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ARTIFICIAL PRESERVATIVES AND THEIR HARMFUL EFFECTS: LOOKING TOWARD NATURE FOR SAFER ALTERNATIVES

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ABSTRACT: Preservatives prolong the shelf-life of food, cosmetics and pharmaceuticals by preventing their spoilage. Antimicrobials such as nitrites, nitrates, benzoates and sulfur dioxide destroy or delay the growth of bacteria, yeast and molds. Anti-oxidants such as butylated hydroxy toluene (BHT), butylated hydroxy anisole (BHA), and propyl gallate slow or stop the breakdown of fats and oils. Anti-enzymatic preservatives such as citric and erythorbic acids block the enzymatic processes such as ripening occurring in foodstuffs even after harvest. Natural substances like salt, sugar, vinegar and spices have been used as preservatives since time immemorial. The majority of preservatives used today are artificial rather than natural. Several of them are toxic and several others have potentially life-threatening side effects. Researchers have reported that artificial preservatives such as nitrates, benzoates, sulfites, sorbates, parabens, formaldehyde, BHT, BHA and several others can cause serious health hazards such as hypersensitivity, allergy, asthma, hyperactivity, neurological damage and cancer. Research has proven that several natural preservatives obtained from plants, animals, microbes and minerals contain antioxidant, antimicrobial and antienzymatic properties. Extracts of basil, clove, neem and rosemary are promising alternatives to their artificial counterparts. This article aims at increasing awareness about the harmful effects of artificial preservatives and recommends the usage of natural preservatives for better therapeutic efficacy, safety and preservation of substances along with improved general health.

INTRODUCTION: Preservatives are natural or synthetic substances that are added to fruits, vegetables, prepared food items, cosmetics and pharmaceuticals in order to increase their shelf life and maintain their quality and safety by inhibiting, retarding or arresting their fermentation, acidification, microbial contamination and decomposition.

Before the advent of preservatives, food was placed in containers such as clay jars to keep them from spoiling. Food storage can be traced back to all ancient civilizations such as Egyptian, Greek, Roman, Sumerian and Chinese. Drying food was a popular preserving method, as most bacteria and fungi require moisture to grow.

Foods such as fruits, vegetables and meats were often dried for preservation. Among the earliest preservatives were sugar and salt, which produced food environments of high osmotic pressure that denied bacteria the aqueous surroundings they needed to live and reproduce.



Jams and jellies are preserved as solutions of high sugar content, and many meats (e.g., hams) and fish are still preserved by salting. The Eastern Civilizations of India and China also used spices to preserve their food. Pickling with salt, vinegar, lemon juice or mustard oil was a popular method to preserve vegetables. Canning in conjunction with pasteurization revolutionized the preservation of food in the early part of the 19th century. Modern methods of preservation involve sterilization including irradiation, filtration and addition of preservatives such as sodium benzoate and propyl gallate.

Classification of Preservatives¹⁻⁷: Preservatives are classified as Class I (natural preservatives) such as salt, sugar, vinegar, syrup, spices, honey and edible oil; and Class II (chemical or synthetic preservatives) such as benzoates, sorbates, nitrites and nitrates of sodium or potassium, sulfites, glutamates and glycerides. The food standards regulations require that not more than one Class II preservative should be used in one particular food item. People consuming or using items containing more than one preservative are at risk of exposure to multiple chemicals. Both, natural and synthetic preservatives are categorized into 3 types:

1. **Antimicrobials**: These destroy or delay the growth of bacteria, yeast and molds, e.g. nitrites

TABLE 1: DETAILS REGARDING USE OF PRESERVATIVES

Preservatives	Foods containing
Ascorbic acid (vitamin C)	Fruit products, acidic foods
Benzoic acid	Fruit products, acidic foods, margarine
BHA (butylated hydroxyanisole)	Bakery products, cereals, fats and oils
BHT (butylated hydroxytoluene)	Bakery products, cereals, fats and oils
Calcium lactate	Dairy products, olives, frozen desserts, jams, jellies
Calcium propionate	Breads and other baked goods
Calcium sorbate	Syrups, dairy products, cakes, mayonnaise, margarine
EDTA (ethylenediaminetetraacetic acid)	Dressings, margarine, canned vegetables
Methylparaben	Beverages, dressings, relishes
Potassium propionate	Breads and other baked goods
Potassium sorbate	Dairy products, syrups, cakes, processed meats
Propionic acid	Breads and other baked goods
Propylparaben	Beverages, cake, pastries, relishes
Propyl gallate	Cereals, snack foods, pastries
Sodium benzoate	Fruit products, margarine, acidic foods
Sodium nitrate and nitrite	Cured meats, fish, poultry
Sodium propionate	Breads and other baked goods
Sodium sorbate	Dairy products, mayonnaise, processed meats, fermented products
Sorbic acid	Dairy products, fruit products, syrups, sweets, beverages, fermented products
TBHQ (tert butyl hydroquinone)	Snack foods, fats, and oils
Tocopherols (vitamin E)	Oils and shortenings

and nitrates prevent botulism in meat products. Sulfur dioxide prevents further degradation in fruits, wine and beer. Benzoates and sorbates are anti-fungal agents used in jams, salads, cheese and pickles.

2. **Anti-oxidants**: These slow or stop the breakdown of fats and oils in food that occurs in the presence of oxygen leading to rancidity. There are three types of antioxidants: **True antioxidants** such as Butylated hydroxytoluene (BHT) and Butylated hydroxyanisole (BHA) block chain reactions by reacting with free radicals; **Reducing agents** such as ascorbic acid have lower redox potential than the drug or excipients they are protecting, and **Antioxidant synergists** such as Sodium edetate enhance the effects of other antioxidants.

3. **Anti-enzymatic preservatives**: These block the enzymatic processes such as ripening occurring in foodstuffs even after harvest, e.g. erythorbic acid and citric acid stop the action of enzyme phenolase that leads to a brown color on the exposed surface of cut fruits or potato.

The details of utilization of preservatives in some common products are mentioned in **Table 1**.

Preservatives commonly found in most oral pharmaceutical products⁸ (such as tablets, capsules, suspensions and syrups), dental products⁹ (such as toothpaste, mouthwash and gargles), dermal products¹⁰ (mostly cosmetic personal care products, such as cream, lotion, ointment, soap, bath gel, hair spray,

shampoo and conditioner), nasal products¹¹ (such as nasal drops, sprays and aerosols) parenteral products¹² including vaccines, rectal products (such as suppositories and enema) and ophthalmic products^{13, 14} (such as eye drops, ointments and contact lens solutions) are listed in **Table 2**.

TABLE 2: PRESERVATIVES USED IN VARIOUS FORMULATIONS

Pharmaceutical Products	Preservatives
Oral	Methyl, ethyl, propyl parabens and their combinations, sodium benzoate, benzoic acid, calcium lactate, sorbates of calcium, sodium and potassium, sorbic acid
Dermal	Benzalkonium chloride, cetrimide, EDTA, benzoic acid, thiomersal, imidurea, chlorhexidine, chlorocresol, phenyl salicylate
Dental	Sodium benzoate, benzoic acid, potassium sorbate, sodium phosphate, triclosan, cetylpyridinium chloride, methyl and ethyl parabens
Ophthalmic	Benzalkonium chloride, EDTA, benzoic acid, thiomersal, imidurea, chlorhexidine, polyamino propylbiguanide, sodium perborate, boric acid
Nasal	Benzalkonium chloride, phenylcarbinol, potassium sorbate, chlorbutanol, chlorocresol, EDTA
Rectal	Benzyl alcohol, benzoic acid, sodium benzoate, methyl hydroxybenzoate, chlorhexidine gluconate
Parenteral	Methyl, ethyl, propyl, butyl parabens and their combinations, benzyl alcohol, chlorbutanol, chlorhexidine, thiomersal, formaldehyde

The Scientific Committee on Food (SCF) is responsible for the safety evaluation of food additives in the European Union. The Commission of the European Union assigns E-numbers after the additive is cleared by the SCF. E numbers ("E" stands for "Europe") are codes for chemicals which can be used as food additives in the European Union and Switzerland, and are adopted by the food industry worldwide. The range of E-numbers assigned to the class "Preservatives" are 200 to 299. E-1105, lysozyme, is also included in the list of approved preservatives. **Table 3** enlists preservatives approved by the European Union¹⁵:

TABLE 3: CODES ASSIGNED BY COMMISSION OF EUROPEAN UNION FOR VARIOUS PRESERVATIVES

E-Number	Name of Preservative
E 200	Sorbic acid
E 202	Potassium sorbate
E 203	Calcium sorbate
E 210	Benzoic acid
E 211	Sodium benzoate
E 212	Potassium benzoate
E 213	Calcium benzoate
E 214	Ethyl p-hydroxybenzoate
E 215	Sodium ethyl p-hydroxybenzoate
E 216	Propyl p-hydroxybenzoate
E 217	Sodium propyl p-hydroxybenzoate
E 218	Methyl p-hydroxybenzoate

E 219	Sodium methyl p-hydroxybenzoate
E 220	Sulphur dioxide
E 221	Sodium sulphite
E 222	Sodium hydrogen sulphite
E 223	Sodium metabisulphite
E 224	Potassium metabisulphite
E 226	Calcium sulphite
E 227	Calcium hydrogen sulphite
E 228	Potassium hydrogen sulphite
E 230	Biphenyl, diphenyl
E 231	Orthophenyl phenol
E 232	Sodium orthophenyl phenol
E 233	Thiabendazole
E 234	Nisin
E 235	Natamycin
E 239	Hexamethylene tetramine
E 242	Dimethyl dicarbonate
E 249	Potassium nitrite
E 250	Sodium nitrite
E 251	Sodium nitrate
E 252	Potassium nitrate
E 281	Sodium propionate
E 282	Calcium propionate
E 283	Potassium propionate
E 284	Boric acid
E 285	Sodium tetraborate (borax)
E 1105	Lysozyme

Harmful effects of Artificial Preservatives¹⁶⁻²⁷: Artificial preservatives are mostly considered safe, but several have negative and potentially life threatening side effects.

Nitrates, upon ingestion, are converted to nitrites that can react with hemoglobin to produce methemoglobin, a substance that can cause loss of consciousness and death, especially in infants. Proteins in the stomach react with nitrites and produce nitrosamines, substances that are carcinogenic. Researchers claim that there is a substantial link between increased levels of nitrates in food and increased deaths from Alzheimer's, Parkinson's and Type 2 diabetes. Headache, sweating, redness of skin, nausea and weakness can occur following consumption of food containing monosodium glutamate (MSG).

Sulfite containing food preservatives may cause severe allergic reactions and exacerbation of asthma. The toxic paraben chemicals are often used along with methylchloroisothiazolinone and

methylisothiazoline. These are reported to possibly cause neurological damage in rats and are potent irritants and allergens. The use of these toxic chemicals by pregnant women may adversely affect fetal brain development. Formaldehyde DMDM hydantoin, diazolidinyl urea and imidazolidinyl urea are all potent skin, eye and lung irritants. High levels of exposure to toxins like these can cause DNA damage to sperm. Research has shown that the food additives used in hundreds of children's foods and drinks can cause temper tantrums and disruptive behavior.

Listed in **Table 4** are some commonly used preservatives along with health hazards namely hypersensitivity, asthma and cancer, which they can cause.

TABLE 4: HEALTH HAZARDS OF SOME COMMONLY USED PRESERVATIVES

Dangerous Food Preservatives				
Preservative	Hypersensitivity (H)	Asthma (A)	Cancer (C)	
Potassium & Calcium Sorbates, Sorbic Acid	H	A	-	
Benzoic Acid	H	A	-	
Sodium Benzoate	H	A	C	
Propylparaben	-	A	-	
Sulphur Dioxide	H	A	-	
Sodium Metabisulphite	-	A	-	
Potassium Bisulfite	H	A	-	
Hexamethylene Tetramine	-	-	C	
Sodium Nitrite	H	A	C	
Sodium or Potassium Nitrate	H	-	C	
Calcium or Potassium or Sodium Propionates, Propionic Acid	H	A	-	
Propyl Gallate	-	A	C	
Tert Butylhydroquinone (TBHQ)	H	A	-	
Butylated Hydroxyanisole (BHA)	H	A	C	
Butylated Hydroxytoluene (BHT)	H	A	C	

Alternatives to Artificial Preservatives²⁸⁻⁵⁰: The days of benzoates, sorbates, metabisulphites, toxic gases and other synthetic chemical preservatives appear to be numbered. Manufacturers and retailers are responding to consumer resistance to chemical preservatives in food, beverages and cosmetics, and to research which has showed that artificial preservatives are causative agents of hyperactivity even in previously non hyper-active individuals. Natural substances or extracts obtained from plants, animals or minerals, can serve as beneficial alternatives. Other than their use in food, cosmetics and pharmaceuticals as flavoring, binding, disintegrating, gelling, thickening or suspending agents, or as vehicles, these can also be used as preservatives. Listed below are some alternatives of artificial preservatives:

1. **Algin** - a compound extracted from seaweed, including the giant kelp *Macrocystis pyrifera*, *Ascophyllum nodosum* and various types of *Laminaria*, is used to make puddings, milkshakes, ice cream creamier and thicker, is also used to extend shelf life of food products.
2. **Grapefruit Seed Extract** - also known as citrus seed extract, is a liquid derived from the seeds, pulp and white membranes of grapefruit *Citrus paradise*. It is a natural broad spectrum preservative used to kill or inhibit the growth of bacteria, viruses, fungi and other microbes. It should be used in conjunction with others broad spectrum preservatives to be effective. It can be used in quantities of up to 1% of the recipe.

3. **Rosemary Extract** – obtained from *Rosmarinus officinalis*, is an anti-oxidant that slows down oxidation of natural materials. Rosemary extract has been shown to improve the shelf life and heat stability of omega 3-rich oils, which are prone to rancidity. It can be used up to 0.5% in pharmaceutical formulations.
4. **Vitamin E Oil** - an anti-oxidant is used in cosmetics, pharmaceuticals and anhydrous products. It is found most abundantly in wheat germ oil, sunflower, and safflower oils.
5. **Carrageenan** - a compound extracted from Irish Moss *Chondrus crispus*, a type of seaweed, is used to make puddings, ice-cream and milkshakes. It makes foods jell and stabilizes food to keep color and flavor even.
6. **Citric Acid** - an acid which occurs naturally in fruits such as lemon and lime. It is used in canned fruit juices, cheese, margarine, pickle and salad dressings as flavoring and acidifying agent.
7. **Erythorbic acid** - also known as iso-ascorbic acid, is a vegetable-derived food additive produced from sucrose, is widely used in processed foods as an antioxidant preservative. Along with sodium erythorbate, it is also used in hair and nail products.
8. **Guar Gum** - a substance made from seeds of the guar plant *Cyamopsis tetragonoloba*, a legume grown in India, is used as a stabilizer in pharmaceutical preparations and food products such as processed cheese, ice cream, jelly and dressings.
9. **Sodium Aluminosilicate** - a naturally-occurring mineral used in dried milk substitutes, egg mixes and grated cheeses, keeps food from caking and clumping up. It is also an acidity regulator used in concentrations below 2%.
10. **Honey** - a sweet food made by bees using nectar from flowers. In its undiluted form, it is a rich source of nutrients and is self-preserving. It is a natural energy-booster, builds immunity and is a natural remedy for many ailments.
11. **Neem Oil** - a vegetable oil pressed from the fruits and seeds of the neem tree *Azadirachta indica* are a popular anti-fungal, anti-bacterial as well as anti-protozoal agent. It has rejuvenating as well as its detoxifying effects. It is used for preparing cosmetics such as soap, hair products, body hygiene creams, hand creams, and in Ayurvedic, Unani and folklore traditional medicine, in the treatment of a wide range of afflictions.
12. **Basil extract** - derived from the culinary herb *Ocimum basilicum*, it is popularly used for its medicinal properties in Ayurveda and Siddha medicines. It is a useful antioxidant and anti-microbial agent.

CONCLUSION: Artificial preservatives are chemical substances that can cause health hazards. Awareness about the harmful effects of these chemicals in food, cosmetics and pharmaceuticals is increasing. Natural preservatives offer greater advantages over their artificial counterparts due to their non-toxic nature along with a wide range of health benefits. Extracts of basil, neem, citrus and rosemary are better alternatives to preservatives such as benzoic acid, nitrates, MSG, BHA and BHT. In order to obtain and maintain good health, people should opt for products containing natural preservatives and should read labels of eatables, cosmetics and pharmaceuticals carefully.

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