurant foods. Some of these naturally exist while a large number of additives can be synthesized in labs. These are classified as natural and synthetic preservatives.

**Natural Food Additives:** Food products are contaminated and spoiled due to pathogens or chemical reactions. In nature, many natural chemicals or substances are obtained from plants or animals to unspoiled food, these are known as natural preservatives. These are added to food to enhance flavor therefore known as natural additives like sugar, salt, vinegar, honey, Guar gum, agar, caffeine, etc.,<sup>[33,34]</sup>. These can be categorized into

**Natural food Colorant:** The natural substances used to enhance color of food items like beta-carotene, anthocyanin, turmeric, saffron, paprika etc.,<sup>[35,36]</sup>

**Natural Antioxidant:** Natural antioxidants are the substances extracted from natural sources like plants and prevent oxidation e.g., polyphenols, tannins, hydroxyl-cinnamic acid, lignans, coumarins, flavonoids, terpenoids, citric acid etc.,<sup>[37,38]</sup>

**Natural Anti-microbial:** Naturally, a large number of chemicals exist that inhibit the growth of pathogens or harmful microorganisms e.g., natamycin, reuterin, nisin, pediocin etc., are called natural antimicrobial additives<sup>[39-41]</sup>

**Natural Sweetener:** From the ancient times humans used several substances to enhance the sweetness of food or to give a sweet effect like sugar, honey, cyclamates, cyclamic acid, aspartame and acesulfame K<sup>[42-44]</sup>.

**Synthetic Food Additives:** The substances that are not extracted but can be prepared by chemical reaction or enzymatic reaction for food preservation or enhancing flavor and color are known as synthetic additives e.g., ammonium bicarbonate, ascorbic acid, ammonium ferric citrate, amylase, benzoate, sorbet, etc.,<sup>[45]</sup>. These cause hazardous effects as compared to natural additives. Currently, special codes (E numbers) are given to these additives. Likewise, natural additives, are also classified into:

**Synthetic antimicrobial:** Antimicrobial agents are the compounds that kills or inhibit the growth of microorganisms like bacteria, fungi and algae such as quinolones, sulphonamides, ampicillin, benzoic acid, carbazoles, azithromycine, miconazole etc.,<sup>[46]</sup>.

**Synthetic Colorant:** Synthetic food color or food colorant is the substance, pigment or dye that adds or enhances color to foods and drinks like tetrazine, Patent blue, Brilliant blue, Brilliant black, Indigo carmine etc.<sup>[47,48]</sup>.

**Synthetic Antioxidant:** Synthetic antioxidants are the chemical substances used in food items and pharmaceuticals to prevent or delayed oxidation e.g., t-butylhydroquinone, propyl gallate, butylated hydroxyanisole, butylated hydroxytoluene etc.,<sup>[37,49]</sup>.

**Synthetic Preservative:** Synthetic or artificial preservatives are chemical compounds that improve appearance or texture and prevent food from spoilage but have some bad effects or side effects on health like benzoates, sorbates and propionate<sup>[50]</sup>. Worldwide, more than 10,000 food additives are used today in different food items. These additives are numbered according to the International Numbering System (INS) or European union number (E codes). Some common food additives are listed below in Table 1 with their codes.

**Harmful effects of preservatives:** Some harmful effects of chemicals that are used for the preservation of food are given in Table 2.

**Conclusion:** Today, food additives are most commonly used due to their availability and applications. These food additives can be divided into natural (extracted from plants) or synthetic (synthesized in labs). Both natural and synthetic additives are further classified into colorant (enhance color), sweeteners (give sweet effect), anti-microbial (reduce microbial activity) and preservative (keep food for long time). Among these, food preservatives are most commonly used because these can increase the shelf life of food and keep food for a long time without degradation. Synthetic food preservatives are commonly used but have more side effects as compared to natural ones. Food additives are given unique numbers called E codes according to the European union, written on every food item.

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Table 1. Common Food Additives

Category	Common Substance (Color)	E number	Mainly used
Natural Colorant	Carotene (Yellow to red)	E160	Soybean products, dairy products, dried vegetables, frozen drinks and processed fruits
	Anthocyanins (Red to blue)	E163	Frozen products, jams, soft drinks, sugar confectionaries and jellies
	Curcumin (yellow)	E100	Confectionery, beverages and sauces
	Canthaxanthin	E161g	Carbonated drinks, tanning pills, sauces, fruit spreads, syrups and candies
	Chlorophyll (green)	E140	Used in vegetables to enhance green color
	Caramel (brown)	E150	Sweets, bread, drinks, cake, biscuit
	Betanin (red/purple)	E162	Soups,
Synthetic Colorant	Tartrazine (yellow/orange)	E102	Mustard yogurt, soups, marmalade, sauces, Jelly, ice creams, jam, ice lollies, soft drinks, marzipan, sweet and chewing gums
	Quinoline yellow (Greenish yellow)	E104	Beverage products, cold fruits, cheese sauces, ice creams, bread, cake and chocolate
	Sunset yellow (yellow)	E110	Beverage products, jam, compound condiments, dairy products, desserts, coca products and starch
	Carmoisine (red/purple)	E122	Ice cream, beverage, sandwich, wine, bayberry, candy, and Greenplum
	Amaranth (red)	E123	Meat, patties
	Ponceau 4R (red)	E124	Yogurt, beverage, ice cream, wine, soya drink, soda, pastry and candy
	Erythrosine (pink/red)	E127	Sweets, chocolates, sprinkles, edible goods, gels, jams, jellies, cake
	Red 2G (red)	E128	Confectionary & meat products
	Indigo carmine (blue)	E132	Ice creams, coatings, confectionary
	Brilliant Blue (blue/green)	E133	Candies, cotton candy, ice creams, ice pops, icings, soft drinks
	Green S (green)	E142	Green vegetables, mint, lime and lemon juice, green sauce
	Black PN (black)	E151	used for darkening fruit juices and sauces
	Brown FK (brown)	E154	Used in smoked fish
	Natural sweeteners	Sorbitol	E420
Mannitol		E421	Chewing gum, candy
Thaumatin		E957	Canned meat, candied fruit, biscuits and candy
Stevioside		E960	Tea products, flavored fermented milk, flavored syrup, candy, canned fruits and condiments
Maltitol, maltitol syrup		LE965	Soybean products, processed fruits and frozen surimi products
Lactitol		E966	Spices, dairy products
Artificial sweetener	Xylitol	E967	Vegetables, dairy products, processed fruits, tea products, starch products, alcoholic drinks and seasonings
	Aspartame	E951	Starch desserts, dairy products, vegetables, cereals and frozen fruits
	Cyclamate	E952	Instant noodles, canned fruits, mixed wines, jams, food and condiments
	Saccharin and its salts	E954	Dried fruits, frozen drinks, cooked beans, dehydrated mangoes, cold fruits, and dried figs
	Sucralose	E955	Baked products, prepared daily products, coarse cereal products and jams
	Neotame	E961	Start desserts, dairy products, cereals, frozen fruits and vegetables
Emulsifiers, stabilizers, thickeners	Polyglycerol esters	E475	Chocolate, soymilk drinks, toffee, ice cream, cakes, spreads and bread
	Karaya Gum	416	
	Sorbitan esters	E491 & E495	Drinks, milk, dried yeast, ice creams, soya products, brads, biscuits and cakes
	Polyoxyethane (8) Stearate	430	instant noodles
	Polyoxyethane (40) Stearate	431	Puddings, bakery products
	Sodium alginate acid	E400	Freezing drinks, milk products, margarine and cheese
	Agar	E406	Maya knees, ice cream, slot dressing, low-fat spreads and dairy products
	Pectin	E440	Yogurt, jam, sauce, Jelly, cheese and candy
	Gellan gum	E418	Bread, pudding, jam products, sugar, dairy products, drinks, sugar drinks, jam products, Jelly and bread pudding
	Sorbitan Monostearate	491	Cream, chocolate, margarine, dairy spreads
	Sorbitan Tristearate	492	Chocolate, cocoa butter
Flavor enhancers	Sorbitan Monolaurate	493	Toothpaste, butter, margarine
	Monosodium glutamate	E621	Jelly, soup, puffed food, sausage, canned food, fish cake and chili sauce
	Dimethylpolysiloxane	E900	Chew gum, chocolate, cooking oil
	Calcium Glutamate	E623	Soups, salads, sauces,

	Sodium Guanylate	E624	Potato chips, snakes, tinned vegetables, instant noodles, rice, meat
	Guanylic acid	E626	Food condiments, meat, ham, soy sauce and bacon
<b>Flavor enhancers</b>	Maltol	E636	Bread, cake, ice creams, candy
	Sodium5-Ribonucleotide	E635	Snakes, chips, crackers, soup, noodles
	Sodium Inosinate	E631	Fish, soup, sauces, sea food
	Ethyl Maltol	E637	Wine, ice cream, candy, chocolate, cooked fruit, caramelized sugar
<b>Glazing agents</b>	Carnauba wax	E903	Broth sauce, candy, fruit juice, dried food, sugar products, baked goods and marshmallows
	Beeswax	E901	Prevent water loss from fruits and vegetables
	Shellac	E904	Wafer biscuits, apple, chocolate, orange, roasted coffee and come sugar base
<b>Natural preservative</b>	Nisin	E234	soy sauce, meat, Tea, dairy products, coffee beverage, vegetable protein products and canned goods
	Natamycin	E235	raw, yogurt and cheese
	Potassium nitrite	E249	Meat and sausages
	Lysozyme	E1105	Fish products, cheese, meat, drink and baby food
<b>Artificial preservative</b>	Sorbic acid and potassium sorbate	E200 & E202	Equity products, dairy products, cooked meat products, soybean products and processed vegetables
	Ethyl-p-hydroxyl-benzoates	E214	Carbonated drinks jam and sauce products
	Sodium nitrite	E250	Buffered foods, soybean products, pastry, meat products and aquatic products

**Table 02.** Harmful effects of some additives

<b>Additive</b>	<b>Harmful effects</b>
Colorant E102, 104, 110, 122, 124, 129	Cause cancer
Sulfites	It causes allergies, palpitations, headaches and even cancer
Nitrates and Nitrites	It is responsible for causing stomach cancer. When used in meat products as a curing agent it is converted into nitric acid which is harmful to health
Benzoates	It caused skin rashes, asthma and allergies
Sorbates/sorbic acid	It caused contact dermatitis and allergies in the urticaria
Acetic acid and acetates	No side effects
diphenyl (E230), orthophenylphenol (E231) and the sodium salt of the latter (E232)	Irritates the nose and eyes, vomiting, nausea add skin allergies It is carcinogenic in high doses. It costs irritation of nose and eyes, vomiting, skin infection
Lysozyme (E1105)	It only shows side effect people having an allergy to egg white
Sodium nitrite	It causes cancer in lab animals
Sodium benzoate	it is responsible for causing hyperactivity