New York State Integrated Pest Management Program | Cornell Cooperative Extension

Potassium Sorbate Profile

Active Ingredient Eligible for Minimum Risk Pesticide Use

Brian P. Baker and Jennifer A. Grant
New York State Integrated Pest Management, Cornell University, Geneva NY

Label Display Name: Potassium sorbate

Active Components: Potassium sorbate

CAS Registry #: 24634-61-5

U.S. EPA PC Code: 075902

CA DPR Chem Code: 1132

Other Names: Sorbic acid, potassium salt; (2E,4E)-2,4-Hexadienoic acid, potassium salt; Potassium (E,E)-1,3-pentadiene-1-carboxylic acid; 2-propenylacrylic acid; Sorbistat-K; Kalium-(2E,4E)-2,4-hexadienoat (German); Kalium-(2E,4E)-2,4-hexadienoat (French)

Other Codes: BRN: Obsolete CAS Number: 590-00-1; SMILES: C/C=C/C=C/C(=O)[O-].[K+]; FEMA 2921; IFN 8-03-761; INS 202

Summary: Potassium sorbate is a food preservative that has fungicidal and other antimicrobial properties. It is also an ingredient in insect repellents, and it is often used as to prevent the degradation of other active ingredients. Formed as the potassium salt of sorbic acid, which occurs naturally in foods, potassium sorbate inhibits bacterial and fungal growth through biocidal modes of action.

Pesticidal Uses: Primarily used as a fungicide, bactericide and algicide. Used as a seed treatment and a post-harvest handling fungicide. Also used with various essential oils as an insect repellent.

Formulations and Combinations: Potassium sorbate can be used as a seed treatment with sodium propionate and various polymers (Patil 2001). It is also used in a number of combinations for control of spoilage organisms in food and feed processing (Dorko et al. 2014). Citric acid can be used as a stabilizer for sorbic acid and its salts (Montagna and Lashley 1958). Previously registered pesticides contained potassium sorbate as an active ingredient with parathion.

Basic Manufacturers: Apac Chemical, Celanese Nutrinova, FBC Industries, Spectrum Chemical, Wuxi Daxin.

Safety Overview: Potassium sorbate has been safely used as a food additive with anti-microbial properties.

This document profiles an active ingredient currently eligible for exemption from pesticide registration when used in a Minimum Risk Pesticide in accordance with the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) section 25b. The profile was developed by the New York State Integrated Pest Management Program at Cornell University, for the New York State Department of Environmental Conservation. The authors are solely responsible for its content. The Overview Document contains more information on the scope of the profiles, the purpose of each section, and the methods used to prepare them. Mention of specific uses are for informational purposes only, and are not to be construed as recommendations. Brand name products are referred to for identification purposes only, and are not endorsements.

Background

Potassium sorbate is a preservative and antimicrobial agent for foods, cosmetics, and pharmaceuticals(Merck 2015). Specifically, it is used as mold and yeast inhibitors in dairy products, chemically leavened baked goods, fresh and fermented vegetables, dried fruit, beverages, confections, and smoked meat and fish (Somogyi 2000).

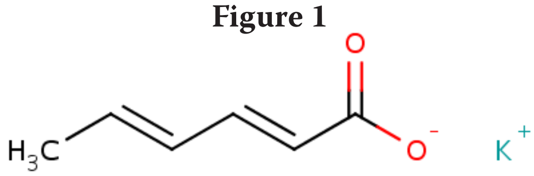
Potassium sorbate is the potassium salt of the carboxylic acid, sorbic acid. Sorbic acid occurs naturally in small quantities in the fruits of various plants. In the berries of the mountain ash (Sorbus aucuparia) it occurs as the lactone, and is called parasorbic acid.

The antimicrobial properties of sorbic acid were first discovered in the late 1930s and early 1940s (Dorko et al. 2014). The potassium salt of sorbic acid is the preferred form for food applications. Potassium sorbate disassociates in solution to ionic potassium and sorbic acid. Sorbic acid inhibits the transport of carbohydrates into yeast cells, inhibits oxidative and fermentative assimilation, and uncouples oxidative phosphorylation in a variety of bacteria (Dorko et al. 2014).

Chemical and Physical Properties

The molecular structure of potassium sorbate is shown in Figure 1.

Figure 1



Source: (EMBL 2015)

The physical and chemical properties of potassium sorbate appear in Table 1.

Table 1

Physical and Chemical Properties of Potassium Sorbate

Property	Characteristic/Value	Source
Molecular Formula:	$C_6H_7KO_2$	(Merck 2015)
Molecular Weight:	150.22	(Merck 2015)
Percent Composition:	C 47.97%, K 26.03%, O 21.30%, H 4.70%	(Merck 2015)
Physical state at 25°C/1 Atm.	Crystals	(Merck 2015)
Color	White	(HSDB 2015)
Odor	Characteristic	(HSDB 2015)
Density/Specific Gravity	1.363 g/ml @ 25°C	(Spectrum 2010; HSDB 2015)
Melting point	Decomposes above 270°C.	(Spectrum 2010; Merck 2015)
Boiling point	446°	(EPI 2012)
Solubility	At 20°C: water 58.2%; alcohol 6.5%	(Merck 2015)
Vapor pressure	At 20°C: <0.01 mm; At 143°C: 50 mm	(Merck 2015)

Property	Characteristic/Value	Source
pH	Not found	
Octonol/Water (K_{ow}) coefficient	-2.19	(EPI 2012)
Viscosity	N/A	
Miscibility	Not found	
Flammability	Not found	
Storage stability	Stable; incompatible with strong oxidizing agents.	(Royal Society of Chemistry 2014)
Corrosion characteristics	Not corrosive to glass	(Spectrum 2010)
Air half life	2.6 hrs	(EPI 2012)
Soil half life	416 hrs	(EPI 2012)
Water half life	208 hrs	(EPI 2012)
Persistence	412 hrs	(EPI 2012)

Human Health Information

Values reported are specifically for potassium sorbate unless otherwise reported. Sorbic acid is not eligible to be an active ingredient in minimum risk pesticides, however, potassium sorbate is because it readily disassociates into sorbic acid in solution. Toxicology studies of sorbic acid will generally be buffered with either sodium or potassium in solution (JECFA 1966). Sorbic acid has low mammalian toxicity, including for humans. However, a review of the literature concluded that "a small but ill-defined subgroup may suffer idiosyncratic reactions to this preservative [sorbic acid]" (Walker 1990). These include contact dermatitis (Le Coz 2005), urticaria (hives) (Hannuksela and Haahtela 1987), stinging sensations, and 'burning mouth syndrome' (Lamey et al. 1987; Haustein 1988).

Acute Toxicity

The acute toxicity of potassium sorbate is summarized in Table 2.

Table 2

Acute Toxicity of Potassium Sorbate

Study	Results	Source
Acute oral toxicity	Rat: 4,920 – 6,170 mg/kg	(JECFA 1966; Walker 1990)
Acute dermal toxicity	Not found	
Acute inhalation	Not found	
Acute eye irritation	Not found	
Acute dermal irritation	Not found	
Skin sensitization	Not found	

Sub-chronic Toxicity

The sub-chronic toxicity of potassium sorbate is summarized in Table 3.

Table 3

Sub-chronic Toxicity of Potassium Sorbate

Study	Results	Source
Repeated Dose 28-day Oral Toxicity Study in Rodents	Not found	
90-Day oral toxicity in rodents	Mice: No adverse effects (sorbic acid) Rats: Slight enlargement of liver	(Hendy et al. 1976; LSRO 1975)
90-Day oral toxicity in non-rodents	Dog: No adverse effects	(Walker 1990)
90-Day dermal toxicity	Not found	
90-Day inhalation toxicity	Not found	
Reproduction/development toxicity screening test	Rat: No significant difference from control	(JECFA 1974)
Combined repeated dose toxicity with reproduction/ development toxicity screening test	Not found	
Prenatal developmental toxicity study	Not found	
Reproduction and fertility effects	Not found	

While allergic reactions to potassium sorbate are considered unusual, there has been a reported incident of repeated occupational exposure in a dairy plant leading to severe rashes in an exposed worker (Le Coz 2005).

Chronic Toxicity

The chronic toxicity of potassium sorbate is summarized in Table 4.

Table 4

Chronic Toxicity of Potassium Sorbate

Study	Results	Source
Chronic toxicity	Ames: Negative	(Walker 1990)
Carcinogenicity	Mouse: Negative	(JECFA 1974; LSRO 1975)
Combined chronic toxicity & carcinogenicity	Not found	

In evaluating GRAS status of potassium sorbate, the FDA reviewed four animal studies for carcinogenesis. One was inconclusive and three had no carcinogenesis in the test animals (LSRO 1975). Potassium sorbate is not identified as carcinogens by the International Agency for Research on Cancer (IARC 2014), is not on the California Proposition 65 list of known carcinogens (Cal-EPA 1997), and does not appear on the Toxics Release Inventory (TRI) Basis of OSHA Carcinogens (US EPA Toxics Release Inventory Program 2015).

Human Health Incidents

The National Pesticide Information Center (NPIC) received two human health incident reports involving exposure to potassium sorbate (NPIC 2016). Both involved other pesticides in addition to potassium sorbate.

Environmental Effects Information

Effects on Non-target Organisms

No data on the effects of potassium sorbate on non-target organisms were found. NPIC received two animal incident reports involving exposure to potassium sorbate (NPIC 2016). Both involved other pesticides in addition to potassium sorbate.

Environmental Fate, Ecological Exposure, and Environmental Expression

No data on the environmental fate, ecological exposure, and environmental expression of potassium sorbate were found. The EPA predicts potassium sorbate to be readily biodegradable (EPI 2012).

Environmental Incidents

No other studies indicating environmental impacts of potassium sorbate were found. NPIC received two reported incidents involving potassium sorbate; these were neither human health nor animal related and contained no narrative details (NPIC 2016).

Efficacy

Fungicidal and Anti-microbial Activity

Given its anti-microbial efficacy and record of safety as a food additive, there is interest in using potassium sorbate as a fungicide, mainly for post-harvest handling, but also as a seed treatment and in field use.

Sorbates have the ability to inhibit the growth of yeast at the surface of food during fermentation, but do not inhibit yeasts and other organisms that are used in the fermentation process (Somogyi 2000). Salts of sorbic acid may have a synergistic effect with various synthetic fungicides, such as methylchloroisothiazolinone or methylisothiazolinone, and salts such as magnesium chloride, mangnesium nitrate, and sodium benzoate when used in plant tissue culture media (Guri and Patel 1998). Over 150 different molds, bacteria, and yeasts—including most food-borne pathogens—are suppressed by potassium sorbate and other salts of sorbic acid (Dorko et al. 2014).

Among the molds inhibited are members of the genuses *Alternaria, Aspergillus, Botrytics, Cercospora, Fusarium, Penicillium, Rhizoctonia,* and *Trichoderma*. Yeasts inhibited include species of *Candida, Cryptococcus, Rhodotorula,* and *Saccharomyces*. Bacteria inhibited include *Acetobacter, Bacillus, Clostridium, Pseudomona, Salmonella,* and *Staphylococcus*, species as well as *Escerichia coli.* Potassium sorbate at concentrations of 0.05, 0.10 and 0.15% delayed or prevented *Aspergillus flavus* and *Aspergillus parasiticus* spore germination and initiation of growth. Potassium sorbate also greatly reduced or prevented production of aflatoxin B1 by both species for up to 70 days at 12°C, with aflatoxin production essentially eliminated with concentrations of potassium sorbate above 0.10% (Bullerman 1983).

Various citrus fruits were inoculated with green mold *(Penicillium digitatum)* and blue mold *(Penicillium italicum).* The infected fruit was treated with a potassium sorbate dip 24 hours after inoculation at various concentrations and temperatures. When compared with a plain water dip control, a treatment with a 3% solution of potassium sorbate in hot (62°C or 143°F) water for 30 seconds was able to control both molds, achieving about a 98% reduction in infection on Valencia oranges (Montesinos-Herrero et al. 2009). This was comparable to the results with the thiabendazole post-harvest fungicide imazalil. Although the results were not conclusive, the same study showed that potassium sorbate significantly reduced the amount of imazalil needed for efficacy, suggesting that potassium sorbate may have a synergistic effect.

In another set of experiments conducted with *P. digitatum,* potassium sorbate was found to work best at a pH of between 4 and 6 (Smilanick et al. 2008). The EC_{95} of potassium sorbate at a pH of 4 was 0.065%. P. italicum was able to develop a tolerance, and prolonged exposure produced evidence that it is possible to select for potassium sorbate resistant strains (Schroeder and Bullerman 1985). P. digitatum did not develop a tolerance.

Peaches *(Prunus persica)* inoculated with one of the fungi associated with brown rot *(Monilinea laxa),* then treated with potassium sorbate, had significantly lower infection rates and fruit damage than untreated fruit. Potassium sorbate's efficacy was estimated to be about 90% (Gregori et al. 2008). The study confirmed that the potassium sorbate treated fruit also had lower rates of other incidental *Monilinea* species and less brown rot damage.

In California, organically grown grapes *(Vitis vinifera)* treated post-harvest with either 0.5% or 1.0% solution of potassium sorbate in 20% alcohol, had *Botrytis cinera* (gray mold) infection levels that were not significantly different from those on grapes treated by sulfur dioxide (SO_2) fumigation (Karabulut et al. 2005). Other ingredients in the treatment were not disclosed.

Pre-harvest field applications of potassium sorbate to table grapes as a preventive fungicide yielded variable results over a three-year period. While one year's data under California field conditions showed no significant difference in incidents between potassium sorbate, various chitosans, and a fungicide program combining pyrimethanil, cyprodinil, fludioxonil, pyraclostrobin and boscalid. All treatments used the surfactant Latron B1956 from BFR Products. The differences in averages over the three years between potassium sorbate—with a 2.8% incidence of gray mold—and the no-treatment control with a 3.9% incidence was barely significant to insignificant (Feliziani et al. 2013). The potassium sorbate treated grapes also had lower berry size and higher solids.

Seeds and plant propagants may be treated with potassium sorbate to protect them from soilborne diseases. In plate studies to evaluate various food preservatives' efficacy to suppress the soil pathogens *Fusarium oxysporum, Macrophonia phaseolina, Rhizoctonia solani,* and *Sclerotinia sclerotiorum* in a medium of sand and cornmeal, potassium sorbate suppressed all four species (Arslan et al. 2009). Treatment levels were 0.0, 0.2, 0.4, 0.6, 0.8, 1.0, 1.5 and 2.0%, w/v. The only other food additive to do so was ammonium bicarbonate.

Mature potato *(Solanum tuberosum)* tubers were dipped in 1%, 2%, and 4% solutions of potassium sorbate, then placed on agar plates inoculated with *R. solani* and *Fusarium roseum*. The 4% solution of potassium sorbate was effective at controlling *R. solani* but not *F. roseum* (Leach et al. 1983). Silver scurf *(Helminthosporium solani)* in potatoes was best controlled by 0.1-0.2 M solutions of potassium sorbate when compared with six other fungicidal salts, although all salts showed inhibitory properties relative to the control (Olivier et al. 1998). Cowpeas *(Vigna sinensis)* treated with a seed dressing of 9% potassium sorbate had an 89% decrease in incidents of *Fusarium* and a 91% reduction in *Rhizoctonia* infections (El-Mougy et al. 2004).

Standards and Regulations

EPA Requirements

The EPA has explicitly exempted potassium sorbate from the requirement of a tolerance [40 CFR 180.1233].

FDA Requirements

Potassium sorbate is Generally Recognized As Safe (GRAS) for use as a food ingredient by the FDA [21 CFR 182.3640].

Other Regulatory Requirements

Potassium sorbate is synthetic and does not appear on the National List of allowed synthetic substances allowed for crop production. Therefore, it is prohibited for use in organic production [7 CFR 205.105(a)].

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