



## Use of Benzoate Preservatives to Prevent Spoilage in Foods and Beverages



White Paper  
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### Causes of Food and Beverage Spoilage and Methods of Preservation

Most food spoilage is caused by the **presence of living microorganisms or microbes**, such as bacteria, molds, and yeasts. These microorganisms produce enzymes, complex organic compounds that may act as catalysts and cause a chemical change to occur — resulting in spoilage. There are two types of enzymes that may be responsible for spoilage: “endoenzymes,” which exist within the microorganism, and “exoenzymes,” which are released by the microorganism. These microorganisms may be active at temperatures from 32° – 158° F (0° – 70° C), meaning that some varieties can grow inside a refrigerator.<sup>1</sup>

The easiest and more effective way to prevent food spoilage is to destroy or inhibit the microorganisms that are responsible. There are **four generally accepted methods for preventing spoilage in food and beverage products**, listed below, which may be used alone or in combination.

1. **Sterilization** by heat or radiation destroys the microorganisms.
2. **Refrigeration** reduces or stops the activity of microorganisms.
3. **Drying** reduces or stops the activity of the microorganism by removing essential water.
4. **The addition of preservative ingredients** reduces or inhibits the activity of the microorganisms.

The addition of preservative ingredients to foods and beverages is not new and been practiced for centuries. Some of the most traditional preservation methods within this category include brining, pickling with vinegar, smoking, and preservation with sugar solutions. These methods inhibit microbial activity and control the rate of microbial growth and multiplication by either a) physically increasing the density of the microorganism’s environment and raising osmotic pressure or b) by chemically inhibiting the microorganism.

It is essential for manufacturers to select the right preservative solution to ensure the **needed preservation efficacy** in each application, beginning with production and extending throughout the supply chain and all the way to consumption by consumer. Preservative selection also includes concerns such as **cost, ease of use and incorporation, and the impact on product odor, taste, and color**.

Additional causes that can trigger spoilage include oxidation, which can be controlled through the use of antioxidants and vapor-proof packaging, and light exposure, which can be controlled with packaging.

## Use and Safety of Benzoates to Inhibit Microbial Activity

Benzoate preservatives, including benzoic acid, sodium benzoate, and potassium benzoate, have been used for many years in foods and beverages to control microbial activity and prevent spoilage. Sodium benzoate and potassium benzoate are the sodium salt and potassium salt of benzoic acid, which occurs naturally in various fruits, berries, and cloves. At high purity levels, they are **virtually odorless and colorless**, and they each **safely inhibit the activity of microorganisms** at low concentrations.

This makes sodium benzoate and potassium benzoate desirable solutions for a **wide variety of acidic food and beverage products**, such as soft drinks, ciders, condiments, sauces, dressings, fruits and fruit products, pickles, olives, fish products, salted margarine, prepared salads, and vegetables during storage. Benzoic acid is also an excellent solution for products such as non-yeast-raised bakery goods.

Benzoic acid, sodium benzoate, and potassium benzoate have been considered as safe food additives for many, many years, considered **Generally Recognized as Safe (GRAS)** by the U.S. FDA. In fact, the “harmlessness” of benzoates as food-grade preservatives dates back to at least 1909, when sodium benzoate was extensively tested in human feeding studies performed by three independent research organizations under the direction of the U.S. Secretary of Agriculture. A summary of these studies was published in a 784-page book titled Report No. 88 of the U.S. Dept. of Agriculture. This report verified that sodium benzoate, when mixed with food in the quantities specified, was not injurious to general health nor found to adversely affect or impair the quality or nutritive value of such food.

The safety of benzoates has been reaffirmed by the U.S. FDA and abroad by regulatory authorities such as the European Food Safety Authority (EFSA).<sup>ii</sup> In the U.S., 21 CFR 184 describes those “DIRECT FOOD SUBSTANCES AFFIRMED AS GENERALLY RECOGNIZED AS SAFE.” Both benzoic acid (21 CFR 184.1021) and sodium benzoate (21 CFR 184.1733) are included in this listing and are approved for use as antimicrobial agents, flavoring agents, and adjuvants. **Good manufacturing practice (GMP) results in a maximum level of 0.1%** of benzoic acid, sodium benzoate, or potassium benzoate in food. In addition, these products must meet the specifications contained in the Food Chemicals Codex (FCC).

Emerald manufactures Kalama® Potassium Benzoate, Kalama® Sodium Benzoate, and Purox® S Sodium Benzoate using the highest standards for safety and quality at **FSSC-22000-certified, food-grade operations** in the U.S. and Europe. These products meet the requirements for key global compendia, such FCC.

## Efficacy of Benzoates in Food and Beverage Preservation

Sodium benzoate and potassium benzoate are most suitable for use as an antimicrobial agent in foods and beverages with a **pH level that is below 4.5** or can be brought within that range by addition of a water-soluble acidulant. Use of benzoates is not recommended for preservation at pH ranges higher than 4.5.

The preservation efficacy of sodium benzoate or potassium benzoate increases with decreasing pH (increasing acidity). This is because the ratio of undissociated (i.e. free) benzoic acid to ionized benzoic acid increases as the pH decreases. It is generally accepted that the undissociated benzoic acid is the active antimicrobial agent. Although no definite theory has yet been proposed to explain this antimicrobial effect, it is believed to be related to the high lipoid solubility of the undissociated benzoic acid, which allows it to accumulate on the cell membranes or on various structures and surfaces of the bacterial cell, effectively inhibiting its cellular activity.

Sodium benzoate and potassium benzoate have activity against yeasts, molds, gram-negative bacteria, and gram-positive bacteria that may be responsible for spoilage, as well as pathogenic microorganisms that may result in foodborne illness, such as E. coli. Although several studies have been performed on the antimicrobial activity of sodium benzoate on these species, it is difficult to obtain substantial evidence on relative activities of benzoates against specific members of those general species. Actual field application trials are recommended for assurance of satisfactory antimicrobial activity against the species in question.

## Formulation Considerations

### Taste

At low pH values, sodium benzoate and potassium benzoate may impart a slight tang in taste attributable to the undissociated benzoic acid. If this effect is undesirable, it may be overcome by using other approved preservatives in conjunction with sodium benzoate to lower the concentration of sodium benzoate below the taste threshold.

### Addition and Ease of Use

An important consideration in preserving with benzoates is the addition of the preservative as early as possible in the food processing. The early addition of sodium benzoate or potassium benzoate will prevent the microorganisms from forming enzymes which may continue to cause deterioration even though the microorganism growth will be inhibited at the later stage in processing.

Sodium benzoate or potassium benzoate may be added conveniently and efficiently in the form of a concentrated stock solution in water. A simple stock solution may be prepared by dissolving one pound of either sodium benzoate or potassium benzoate in one gallon of water. One fluid ounce of this solution when added to one gallon of beverage gives a concentration of about 0.1 % of sodium benzoate or potassium benzoate. If the specific gravity of the beverage is significantly higher than water after sodium benzoate is added in processing, and an acidic pH adjustment is needed with the addition of a strong acid such as citric acid, sufficient agitation should be available to prevent localized precipitation of benzoic acid, which has a solubility of about 0.2% in water at 20° C. This processing step is important because the relatively water-insoluble benzoic acid may precipitate inside the processing vessels and lines causing plugging problems and loss of essential preservative in the total batch contents.

### Operational Hygiene

One of the most important considerations in preserving with benzoates is the maintenance of absolute cleanliness. It should be clearly understood that although preservatives such as sodium benzoate and potassium benzoate serve a very useful purpose in foods, they cannot take the place of cleanliness in food processing. Products that have already spoiled will not benefit from the use of benzoates as preservatives.

## Common Food and Beverage Applications

Sodium benzoate is widely used in carbonated and still beverages, syrups, cider, salted margarine, olives, sauces, relishes, jellies, jams, preserves, pastry and pie fillings, low fat salad dressing, fruit salads, prepared salads, and in storage of vegetables. Some generalized applications are described in the following examples. Federal and regional regulations may apply to specific applications. These regulations should be reviewed and verified as applicable or non-applicable for each specific use application.

**BEVERAGES:** Sodium benzoate is the standard preservative used in carbonated beverages. Typically, 0.03 to 0.08% is used for the finished products. Sodium benzoate is often used to preserve the flavor syrup prior to the addition of the

beverage acidulant. Non-carbonated beverages normally require somewhat higher concentrations of 0.05 to 0.1% sodium benzoate in the finished products.

Typically used for finished products, potassium benzoate may be used in carbonated beverages at 0.03 to 0.08 % and may also be used to preserve the flavor syrup prior to the addition of the beverage acidulant. Non-carbonated beverages normally require somewhat higher concentrations of 0.05 to 0.1% potassium benzoate in the finished products.

**CIDER:** The shelf life of non-pasteurized cider can be greatly extended by using sodium benzoate or potassium benzoate, either of which should be added as soon as the juice is pressed. A slight tang, which many tasters apparently prefer, may be imparted to the cider by concentrations of sodium benzoate or potassium benzoate as low as 0.04%.

**MARGARINE:** Margarine is regulated by standards of identity described in U.S. FDA 21 CFR Part 166.110. Sodium benzoate is allowed as a preservative up to 0.1%. Special attention to the preservation may be required for low salt or salt free margarine, as salt may exhibit a synergistic effect with sodium benzoate.

**SYRUPS:** Concentrated sugar solutions are somewhat resistant to fermentation under ideal conditions but may be subject to quality deterioration in non-ideal circumstances. Sodium benzoate may be used to inhibit microbial growth in these syrups at levels of about 0.1% at pH values below 4.5. In chocolate syrups and other fountain syrups with pH values above 4.5, sodium benzoate may be used in conjunction with other preservatives that are more effective in that pH range.

**FRUITS, FRUIT JUICES, AND FRUIT SALADS:** Typically sodium benzoate will be used at levels of 0.05 to 0.1% to preserve these products. Maraschino cherries are preserved with 0.05 to 0.1% sodium benzoate. The shelf life of chilled citrus salads is materially improved by the use of 0.03 to 0.08% sodium benzoate in the cover syrup.

**FRUIT BUTTERS, JELLIES, PRESERVES, AND RELATED PRODUCTS:** Fruit butters, jellies, preserves, and related products are regulated by standards of identity for those products as described in U.S. FDA 21 CFR Part 150. According to that regulatory description, GRAS preservatives such as sodium benzoate are permitted as optional ingredients in a concentration reasonably required for preservation. Artificially sweetened fruit jelly is specifically described in 21 CFR §150.141 and artificially sweetened fruit preserves and jams are specifically described in 21 CFR Part 150.161. Both sections specifically allow these products to contain sodium benzoate up to a level not to exceed 0.1%, by weight, of the finished food.

**SALAD DRESSINGS:** Non standardized salad dressings which have a relatively low fat content may be preserved by the use of sodium benzoate at a use level of 0.1%, if the product is below a pH of 4.5.

**PREPARED SALADS:** Prepared salads are generally kept under refrigeration but additional protection against mold and yeast growth may be gained by using 0.1% sodium benzoate. The pH of these products should be below 4.5 for the preservative to be effective. The preservative should be added with the salad dressing or with the gelatin solution.

**NON-STANDARDIZED SAUCES AND CONDIMENTS:** Many non-standardized sauces and condiments that have a pH range below 4.5 may be effectively preserved with sodium benzoate at 0.05 to 0.1%.

**PICKLES AND PICKLE PRODUCTS:** Yeast and mold contamination and scum formation in pickles and pickle products may be controlled with up to 0.1% sodium benzoate. The sodium benzoate may be added with the sweet juice to be used on the pickles, which may make up about one-third of the total bulk content. Consequently, 0.3% sodium benzoate could be added to the sweet juice to attain not more than 0.1% sodium benzoate in the entire finished product.

## More Information

Emerald Kalama Chemical is a leading global producer of sodium benzoate and uses the highest global standards for quality and purity. Emerald offers both Purox® S Sodium Benzoate and Kalama® Sodium Benzoate, which are produced using the highest global standards for quality and purity (including FSSC 22000) at its facilities in the U.S. and Europe.

For more information about food and beverage applications, preservation, or these products, please visit [www.emeraldkalama.com](http://www.emeraldkalama.com) or contact Emerald at [kalama@emeraldmaterials.com](mailto:kalama@emeraldmaterials.com).

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<sup>i</sup> Albrecht, J. A. Sumner, S. S (1992). EC92-2307 Food Microbiology / Foodborne Illness. *University of Nebraska – Lincoln*. <http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=2564&context=extensionhist>

<sup>ii</sup> European Food Safety Authority (2016). Scientific Opinion on the re-evaluation of benzoic acid (E 210), sodium benzoate (E 211), potassium benzoate (E 212) and calcium benzoate (E 213) as food additives. <https://www.efsa.europa.eu/en/efsajournal/pub/4433>