

SCOGS-9

EVALUATION OF THE HEALTH ASPECTS OF SORBITOL
AS A FOOD INGREDIENT

DECEMBER 1972

Prepared for

Bureau of Foods
Food and Drug Administration
Department of Health, Education, and Welfare
Washington, D.C.



Contract No. FDA 72-85



LIFE SCIENCES RESEARCH OFFICE
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FOR EXPERIMENTAL BIOLOGY
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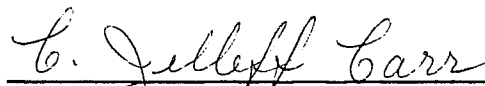
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NOTICE

This report is one of a series of evaluations of the health aspects of the Generally Recognized as Safe (GRAS) food substances that are being made by the Life Sciences Research Office of the Federation of American Societies for Experimental Biology under contract with the Food and Drug Administration of the U. S. Department of Health, Education, and Welfare. The Federation recognizes that the safety of GRAS substances is of national significance, and its resources are particularly suited to marshalling the opinions of knowledgeable scientists to assist in these evaluations. The Life Sciences Research Office, established in 1962 to make scientific assessments in the biomedical sciences, is conducting these studies.

Qualified scientists were selected as consultants to make a continuing review, analysis, and evaluation of the available information on each of the GRAS substances. These scientists, designated the Select Committee on GRAS Substances, were chosen for their competence and judgment with due consideration for balance and breadth in the appropriate professional disciplines. Members of the Select Committee on GRAS Substances who have contributed to this report are named in Section VII. The Select Committee's evaluations are being made independently of FDA or any other governmental or nongovernmental group.

These reports are approved by the Select Committee prior to submission to FDA. Although most LSRO consultants are members of FASEB constituent societies, the reports do not necessarily reflect the views of the Federation as a corporate body or carry the endorsement of the members of its constituent societies.


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I. INTRODUCTION

Under the terms of FDA Contract 72-85, dated March 30, 1972, FASEB's Life Sciences Research Office was requested to evaluate the health aspects of using sorbitol as a food ingredient, primarily on the basis of information contained in a monograph summarizing the world's scientific literature from 1920 through 1970, and in certain supplemental documents available as of December 1972. The LSRO Select Committee on GRAS Substances has reviewed these materials and submits its interpretation and assessment in this report, which is intended for the use of FDA in determining the future status of sorbitol under the Federal Food, Drug, and Cosmetic Act.

II. BACKGROUND INFORMATION

Sorbitol, which is one of the hexahydric alcohols derived commercially by the catalytic reduction of glucose, is a normal constituent of such fruits as cherries, plums, pears, apples, and many berries (1, 2).

The Food Chemicals Codex specifies that the food grade product should contain not less than 91 percent sorbitol, and the food grade solution, not less than 64 percent sorbitol. Maximum limits are specified for arsenic, heavy metals, chloride, sulfate, total sugars, and reducing sugars (3).

In the food industry, sorbitol is used to promote retention of original food quality during storage and shipment or to endow foods with improved quality or texture, because of its capacity to function as a crystallization modifier, humectant, softening or plasticizing agent, sweetness or viscosity controller, or rehydration aid (2).

Sorbitol is present in amounts ranging from 93.5 to 0.001 percent in the following categories of foods, arranged in decreasing order of sorbitol content: hard candy, chewing gum, soft candy, baked goods, frozen dairy products, milk products, poultry products, fish products, nonalcoholic beverages, meat products, frostings, snack foods, processed fruits, nut products, fats and oils, gelatin puddings, alcoholic beverages, sweet sauces, and seasonings and flavors (4).

It should be noted that the Federal Food and Drug Administration's GRAS list indicates a tolerance of 7 percent for sorbitol in foods for special dietary use (23). In a conflicting order (24), FDA states that sorbitol may be safely used in food provided the amount used does not exceed that reasonably required to accomplish the physical or technical effect.

Sorbitol is reported to have been first used as a food ingredient in the United States in 1929. The total amount of sorbitol used in foods in 1970 is reported to be about seven times that used in 1960 (4). However, there is no information now available to the Select Committee that permits it to determine the extent to which there has been significant change in the sorbitol content of the foregoing food categories over the past decade.

III. CONSUMER EXPOSURE DATA

A comprehensive survey by a National Research Council subcommittee has provided information on the possible daily human intake of sorbitol in the total diet, as shown in the following table for individuals in various age groups (4). The Select Committee has converted these figures to possible intakes per kilogram of body weight.

Age group	Possible daily intake			
	Total		Per kilogram of body weight*	
	Average	Maximum	Average	Maximum
	mg	mg	mg	mg
0-5 months	770	2,096	154	419
6-11 months	6,959	17,223	870	2,153
12-23 months	13,670	27,419	1,243	2,493
2-65+ years	30,191	55,439	503	924

*Calculations based on an average weight of 60 kg for an adult (5) and the following estimated weights of infants by age groups: 0-5 mos., 5 kg; 6-11 mos., 8 kg; and 12-23 mos., 11 kg (6).

It is recognized that the figures calculated for the daily intake of sorbitol per kg of body weight in the age group 2-65+ years could be deceptively low, since the majority of individuals from age 2 to maturity will probably weigh less than 60 kg. Thus the daily intake of sorbitol for children could be significantly higher than the figures indicated. For example, a child weighing 20 kg could consume, on the average, 1,510 mg per kg rather than 503 mg, and at a maximum, 2,772 mg per kg per day rather than 924 mg.

However, such deviations from the figures in the table must also be considered in respect to total production and use of sorbitol. The data developed by the NRC subcommittee are based on (a) a survey of the frequency of eating various food products, (b) a determination of the portion size of these food products, and (c) a survey of food producers to determine the percentage use of sorbitol in these food products (4). The NRC subcommittee has pointed out that its calculations of intakes in most cases are overstated, often by considerable margins.* That human intakes are undoubtedly overstated in the case of sorbitol is borne out by the following two calculations.

The NRC subcommittee has also provided data (4) to show that the use of sorbitol for food purposes in the United States was 7,622,141 pounds (3.46 million kg) in 1970. This figure is reported to comprise between 60 and 70 percent of the total actual poundage used in food. On the basis of 60 percent adjusted to 100 percent (12.70 million pounds or 5.77 million kg), and a U. S. population of 200 million, the per capita per day average intake would be only 79 mg rather than the 30,191 mg given in the foregoing table.

U. S. Tariff Commission figures (21) show that 105 million pounds (47.7 million kg) of sorbitol were produced in the U. S. in 1970 for all purposes. Even if all of the 105 million pounds were used in food, the per capita per day average intake of sorbitol would be only 654 mg rather than the 30,191 mg given in the foregoing table.

*An explanation for such overstatements is detailed in Section XI, "Significance and Use of Data in Safety Evaluations," of the NRC subcommittee report (4). The Select Committee finds this explanation reasonable and concurs in the first recommendation of Section XII of the same report that "In order to conduct a more accurate survey on the intake of substances used in food processing, food consumption data collected specifically for this purpose are needed."

On the basis of these considerations, the Select Committee regards the figures given in the table as levels that are highly unlikely to be achieved by any of the age groups, but more likely, are generous over-estimates of the sorbitol content of the daily diet.

IV. BIOLOGICAL STUDIES

Orally administered sorbitol is absorbed and metabolized rapidly by man through normal glycolytic pathways, ultimately to carbon dioxide and water (7, 8, 9, 10). After a 35 g dose (equivalent to 583 mg per kg) in normal and in diabetic adults, for example, less than 3 percent of the sorbitol was excreted in the urine in any case and the concentration of sorbitol in the blood was found to be immeasurably small. No evidence of toxicity was reported (7).

The oral LD₅₀ of sorbitol in male and female mice is reported to be 23,200 and 25,700 mg per kg respectively; in male and female rats, 17,500 and 15,900 mg per kg respectively (11). The oral LD₁₀₀ for the male rat is separately reported as 26,000 mg per kg (12).

The following short term studies of the oral administration of sorbitol are relevant:

In 40 g male rats, fed 5 percent sorbitol in a balanced diet, no toxic effects were observed during the three months of feeding (13). Feed consumption is not reported, but estimates based on other data presented indicate that sorbitol was being fed at a level of approximately 5 g per kg per day.

Rhesus monkeys fed sorbitol at a level of 8 g per kg per day for 3 months remained unaffected (13).

Man, consuming 10 g of sorbitol each day (equivalent to 167 mg per kg) for one month remained unaffected (13).

Normal children, 5-6 years old and normal infants, 20-35 months old, fed 9.3 g of sorbitol (equivalent to 500 or more mg per kg) remained unaffected except for the appearance of diarrheal stools in the younger group (14).

The laxative threshold for sorbitol, established in 12 normal adults, has been reported to be 50 g (equivalent to 833 mg per kg) (13). It is also reported, in a study involving 86 volunteers, that a dosage level of 25 g per day in two doses does not cause laxation (22).

The following long-term studies of the oral administration of sorbitol are relevant:

Rats fed 5 percent sorbitol (equivalent to 5 g per kg per day) through three generations showed no deleterious effects on growth rate or liver glycogen storage capacity. There were no gross or histological abnormalities in kidney, liver, spleen, pancreas, or duodenum attributable to sorbitol (15). A subsequent report has indicated that weanling rats, given sorbitol at levels of 10 to 15 percent in the diet for 17 months and observed over 4 successive generations, showed no evidence of deleterious effects on weight gain, reproduction, lactation, or histological appearance of the main organs (11).

Rats fed 16 percent sorbitol for 19 months showed a tendency to become hypercalcemic after one year, with the appearance in some animals of bladder concretions and a generalized thickening of the skeleton (16). No feed consumption or animal weight figures were reported, but sorbitol level was estimated to be of the order of 16 g per kg.

No oral studies of the carcinogenic activity of sorbitol have been reported. However, studies in rats revealed that injected sorbitol, in the form of an iron-sorbitol citric acid product (Jectofer), produced no injection site tumors.

Sorbitol, at dose levels of 5 g per kg did not produce any measurable mutagenic response in the host-mediated assay in mice, in the metaphase chromosomes of rat bone marrow, or in the dominant lethal test in the rat. A slight increase was noted in the mitotic recombination frequency for Saccharomyces cerevisiae in the host-mediated assay, and a moderate, dose-related adverse effect was exhibited by human embryonic lung cells scored at anaphase (19).

Sorbitol elicited no teratogenic response in pregnant mice or rats fed a daily dose of 1600 mg per kg for 10 days, or in hamsters fed 1200 mg per kg per day for 5 days (20).

The Joint Food and Agriculture Organization/World Health Organization Committee on Food Additives indicates the acceptable daily intake of sorbitol for man as follows: "Conditional acceptance (as a food additive or as a food) not limited" (11).

V. OPINION

The available information reveals that there are no short-term toxicological consequences in rats, mice, monkeys, or man, and no long-term toxicological consequences in rats, of consuming sorbitol in amounts exceeding those currently consumed in the normal diet of the U. S. population. There is no evidence that consumption of sorbitol as a food ingredient has had adverse effects on man in the many years it has been so used.

It is to be noted that sorbitol begins to exert a laxative effect at levels that are about twice the estimated average adult intake level and about equal to the estimated maximum adult intake level. It should be noted also that the average consumption levels of children in the age groups 6-11 months and 12-23 months are now estimated to be close to, or in excess of, those capable of exerting a laxative effect. However, because the reported average and maximum intake levels are known to be generous overestimates, it is the opinion of the Select Committee that the use of sorbitol in food in the present or reasonably foreseeable amounts poses no problem in this regard.

The Select Committee is concerned that the actual consumption of sorbitol may be considerably higher than average consumption in certain segments of the population. These individuals, for dietary reasons, may select foods containing particularly high levels of sorbitol. Currently available food consumption data do not permit the Select Committee to determine the extent and significance of this problem in regard to sorbitol.

The Select Committee has weighed the foregoing and concludes that:

There is no evidence in the available information to show that sorbitol as a food ingredient constitutes a hazard to the general public when used at levels that are now current or that might reasonably be expected in future.

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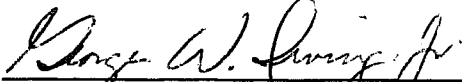
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January 22, 1973
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