Sorbic Acid & Derivatives 6/29/73 Q 25

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SORBIC ACID and DERIVATIVES

Submitted to:

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Bureau of Foods
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SORBIC ACID and DERIVATIVES

Compound	Accession No.	CAS Reg. No.
SORBIC ACID	607	000110441
SODIUM SORBATE	600	007757815
POTASSIUM SORBATE	508	000590001
CALCIUM SORBATE	140	007492559

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SORBIC ACID AND DERIVATIVES

Summary - Toxicological Information

In mice, the intraperitoneal acute toxicity tests of sodium and potassium sorbates revealed LD_{50} values to be 2,500 and 1,300 mg/kg, respectively (208a). The acute oral toxicity (LD_{50}) of sorbic acid, and its sodium and potassium salts for the rat ranges from 5,000 to 10,500 mg/kg (256, 498). In starving male and female rats, the LD_{50} values were determined to be 4,300 and 3,600 mg/kg, respectively (98). No acute toxicity data has been presented for the calcium salt of sorbic acid.

The maximum safe dosage of sorbic acid in 30-day feeding tests on rats without causing reduced growth or adverse micropathological changes have both been determined to be 48 mg/kg/day (423).

A lack of toxic effects was observed for sorbic acid in a multi-indices study on albino mice and rats in 3-month subacute and 8- to 18-month chronic toxicity studies. These studies did indicate the positive effects of increased immunobiological activity and detoxification function of the liver (193). A similar study in which mice and rats were given 40 mg/kg/day for 3, 17, or 18 months and tested for growth, survival, hematology, and blood chemistry; stress factors such as dietary restrictions, low temperature and carbon tetrachloride (CCl_4) in rats and mice indicated that sorbic acid was the least toxic of a group of food preservatives and combination thereof. The same comparatively low toxicity was found for the action of sorbic acid on liver function in rats and reproduction in mice. A polymeric impurity of sorbic acid showed similar results in a 2-month study (417).

The harmless nature of sorbic acid at the 5% level in the diet of rats, mice, guinea pigs, and dogs has been indicated since no adverse side effects were reported at this level in several studies (95, 98, 243).

Even up to a 10% sorbic acid level in the diet of albino rats did not appreciably affect the quantity of food consumed. However, it resulted in a higher growth rate, yielded a higher ratio of liver to body weight, and had no influence on the reproductive capacity when compared to the controls (95, 234). The liver though enlarged showed no pathology when some of these albino rats were fed 1-2% sorbic acid in the diet for 10 weeks (234).

A dependency of possible toxicity on the dosage, frequency and duration of sorbic acid and potassium sorbate administration is indicated in a variable study on these two materials. A single dose of 200 mg of sorbic acid or potassium sorbate to rats resulted in a lowering of bile secretions, biliary protein and sodium while the potassium remained the same (121). 1, 200 mg/kg/day as a single dose of sorbic acid for 22 weeks showed no pathological alteration in the pancreas or liver. When 1, 600 mg/kg/day for 12 weeks and 2,000 mg/kg as a single dose was tested, pathological alterations were found in the pancreas and liver (498). However, the sodium and potassium levels were not affected by 2% and 0.25% levels of sorbic acid and potassium sorbate in the diet for 3 months (121).

Pancreatic and bile secretion studies on rats administered sorbic acid and potassium sorbate by stomach tube had slightly reduced total protein content and chymotrypsin activity and increased lipase and amylase activity of pancreatic secretion and bile secretion (499). In the chronic administration of sorbic acid, all indices except chymotrypsin and lipase activity were increased (498, 499).

As might be expected, no toxic effect was encountered when 35 mg/kg/day of sorbic acid as a 10% alcohol solution and equivalent dosages of several of its derivatives were administered intramuscularly for 3 months to mice (432).

The administration of sorbic acid to albino mice and rats in subacute and chronic toxicity tests showed that sorbic acid prevents the toxic effect of nisin. In a parallel test, it was found that sodium bisulfite ($NaHSO_2$) may also be used in conjunction with sorbic acid (105, 193, 417).

Nine second generation albino rats fed a 10% sorbic acid diet up to 3 months produced a significant difference at the 95% level in the oxygen consumption of liver homogenates. There was no significant difference in 5 parent generation rats similarly treated. A contradiction seems to present itself in that the control female liver homogenates in this study had the highest oxygen consumption while the results for the treated females were lowered. The values for the treated females having been the same as for the treated males (95).

Additional evidence that sorbic acid and its salts are generally accepted as harmless here and in the United Kingdom is contained in a report that states that they meet the United Kingdom food regulation standards (256). This is reinforced by the fact that the implied human ingestion of large amounts of beverage, juice, wines, and soft drinks, treated with 400 mg to greater than 1,000 mg per liter of potassium sorbate caused no side effects (594). The suitability of sorbic acid and sodium sorbate as antiseptic and antifungal agents in mixtures for internal use has been shown in studies on rats (2,). Test and control rats and mice showed no observable differences when sorbic acid was administered for 12 months along with glucose oxidase and catalase (36).

One of the few toxic effects seen as a result of the use of sorbic acid and potassium sorbate is a mild irritation of the skin (130a).

Albino rats fed sorbic acid along with carotene for 2, 4, and 6 weeks had an increased secretion and decreased liver storage of vitamin A as compared to the control rats (234).

The only evidence of carcinogenicity observed was after repeated subcutaneous injections into rats of sorbic acid in oil (99). A protective role of sorbic acid against the photodynamic action of benzopyrenes, known carcinogens, was found for some microorganisms. Increases of the protective action observed with the quantity of this and other antioxidants suggests that further studies on the relationship of cancer and sorbic acid and other antioxidants be undertaken (115).

The carcinogenicity was not increased when 73 mice continuously fed 40 mg/kg/day sorbic acid were inoculated with Erlich ascites cells but they tended to fatten (105). No studies were found on the possible carcinogenicity of sorbic acid salts in the available literature.

The main metabolic products of sorbic acid were identified as carbon dioxide and water along with minor products of muconic and sorbic acids in the urine of mice (481). The metabolism of sorbic acid to carbon dioxide and water along with energy was also found in rats fed sorbic acid during fasting. These products were accompanied by a ketonuria (98). The presence of muconic acid as a metabolic product of sorbic acid has been verified as its trans-trans isomer at the 0.1 - 0.2% level in the urine of rabbits fed sorbic acid and selected esters thereof (237). Thorough investigation of sorbic acid in all phases reveals its metabolism to be identical in animals and human beings (256).

Other metabolic studies also show that sorbic acid is metabolized to carbon dioxide, water and energy, (98, 256, 493), which is similar to the metabolism of hexanoic and hexenoic acids (243), and caproic and butyric acids (98).

Two series of experiments indicate that germination of some microorganisms is inhibited by 10 mg% of sorbic acid and 30-50 mg% of sodium sorbate (41). The growth development and survival rate of larvae were decreased by 4 nutrient levels of potassium sorbate. However, as the sorbate level increased the inhibition decreased (602).

In the apparently complex inhibitory effects of sorbic acid on enolase activity in yeast, there is a dependence on the substrate and sorbic acid concentrations (34, 169). This correlates with a dependence of the permeability of the yeast cells on the undissociated sorbic acid content. Yeast cell permeability has been shown to influence enolase inhibition (34). Another direct relationship to the concentration of undissociated sorbic acid was found to be its toxicity to yeast cells (45).

No inhibition of many phospho enzymes and related systems by sorbic acid was encountered when studies were performed on cell free yeast extracts. Other intact microorganisms showed a pH dependence of in vivo respiration, of cell permeability and of toxic action directly related to sorbic acid dissociation (34). No decomposition of sorbic acid is brought about by the extracellular enzymes of

Aspergillus Niger organisms (275). Potassium sorbate inhibited some sugars and similar compounds as well as some enzyme systems in the production of carbon dioxide (92).

Again, in the Aspergillus Niger cells, the evidence points to the metabolism of the major part of sorbic acid to carbon dioxide, water, and energy along with some methyl ketones (275). Potassium sorbate has also been found to be used as a source of energy in other microorganisms (92).

At a concentration of 10^{-4} moles per liter, sorbic acid is an inhibitor of the sulfhydryl enzymes ficin and alcoholic dehydrogenase (482), but aldolase, urease and other enzymes were not significantly inhibited (34, 482). However, irradiated sorbic acid was a better inhibitor of ficin than ordinary sorbic acid (482).

Contrasting results to those previously reported have been found for the effect of cysteine and glutathione increasing the degree and duration of the inhibitory effects of potassium sorbate (92).

The total United States usage, in pounds, in 1970 as reported in an NAS/FEMA study is:

Sorbic Acid	Sodium Sorbate	Calcium Sorbate	Potassium Sorbate
903, 652	No reports	No reports	1, 028, 960

A 1969 review comparing sorbic acid and sulfur dioxide reports Food Facts and Household Food Consumption and Expenditure as indicating that unconditional maximum daily intake of sorbic acid to be 750 mg/day for a 60 kg person, 12.5 mg/kg, and the conditional maximum intake to be 1,500 mg/day for the same person, 25 mg/kg. Similar data was not available for the sodium, potassium, and calcium salts of sorbic acid.

Complete data on probable average, high, and maximum exposure to sorbic acid and potassium sorbate are given under Consumer Exposure Information(314b). No such data was available for sodium and calcium sorbate.

Chemical Information

I. Nomenclature

A. Common names (294a)

Sorbic Acid

Sodium Sorbate

Potassium Sorbate

Calcium Sorbate

B. Chemical names (294a)

Sorbic Acid

Trans, trans 2,4-Hexadienoic Acid

2-Propenylacrylic Acid

Sodium Sorbate

Sodium 2,4-Hexadienate

Potassium Sorbate

Sorbic Acid, potassium salt

Potassium 2,4-Hexadienate

2,4-Hexadienoic Acid, potassium salt

Calcium Sorbate

Calcium 2,4-Hexadienate

C. Trade names (294a)

Sorbic Acid - No accessible data in available literature.

Potassium Sorbate - B B powder

Sodium Sorbate - No accessible data in available literature.

Calcium Sorbate - No accessible data in available literature.

D. Chemical Abstracts Services Unique Registry Number

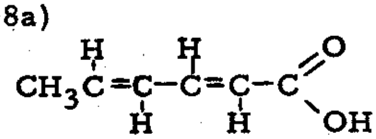
Sorbic Acid :	000110441
Sodium Sorbate :	007757815
Potassium Sorbate :	000590001
Calcium Sorbate :	007492559

II. Empirical Formulae (294a)

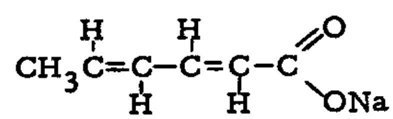
Sorbic Acid :	$C_6H_8O_2$
Sodium Sorbate :	$C_6H_7NaO_2$
Potassium Sorbate :	$C_6H_7KO_2$
Calcium Sorbate :	$C_{12}H_{14}O_4Ca$

III. Structural Formulae (294a, 208a)

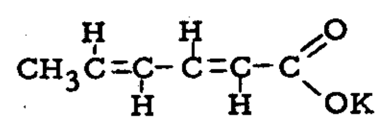
Sorbic Acid :



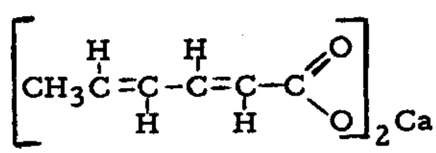
Sodium Sorbate :



Potassium Sorbate :



Calcium Sorbate :



IV. Molecular Weight (130a, 243a)

Sorbic Acid :	112.13
Sodium Sorbate :	134.12
Potassium Sorbate :	150.22
Calcium Sorbate :	262.3

V. Specifications (130a)

A. Chemical

- Sorbic Acid - 99.0 to 101.0% on anhydrous basis
- Sodium Sorbate - No accessible data in available literature
- Potassium Sorbate - 98.0 to 101.0% - $C_6H_7KO_2$ on a dried basis
- Calcium Sorbate - 98 - 102% - $C_{12}H_{14}O_4Ca$ on a dried basis

B. Food Grade (130a)

Sorbic Acid

Assay: Not less than 99% nor more than 101.0% on anhydrous basis.

Limits of Impurities:

Arsenic (as As). Not more than 3 ppm (0.0003%).

Heavy metals (as Pb). Not more than 10 ppm (0.001%).

Residue on ignition. Not more than 0.2%.

Water, Not more than 0.5%.

Sodium Sorbate - No accessible data in available literature.

Potassium Sorbate

Assay: Not less than 98.0% and not more than the equivalent of 101.0% of $C_6H_7KO_2$, calculated on the dried basis.

Limits of Impurities:

Acidity (as sorbic acid). Passes test (about 1%).

Alkalinity (as K_2CO_3). Passes test about 1%).

Arsenic (as As). Not more than 3 parts per million (0.0003%).

Heavy metals (as Pb). Not more than 10 parts per million (0.001%).

Loss on drying. Not more than 1%.

Calcium Sorbate - No accessible data in available literature.

C. Official Compendia

Food Chemical Codex. 2nd Edition. 1972 (130a)

VI. Description

A. General characteristics

- Sorbic Acid is a white, free flowing powder with a characteristic odor. It is slightly soluble in water. One gram dissolves in about 10 ml. of alcohol and in about 20 ml. of ether (130a).
- Sodium Sorbate - No accessible data in available literature.
- Potassium Sorbate is a white crystalline material powder or pellets (130a).
- Calcium Sorbate - No accessible data in available literature.

B. Physical Properties (294a)

Sorbic Acid

Melting Point	134.5°
Boiling Point	228° (decomposes)
Vapor Pressure at 20°	< 0.01 mm
143°	50 mm
Flash Point	127°
Ionization Constant at 25°	1.73×10^{-5}

Solubility

Water	30°	0.25%
	100°	3.8%
Propylene Glycol	20°	5.5%
Glycerides		0.6-0.8%

Absolute alcohol or Methanol	12.90%
20% Ethanol	0.29%
Glacial Acetic Acid	11.5%
Acetone	9.2%
Benzene	2.3%
Carbon Tetrachloride	1.3%
Cyclohexane	0.28%
Dioxane	11.0%
Glycerol	0.31%
Isopropanol	8.4%
Isopropyl Ether	2.7%
Methyl Acetate	6.1%
Toluene	1.9%

Sodium Sorbate - No accessible data in available literature.

Potassium Sorbate

Optical rotation d_{30}^{25}	1.363
Melting point	270° (decomposes)
Solubility H_2O at 20°	58.2%
Alcohol	6.5%

Calcium Sorbate - No accessible data in available literature.

C. Stability in containers.

- Sorbic Acid - Store in tight containers protected from light preferably at temperature not exceeding 38° (130a).
- Sodium Sorbate - No accessible data in available literature.
- Potassium Sorbate - Store in tight containers.
- Calcium Sorbate - No accessible data in available literature.

VII. Analytical Methods

A. Identification to distinguish among antioxidants

- TAS (thermonicroseparation) (428)
- Germination (sorbic acid and sodium sorbate) (non-specific) (41)
- Ion Exchange (196)

B. Detection and quantitation in foods and food packaging

General

- Thin Layer Chromatography (sodium, potassium and calcium salts) (88, 348)
- Paper Chromatography, pre-extracted (371)
- Volumetric (426)
- Infrared Spectra (195)
- Gas Chromatography (149)
- Ion Exchange (196)
- Column Chromatography and Ultraviolet (309)
- Ultraviolet (581)

Beer and Wine

- Thiobarbituric Acid (210)
- Ascending Paper and Ultraviolet (162)
- Gas Chromatography (149)

VII. Analytical Methods

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- Column Chromatography and Ultraviolet (309)

Beer and Wine

- Thiobarbituric Acid (210)
- Ascending Paper and Ultraviolet (162)
- Gas Chromatography (149)

- Germination (potassium salt) (576)
- Germination (sorbic acid and sodium salt) (41)

Non-alcoholic Beverages

- Modified Vander Cook and Rolle (rapid) (130)
- Ultraviolet (rapid) (139)
- Germination (sorbic acid and sodium salt) (41)

Fats and Oils

- Color (6)
- TAS (thermomicroseparation) (428)
- Polarographic (277)

Cheese and its Wrappers

- Distillation and Ultraviolet (288)
- Gas Liquid chromatography (240)

Rye Bread

- Gas Chromatography (151a)

Other Detection

- Faraday Tyndall (123)
- Microbiological, turbimetric (457)

VIII. Occurrence and Levels

A. Plants

Sorbic Acid - Natural - rowanberry (sorbapple or mountain ash berry) as the lactone, called parasorbic acid. No levels noted (222a).

Sodium Sorbate - No natural occurrence noted in available literature.

Potassium Sorbate - No natural occurrence noted in available literature.

Calcium Sorbate - No natural occurrence noted in available literature.

B. Animals

Sorbic acid has been detected throughout carcasses.

Sodium Sorbate - No animal occurrence noted in available literature.

Potassium Sorbate - No animal occurrence noted in available literature.

Calcium Sorbate - No animal occurrence noted in available literature.

C. Synthetics

No occurrences noted in available literature.

D. Natural Inorganic Sources

No occurrences noted in available literature.

Biological Data

I. Acute toxicity

Table 1

Animal	Route	Material	LD_{50} mg/kg	Ref.
Rat	oral	Sorbic Acid	7,360	423
Rat	oral	Sodium Sorbate	7,160	423
Rat		Sorbic Acid	5-10,000	498
Rat	oral	Sorbic Acid	10,500	2
		Sorbic Acid	10,500	256
Mouse	i. p.	Sodium Sorbate	2,500	208a
Mouse	i. p.	Potassium Sorbate	1,300	208a
Starving rats				
Male	peroral	Sorbic Acid	4,300	98
Female	peroral	Sorbic Acid	3,650	98

II. Short Term Studies

As seen in Table 2 varying the dosage and duration of the study caused slightly differing results and side effects for sorbic acid and potassium sorbate when administered to mice, guinea pigs, and dogs. No reports were found for subacute toxic effects due to the sodium and calcium sorbates.

Subacute studies of 3-month duration show contradictory results when albino mice and rats were administered sorbic acid (193, 417). On mice and rats fed 40-80 mg/kg/day of sorbic acid, some adverse effects were noted on growth, survival, hematology, blood chemistry, liver function. Similar results were obtained when stress factors such as dietary restriction, low temperature and exposure to carbon tetrachloride (CCl_4) were evaluated. Reproduction in mice and liver function in rats also were adversely effected. However, sorbic acid showed the least undesirable effects on growth, survival, and susceptibility to stress of the substances studies. Interestingly, a polymeric impurity extracted from sorbic acid studied for 2 months in mice and rats at levels of 800 mg/kg showed the same adverse growth, survival, hematological, blood chemistry, and stress effects as did sorbic acid (417). The contradiction is in a study that reported no toxic effects when weight gain, food consumption, survival rate and the effects of stress were measured in 400 albino rats and 1900 mice administered dosages as above, 40-80 mg/kg/day of sorbic acid (193). The same study shows the positive effects of increased immunobiological activity and detoxification function of the liver. Another

SIDE EFFECTS

Table 2

Material	Dosage	Duration Months	Route	Animal	Results	Ref.
Sorbic Acid	40mg/kg/day	3-18	Oral	Mice	Some adverse growth, reproduction and survival; hematology & blood chemistry; stress factors such as dietary restrictions, low temperature and carbon tetrachloride.	(417)
Sorbic Acid 1% oily		2/3	Oral	Guinea Pigs	Increase 4-6 fold phagocytosis of staphylococcus.	(432)
Sorbic Acid	200mg	single dose		Rats	Reduction bile secretions, biliary protein, sodium. Potassium unchanged.	(121)
Potassium Sorbate	200mg	single dose		Rats	Reduction bile secretions, biliary protein, sodium. Potassium unchanged.	(121)
Potassium Sorbate	200mg	single dose		Rats	Slight increase bilirubin, cholesterol pancreatic juice and its protein and its lipase and amylase activity. Reduced chymotrypsin activity.	(121)
Sorbic Acid	2%	3	Oral	Rats	Decrease chymotrypsin and amylase. Slight increase bilirubin and cholesterol. Reduced lipase.	(121)
Potassium Sorbate	2%	3	Oral	Rats	Decrease chymotrypsin and amylase. Slight increase bilirubin and cholesterol. Reduced lipase.	(121)
Sorbic Acid	0.25%	3	Oral	Rats	Increase pancreatic juice and its protein content and all its enzymes.	(121)
Potassium Sorbate	0.25%	3	Oral	Rats	Increase pancreatic juice and its protein content and all its enzymes.	(121)

Table 2 - cont.

Material	Dosage	Duration Months	Route	Animal	Results	Ref.
Sorbic Acid	10% in diet	3	Oral	M & F Albino Rats 2nd generation	Liver homogenate oxygen consumption difference significant at 95% level.	(95)
Sorbic Acid	10% in diet	3	Oral	M & F Albino Rats	Female controls, highest liver homogenate oxygen consumption. Treated M. & F. results almost identical.	(95)
Sorbic Acid	10% in diet		Oral	Albino Rats	Higher liver weight to body weight.	(95)
Sorbic Acid	.1-2%	2 1/2	Oral	Albino Rats Male	Larger liver.	(234)
Sorbic Acid	40mg/kg/day	3-18	Oral	Rats	Some adverse growth, liver function, survival, hematology and blood chemistry; stress factors such as dietary restrictions, low temperature and carbon tetrachloride.	(417)
Sorbic Acid	2,000	single dose	Oral	Rats	Inhibited exocrine function of pancreas.	(498)
Sorbic Acid	1,600	3	Oral	Rats	Inhibited exocrine function of pancreas.	(498)
Sorbic Acid			Stomach Tube	Rats	Slight reduction of total protein content and chymotrypsin activity. Raised amylase and lipase activity.	(499)
Potassium Sorbate			Stomach Tube	Rats	Slight reduction of total protein content and chymotrypsin activity. Raised amylase and lipase activity.	(499)
Sorbic Acid		Chronic	Stomach Tube	Rats	Increase all indices except chymotrypsin and lipase activity.	(499)

positive factor was the prevention of the toxic effect of the antibiotic Nisin but this was at the expense of some of the benefits resulting from the use of sorbic acid (193).

"Unequivocal proof" of the harmlessness of sorbic acid used as a fungistat in foods is indicated by the acute toxicity data previously cited and by the lack of adverse effects observed in rats and dogs fed a diet containing up to 8% sorbic acid for 3 months. The same study showed a definite toxicity of sodium benzoate at the 8% level (98). In a comparative study of preservatives, it was clearly shown that sorbic acid was more desirable than other preservatives including sulfur dioxide. Greater daily intakes of sorbic acid were determined to be acceptable (256, 417). The United Kingdom has found sorbic acid acceptable for their food regulations because of its low toxicity. Another advantage of sorbic acid is the production of energy from its breakdown in the animal including man (256).

The safety of sorbic acid was again indicated in a 3-month study that showed no side effects. The mice tested were injected intramuscularly with 35 mg/kg/day as a 10% solution in alcohol of sorbic acid, propyl sorbate, sorbyl alcohol, or sorbyl butyl ether (432).

Even when fed sorbic acid at the 10% level for 30-120 days, the safety of sorbic acid in albino male and female rats in groups of 5 to 10 was evident. Food intake and reproduction were normal but there was a somewhat higher growth rate and a higher liver to body weight ratio. Homogenates of the livers of the above male and female albino rats fed 10% of sorbic acid in the diet consumed oxygen normally with two exceptions. The female control rats had the highest liver homogenate oxygen consumption while the oxygen uptake was the same for the female and male treated rats. There was a statistically significant difference at the 95% level in the oxygen uptake of liver homogenates of the second generation mice in spite of normal values in the parent generation (95).

Other studies showed enlarged livers with normal histology in studies of male albino rats fed 1 to 2% of sorbic acid in their rations for 2 1/2 months. This was accompanied by normal histology of the intestines and by a normal weight curve (234).

A single dose of 200 mg of sorbic acid and potassium sorbate given to rats resulted in a reduction of bile secretions, biliary protein and sodium but the potassium remained unchanged. Those receiving potassium sorbate had slightly elevated bilirubin, cholesterol, pancreatic juice, pancreatic protein, lipase and amylase, and a decreased chymotrypsin activity (121). Extending the study by feeding rats 2 and 0.25% of sorbic acid and potassium sorbate in the diet for 3 months, produced no well defined changes in bile secretion or its protein level. In this part of the test, both the sodium and potassium levels remained normal but billirubin and cholesterol increased in the same study. Pancreatic protein chymotrypsin and amylase were decreased in the 2% of sorbic acid and potassium sorbate segment of the diet study. Potassium sorbate also reduced the lipase activity. Those rats fed the 0.25% of sorbic acid and potassium sorbate, the pancreatic juice secretion, its protein content, and the activity of all the enzymes were increased (121).

An unusual side effect of a 4-6 fold increase in phagocytosis of staphylococcus was found in a 20-day test where sorbic acid was administered as a 1% oily solution by mouth to guinea pigs (432).

III. Long Term Studies

Studies covering from 8 to 18 months show contradictory results when albino mice and rats were administered sorbic acid (193, 417). Though sorbic acid showed the least undesirable effects on growth survival, and susceptibility to stress of the substances studied, some adverse effects were noted on growth, survival, hematology, blood chemistry, liver function. Similar results were obtained when stress factors such as dietary restriction, low temperature and exposure to carbon tetrachloride (CCl_4) were considered. These mice and rats were fed 40-80 mg/kg/day of sorbic acid for 17 to 18 months. Reproduction in the mice and liver function in the rats also were adversely effected (417).

The contradictory study shows that no toxic effects due to sorbic acid were reported when weight gain, food consumption, survival rate and the effects of stress were measured in 400 albino rats and 1900 mice administered the same dosage as above, 40-80 mg/kg/day of sorbic acid for 8 to 18 months. This study also shows the positive effects of increased immunobiological activity and detoxification function of the liver (193). Another positive effect was the prevention of the toxic effect of the antibiotic Nisin but this is at the expense of part of the beneficial effect of sorbic acid (193, 417). Similar feeding studies on 50 female and 50 male rats at 0.1 to 5% sorbic acid levels in the diet reinforced the above study in reporting on toxic symptoms whatsoever for the parent and first generations. Provisional histological examination of 30 second generation rats that received 5% sorbic acid in the diet for 252 days showed no pathological findings (243).

Other chronic administration studies on rats with sorbic acid show an increase in all indices measured except chymotrypsin and lipase activity (499).

No carcinogenicity due to sorbic acid, its sodium, potassium or calcium salts has been found in feeding studies. The only relevant feeding data reported indicates that the incidence of carcinogenicity was not increased over that of the controls in 73 mice fed a continuos diet of 0.2% sorbic acid for 30 days before implantation of Erlich Ascites cells. However, these mice tended to fatten. When sorbic acid was combined with Nisin, the volume of Ascites fluid was lessened (105). Sorbic acid was reported to be actively carcinogenic upon repeated bi-weekly subcutaneous injections of 2 mg sorbic acid in 0.5 ml of arachis oil into 6 male rats for 65 weeks and 97 weeks observation. The first appearance of tumors was 81 weeks for the oil controls and 82 weeks for sorbic acid. At that time only 3 of the control but all 6 of the test rats were alive. This data combined with a 12-week longer observation of the sorbic acid rats tends to invalidate any conclusion that the 5 test rats developing tumors was more significant than the 1 control rat developing tumors.

A possible inhibitor of some engine exhaust carcinogens is indicated in a report of the protection against the photodynamic injury due to benzopyrene Tetrahymena pyriformis by sorbic acid. Other antioxidants showed similar results which were also in direct relationship to their concentration (115).

The many studies on sorbic acid and potassium sorbate reporting no side effects or negative results for specific tests are summarized in Table 3. No data on Long Term Studies of sodium and calcium salts or sorbic acid was accessible in the available literature.

NO ADVERSE SIDE EFFECTS

Table 3

Material	Dosage	Duration Months	Route	Animal	Sex & No.	Parameter Observed	Ref.
Sorbic Acid	35mg/kg/day(a)	3	i.m.	Mice		Toxicity	(432)
Sorbic Acid	40-80mg/kg/day	3-18	Oral	Mice		See table 2	(193)
Sorbic Acid	2% (b)	3	Oral	Rats		Bile secretion, its protein content, sodium and potassium	(121)
Potassium Sorbate	2% (b)	3	Oral	Rats		Bile secretion, its protein content, sodium and potassium	(121)
Sorbic Acid	0.25% (b)	3	Oral	Rats		Bile secretion, its protein content, sodium and potassium	(121)
Potassium Sorbate	0.25% (b)	3	Oral	Rats		Bile secretion, its protein content, sodium and potassium	(121)
Sorbic Acid	1-2% (b)	2 1/2	Oral	Albino Rats	Male	Histology liver, intestines and weight	(234)
Sorbic Acid	1,200mg/kg/day	5	Oral	Rats		Pathology pancreas and liver	(498)
Sorbic Acid	10% (b)		Oral	Albino Rats		Food intake, growth reproduction	(95)
Sorbic Acid	10% (b)		Oral	Albino Rats	Parent M & F	Oxygen uptake of liver homogenates	(95)

Table 3 - cont.

Material	Dosage	Duration Months	Route	Animal	Sex & No.	Parameter Observed	Ref.
Sorbic Acid	5% (b)		Oral	Rats		Metabolism essential fats	(98)
Sorbic Acid	1,200mg/kg/day	3	Oral	Rats		Pathology pancreas and liver	(498)
Sorbic Acid	5% (b)			Dogs & Rats		Essential fats	(98)
Sorbic Acid	5% (b)	chronic	Oral	Dogs & Rats		Toxicity	(243)
Potassium Sorbate	400-1,000 & greater mg/liter		Oral in juice, wine, soft drinks	Presumed human		Toxicity	(594)

(a) 10% in alcohol, also propyl sorbate, sorbyl alcohol, and sorbyl butyl ether.

(b) of diet.

IV. Special Studies

As a part of other studies, the following important significant findings have been elucidated:

- Test male albino rats showed less storage in the liver and increased excretion of vitamin A after the administration of carotene for 2, 4, and 6 weeks than did the controls with the storage decrease most pronounced after 2 weeks (234).
- Sorbic acid and sodium sorbate have been found to be safe antiseptics and antifungal agents (2, [illegible]).
- When 1% oily solution of sorbic acid and several of its derivatives were administered orally to guinea pigs for 20 days, a 4-6 fold phagocytosis of staphylococcus gradually developed (432).

A biproduct of testing the action of sorbic and its sodium and potassium salts as food preservatives has been the following pertinent biochemical and microbiological information.

- Studies on intact microorganisms showed a pH dependence of in vivo respiration and of cell permeability (34).
- Toxic action directly related to sorbic acid dissociation (34).
- The production of ethyl ketones were found with studies on *Aspergillus niger* but the synthesis of citric and oxalic acids were not influenced by sorbic acid (275).

- No inhibitory effects on the germination of microorganisms were noted using a media containing 10 mg% sorbic acid and 30-50 mg% of sodium sorbate (41).

- Larvae of <u>Agria affinis</u> showed that higher dosages of potassium sorbate produced decreased growth rate. development, and survival (602).

- The toxicity of the esters of sorbic acid was found to be greater than that of sorbic acid on microorganism (491).

No special studies on calcium sorbate were found in the available literature.

Biochemical Aspects

I. Breakdown

None noted in available literature

II. Absorption - Distribution

None noted in available literature

III. Metabolism and Excretion

Thorough investigation of sorbic acid in all phases delineates its metabolism to be identical in animals and human beings (256).

In rabbits fed sorbic acid, its salts and selected derivatives, the urine yielded 0.1% - 0.2% of trans-trans muconic acid for sorbic acid; methyl sorbate yielded no product, and ethyl sorbate yielded 0.5% of trans-trans muconic acid. Sorbamide, sorbmethylamide and sorbanilide were also studied (237). Small amounts of sorbic acid have also been found in the urine of mice (481). Yet, when fasting rats were fed equimolar amounts of sorbic, caproic, and butyric acids, an identical ketonuria was found (98).

In rats, sorbic acid does not act as an anti-metabolite for essential fats as there was no alteration in their levels observed in these animals when fed 5% sorbic acid in the diet (98).

The appropriateness of sorbic acid to be used as a poultry feed was based mainly on the availability of energy therefrom, its digestibility and palatability, and the rate of mortality during testing (493).

The metabolic results of a group of enzyme studies on bacteria and yeast cells tend to confirm the cellular breakdown of sorbic acid and some of its salts to carbon dioxide and water (92, 275).

IV. Effects of Enzymes and Other Biochemical Parameters

When a diet containing glucose oxidase 0.28 units/100 grams or containing glucose oxidase and catalase 0.14 - 0.28 units/100 grams plus sorbic acid was fed daily for 12 months to mice and rats, no difference was experienced between the test and control animals (36).

A study of sorbic acid on 400 albino rats and 1900 mice administered 40-80 mg/kg/day over a 3- to 18-month period showed increased immunobiological activity and detoxification function of the liver (193).

Manometric studies suggest that sorbate would competitively combine with co-enzyme A and acetate. Consequently, it would inhibit the enzyme reaction relating to co-enzyme A. It is suggested that the sorbate moiety of sorbyl-co-enzyme A might be transferred to the 4-amino radical of sulfanilamide enzymatically as does acetyl-co-enzyme A. The sorbate being taken up in preference by co-enzyme A may inhibit the enzyme reactions relating to co-enzyme A. Respiration of the yeast cells was only slightly reduced in the presence of a high concentration of co-enzyme A (169).

The enzymes aldolase and urease were not significantly inhibited by sorbic acid in ficin but the sulfhydryl enzymes and alcohol dehydrogenase were inhibited at the level of 10^{-4} moles per liter (482).

Phospho and other enzymatic systems in cell free yeast extracts showed no inhibitory effect due to sorbic acid and/or potassium sorbate. Another study on cell free yeast extracts shows that sorbic acid inhibits carbon dioxide production in some sugars and 1, 6-diphospho and 3-phosphoglyceric acid (34), and potassium sorbate decreases the uptake of D-xylose due to the inhibition of the energy supply necessary for metabolism (93). The site of sorbic acid inhibition was between 2-phosphoglyceric acid and phosphoenolpyruvate (92).

In the complex reactions of the inhibition of enolase by sorbic acid, there is a dependence on the substrate and sorbic acid concentrations (34, 169). A dependence of the permeability of yeast cell on undissociated sorbic acid content has been shown to influence enolase inhibition (34).

Extensive growth studies of Procandida albicans in a sorbic acid environment show a stronger inhibitory effect under anaerobic than aerobic conditions.

The decreased inhibitory effects of sorbic acid on the growth of yeast cells aerobically is attributed to the aerobic detoxification of the sorbic acid by the yeast cells. Cysteine and glutathione increase the degree and duration of the inhibitory effects of sorbic acid by decreasing the detoxification thereof. Potassium sorbate at 250 ppm showed no difference in the anaerobic and aerobic activity (92).

Results of experiments on the enzyme polyphenoloxidase point to the idea that it may be stabilized by sorbic acid attaching to the apoferment (114).

Sorbic acid was not found to be oxidized by catalytic aciton of the blood (414).

V. Drug Interaction

When administered in conjunction with Nisin, the toxic effect of both compounds is reduced and the benefits of sorbic acid are reduced (105, 193, 417). Fattening also occurs in mice with the co-administration of sorbic acid and Nisin (105). No data as to drug interaction of the sodium, potassium and calcium sorbates was found in the available literature.

VI. Consumer Exposure Information

The total United States usage, in pounds, in 1970 as reported in an NAS/FEMA study is:

Sorbic Acid	Sodium Sorbate	Potassium Sorbate	Calcium Sorbate
903,652	No reports	1,028,960	No reports

A 1969 review comparing sorbic acid and sulfur dioxide reports Food Facts and Household Food Consumption & Expenditures as indicating that sorbic acid was already widely used in 1966. The potential human intake in mg/day based on the ounces/week or g/day and parts per million of sorbic acid consumed by an average person thusly reported are shown in Table 4. The same article shows the unconditional maximum daily intake of sorbic acid to be 750 mg/day for a 60 kg person, 12.5 mg/kg, and the conditional maximum acceptable daily intake to be 1,500 mg/day for the same person, 25 mg/kg (256).

The level of usage in all sorbic acid and its sodium, potassium and calcium salts ranges from 0.003 to 0.05% in foods (314a).

Reprints of survey data on the average usage, usual high usage and maximum usage of sorbic acid and potassium sorbate are given in Tables 5 and 6 (314b).

TABLE 4
Per Head
Potential intake of Sorbic Acid in mg/day

Food	Food oz/wk	Food g/day	Sorbic Acid ppm	Sorbic Acid mg/day
Cheese	3·38	12·9	1 000	12·9
Preserves	2·96	12·0	500	6
Dried fruits, nuts and nut and fruit products	0·99	4·0	1 000	4
Bread	38·47	156·4	2 000 (on flour wt. i.e. 280–395 of bread)	221·7
Cakes & pastries	4·45	18·0	1 000	18
Pickles & Sauces	1·21	5·0	1 000	5
Fruit juices (incl. welfare orange juice)	0·54	2·2	600	1·3
Wine	3·9	15·8	250	4·0
Fruit or fruit pulp for manufacturing purposes	0·59	2·4	1 500	3·6
Soft drinks	30·8	124·7	160	20·0
TOTAL				292·5

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TABLE 5 PART A — POSSIBLE DAILY INTAKES OF NAS APPENDIX A SUBSTANCES (GROUPS I & II), PER FOOD CATEGORY AND TOTAL DIETARY, BASED ON FOOD CONSUMPTION BY TOTAL SAMPLE - - -

SUBSTANCE NAME (SURVEY NO.)	FOOD CATEGORY NO. NAME	# OF FIRMS	(AGE)	********** POSSIBLE DAILY INTAKE, MG. ********** AVERAGE	HIGH A	HIGH B
SORBIC ACID NAS 0211	01 BAKED GOODS(R)	10	0-5 MO.	.902360	1.194300	1.423240
			6-11 MO.	6.741160	13.747720	10.632440
			12-23 MO.	14.464300	23.832970	22.813700
			2-65+ YR.	36.412880	54.080520	57.431920
SORBIC ACID NAS 0211	04 FATS OILS(R)	4	0-5 MO.	.275550	.275550	.275550
			6-11 MO.	1.543080	4.133250	1.543080
			12-23 MO.	3.471990	6.613200	3.471930
			2-65+ YR.	9.644250	17.414760	9.644250
SORBIC ACID NAS 0211	05 MILK PRODS(R)	*	0-5 MO.	.321300	.23[illegible]000	.3[illegible]3700
			6-11 MO.	3.712[illegible]00	17.555950	4.037200
			12-23 MO.	3.242750	10.376800	3.565750
			2-65+ YR.	2.350250	7.175700	2.587250
SORBIC ACID NAS 0211	06 CHEESE(R)	5	0-5 MO.	**************	.147080	**************
			6-11 MO.	3.971160	14.265760	5.121630
			12-23 MO.	11.472240	32.651760	14.755820
			2-65+ YR.	13.225520	34.710680	17.230860
SORBIC ACID NAS 0211	07 FROZN DAIRY(R)	*	0-5 MO.	.100000	.410000	.120000
			6-11 MO.	.950000	2.640000	1.140000
			12-23 MO.	1.440000	3.380000	1.725000
			2-65+ YR.	2.560000	6.170000	3.072000
SORBIC ACID NAS 0211	14 PRCCSD VEGS(R)	*	0-5 MO.	.368900	1.106700	.369740
			6-11 MO.	6.324000	14.756000	6.338400
			12-23 MO.	10.276500	17.200550	10.259900
			2-65+ YR.	22.397300	37.733700	22.448500
SORBIC ACID NAS 0211	15 CONDM RELSH(R)	*	0-5 MO.	**************	.010000	**************
			6-11 MO.	.080000	.220000	.400000
			12-23 MO.	.280000	.760000	1.400000
			2-65+ YR.	.880000	2.120000	4.400000
SORBIC ACID NAS 0211	16 SOFT CANDY(R)	*	0-5 MO.	2.800000	28.000000	2.800000
			6-11 MO.	30.800000	95.200000	30.800000
			12-23 MO.	49.000000	130.200000	49.000000
			2-65+ YR.	81.200000	246.400000	81.200000
SORBIC ACID NAS 0211	17 CONF FROST(R)	*	0-5 MO.	**************	.005000	**************
			6-11 MO.	.005000	.010000	.010000
			12-23 MO.	.010000	.035000	.020000
			2-65+ YR.	.015000	.040000	.030000
SORBIC ACID NAS 0211	18 JAM JELLY(R)	*	0-5 MO.	**************	.150000	**************
			6-11 MO.	3.350000	11.150000	6.700000
			12-23 MO.	1.500000	5.600000	3.000000
			2-65+ YR.	2.850000	8.850000	5.700000

COMPREHENSIVE GRAS SURVEY --- NAS/NRC 1972 10/02/72

TABLE 5 PART A — POSSIBLE DAILY INTAKES OF NAS APPENDIX A SUBSTANCES (GROUPS I & II), PER FOOD CATEGORY AND TOTAL DIETARY, BASED ON FOOD CONSUMPTION BY TOTAL SAMPLE - - -

SUBSTANCE NAME (SURVEY NO.)	FOOD CATEGORY NO. NAME	# OF FIRMS	(AGE)	AVERAGE	HIGH A	HIGH B
SORBIC ACID NAS 0211	19 SWEET SAUCE(R)	6	0-5 MO.	.139170	.185550	.258330
			6-11 MO.	.417510	1.438090	.774990
			12-23 MO.	1.206140	3.525640	2.238560
			2-65+ YR.	3.154520	8.303810	5.855450
SORBIC ACID NAS 0211	20 GELATIN PUD(R)	*	0-5 MO.	.006800	.009180	.007200
			6-11 MO.	.043520	.131920	.046080
			12-23 MO.	.046920	.114240	.049680
			2-65+ YR.	.069360	.178500	.073440
SORBIC ACID NAS 0211	23 BEV TYPE I(R)	*	0-5 MO.	.000240	.000360	.000240
			6-11 MO.	.002270	.007770	.002270
			12-23 MO.	.005420	.016250	.005420
			2-65+ YR.	.010400	.027770	.010400
SORBIC ACID NAS 0211	27 GRAVIES(R)	*	0-5 MO.	.087040	.261120	.121600
			6-11 MO.	1.218560	3.394560	1.702400
			12-23 MO.	3.132440	8.875080	4.377600
			2-65+ YR.	7.224320	18.539520	10.092800
SORBIC ACID NAS 0211	28 IMIT DAIRY(R)	*	0-5 MO.	.000000	.000000	**************
			6-11 MO.	.700000	1.150000	**************
			12-23 MO.	.400000	1.700000	**************
			2-65+ YR.	.450000	.750000	**************
SORBIC ACID NAS 0211	ALL CATEGORIES	28	0-5 MO.	5.001360	31.992850	5.729600
	**************		6-11 MO.	99.259060	180.102020	69.298470
	**************		12-23 MO.	99.945640	244.850440	116.770680
	**************		2-65+ YR.	183.044000	442.502460	220.370900

COMPREHENSIVE GRAS SURVEY -- NAS/NRC 1972 — 10/02/72

TABLE 6 PART A — POSSIBLE DAILY INTAKES OF NAS APPENDIX A SUBSTANCES (GROUPS I & II), PER FOOD CATEGORY AND TOTAL DIETARY, BASED ON FOOD CONSUMPTION BY TOTAL SAMPLE - - -

SUBSTANCE NAME (SURVEY NO.)	FOOD CATEGORY NO. NAME	# OF FIRMS	(AGE)	POSSIBLE DAILY INTAKE, MG. AVERAGE	HIGH A	HIGH B
POTASSIUM SORBATE NAS 0158	01 BAKED GOODS(R)	14	0-5 MO.	2.149140	2.844450	2.459900
			6-11 MO.	16.055340	32.742900	18.576[illegible]
			12-23 MO.	34.445450	56.762580	[illegible]
			2-65+ YR.	66.724120	126.621980	59.2[illegible]
POTASSIUM SORBATE NAS 0158	04 FATS OILS(R)	12	0-5 MO.	.680550	.683550	.722250
			6-11 MO.	3.811000	10.208250	4.044600
			12-23 MO.	8.574930	16.331200	9.100350
			2-65+ YR.	23.815250	43.010760	25.278750
POTASSIUM SORBATE NAS 0158	05 MILK PRODS(R)	4	0-5 MO.	1.066500	.790600	2.529760
			6-11 MO.	12.324000	59.269750	30.392510
			12-23 MO.	10.763750	34.444000	26.531050
			2-65+ YR.	7.801250	23.818500	19.232550
POTASSIUM SORBATE NAS 0158	06 CHEESE(R)	8	0-5 MO.	**************	.151550	**************
			6-11 MO.	4.092660	14.703260	5.453690
			12-23 MO.	11.623240	33.650760	15.070560
			2-65+ YR.	14.248520	35.772880	19.126120
POTASSIUM SORBATE NAS 0158	07 FROZN DAIRY(R)	6	0-5 MO.	.050500	.207050	.061900
			6-11 MO.	.479750	1.333200	.[illegible]
			12-23 MO.	.727200	1.706900	1.424100
			2-65+ YR.	1.292000	3.115850	2.[illegible]
POTASSIUM SORBATE NAS 0158	08 PROCSD FRUT(R)	9	0-5 MO.	2.763390	7.35[illegible]	4.76[illegible]
			6-11 MO.	30.235660	75.297300	52.737[illegible]
			12-23 MO.	58.720220	116.564590	102.470[illegible]
			2-65+ YR.	69.051710	146.275220	120.461[illegible]
POTASSIUM SORBATE NAS 0158	09 FRUIT ICES(R)	*	0-5 MO.	.000000	.000000	.000000
			6-11 MO.	.195000	.520000	.210[illegible]
			12-23 MO.	.390000	1.365000	.490000
			2-65+ YR.	.455000	1.625000	.490000
POTASSIUM SORBATE NAS 0158	10 MEAT PRODS(R)	*	0-5 MO.	.002200	.005000	.[illegible]
			6-11 MO.	.041400	.111600	.[illegible]
			12-23 MO.	.060400	.168000	.0[illegible]
			2-65+ YR.	.156000	.260200	.235200
POTASSIUM SORBATE NAS 0158	13 FISH PRODS(R)	*	0-5 MO.	.042800	.128400	.042800
			6-11 MO.	.556400	2.097200	.556400
			12-23 MO.	2.311200	5.778000	2.311200
			2-65+ YR.	5.307200	13.225200	5.307200
POTASSIUM SORBATE NAS 0158	14 PROCSD VEGS(R)	*	0-5 MO.	.707280	2.121840	1.170660
			6-11 MO.	12.124000	28.291200	20.20[illegible]
			12-23 MO.	14.702600	32.9[illegible]	[illegible]
			2-65+ YR.	42.442000	72.344640	71.[illegible]

TABLE 6 PART A -- POSSIBLE DAILY INTAKES OF NAS APPENDIX A SUBSTANCES (GROUPS I & II), PER FOOD CATEGORY AND TOTAL DIETARY, BASED ON FOOD CONSUMPTION BY TOTAL SAMPLE - - -

SUBSTANCE NAME (SURVEY NO.)	FOOD CATEGORY NO. NAME	# OF FIRMS	(AGE)	******************** POSSIBLE DAILY INTAKE, MG. AVERAGE	HIGH A	HIGH B *************
POTASSIUM SORBATE NAS 0158	15 CONDM RELSH(R)	5	0-5 MO.	*************	.030030	*************
			6-11 MO.	.240240	.660660	.435720
			12-23 MO.	.840840	2.282230	1.535520
			2-65+ YR.	2.642640	6.376360	4.225523
POTASSIUM SORBATE NAS 0158	16 SOFT CANDY(R)	10	0-5 MO.	.108420	1.084200	.115720
			6-11 MO.	1.192420	3.638260	1.277520
			12-23 MO.	1.897350	5.041530	2.025100
			2-65+ YR.	3.144120	9.540960	3.374880
POTASSIUM SORBATE NAS 0158	17 CONF FROST(R)	8	0-5 MO.	*************	.082620	*************
			6-11 MO.	.082620	.165240	.083330
			12-23 MO.	.165240	.578340	.166660
			2-65+ YR.	.247860	.660960	.249990
POTASSIUM SORBATE NAS 0158	18 JAM JELLY(R)	4	0-5 MO.	*************	.177100	*************
			6-11 MO.	3.957020	13.170330	6.395570
			12-23 MO.	1.771800	6.614720	2.863008
			2-65+ YR.	3.366420	10.453670	5.441270
POTASSIUM SORBATE NAS 0158	19 SWEET SAUCE(R)	13	0-5 MO.	.168540	.225120	.159920
			6-11 MO.	.506520	1.744680	.598750
			12-23 MO.	1.453280	4.277230	1.730040
			2-65+ YR.	3.827040	10.074120	4.524770
POTASSIUM SORBATE NAS 0158	20 GELATIN PUD(R)	8	0-5 MO.	11.109800	15.478230	11.470010
			6-11 MO.	74.402720	225.221170	74.776400
			12-23 MO.	80.107620	195.044640	80.224400
			2-65+ YR.	118.419960	304.757250	119.055200
POTASSIUM SORBATE NAS 0158	22 SNACK FOODS(R)	*	0-5 MO.	*************	.030000	*************
			6-11 MO.	.120000	.330000	.330000
			12-23 MO.	.330000	.531000	.600000
			2-65+ YR.	.390000	1.110000	1.040000
POTASSIUM SORBATE NAS 0158	23 BEV TYPE I(R)	12	0-5 MO.	.392400	.591600	.093440
			6-11 MO.	3.711450	12.703056	8.072120
			12-23 MO.	8.861700	26.560750	19.273100
			2-65+ YR.	17.004600	45.403950	36.982400
POTASSIUM SORBATE NAS 0158	24 BEV TYPE II(R)	*	0-5 MO.	.000000	.000000	.000000
			6-11 MO.	*************	.020970	*************
			12-23 MO.	*************	.041940	*************
			2-65+ YR.	6.615250	19.735680	8.265250
POTASSIUM SORBATE NAS 0158	27 GRAVIES(R)	*	0-5 MO.	.048940	.146820	.066130
			6-11 MO.	.685150	1.908660	.897520
			12-23 MO.	1.761840	4.991880	2.308620
			2-65+ YR.	4.052620	10.424220	5.322790

TABLE 6 PART A -- POSSIBLE DAILY INTAKES OF NAS APPENDIX A SUBSTANCES (GROUPS I & II), PER FOOD CATEGORY AND TOTAL DIETARY, BASED ON FOOD CONSUMPTION BY TOTAL SAMPLE - - -

SUBSTANCE NAME (SURVEY NO.)	FOOD CATEGORY NO. NAME	# OF FIRMS	(AGE)	******** POSSIBLE DAILY INTAKE, MG. ******** AVERAGE	HIGH A	HIGH B
POTASSIUM SORBATE NAS C158	28 IMIT DAIRY(R)	*	0-5 MO.	.000000	.000000	[illegible]
			6-11 MO.	.910000	[illegible]	[illegible]
			12-23 MO.	.520000	2.210000	.400000
			2-65+ YR.	.585000	.975000	.675000
POTASSIUM SORBATE NAS C158	48 SEAS FLAVRS(R)	*	0-5 MO.	**************	**************	**************
			6-11 MO.	**************	.001000	**************
			12-23 MO.	**************	.002000	**************
			2-65+ YR.	.001000	.005000	.001000
POTASSIUM SORBATE NAS C158	ALL CATEGORIES	63	0-5 MO.	19.770780	52.322090	[illegible]
	**************		6-11 MO.	165.224440	425.691480	[illegible]
	**************		12-23 MO.	245.242860	548.202050	[illegible]
	**************		2-65+ YR.	412.304020	887.837350	553.371020

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