EVALUATION OF THE HEALTH ASPECTS OF DEXTRIN
AND CORN DEXTRIN AS FOOD INGREDIENTS

1975

Prepared for

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

Contract No. FDA 223-75-2004
EVALUATION OF THE HEALTH ASPECTS OF DEXTRIN
AND CORN DEXTRIN AS FOOD INGREDIENTS

1975

Prepared for

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

Contract No. FDA 223-75-2004

Life Sciences Research Office
Federation of American Societies
for Experimental Biology
9650 Rockville Pike
Bethesda, Maryland 20014
NOTICE

This report is one of a series concerning the health aspects of using the Generally Recognized as Safe (GRAS) or prior sanctioned food substances as food ingredients, being made by the Federation of American Societies for Experimental Biology (FASEB) under contract no. 223-75-2004 with the Food and Drug Administration (FDA), U.S. Department of Health, Education, and Welfare. The Federation recognizes that the safety of GRAS substances is of national significance, and that its resources are particularly suited to marshalling the opinions of knowledgeable scientists to assist in these evaluations. The Life Sciences Research Office (LSRO), established by FASEB in 1962 to make scientific assessments in the biomedical sciences, is conducting these studies.

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

Tentative reports are made available to the public for review in the Office of the Hearing Clerk, Food and Drug Administration, after announcement in the Federal Register, and opportunity is provided for any interested person to appear before the Select Committee at a public hearing to make oral presentation of data, information, and views on the substances covered by the report. The data, information, and views presented at the hearing are considered by the Select Committee in reaching its final conclusions. Reports are approved by the Select Committee and the Director of LSRO, and subsequently reviewed and approved by the LSRO Advisory Committee (which consists of representatives of each constituent society of FASEB) under authority delegated by the Executive Committee of the Federation Board. Upon completion of these review procedures the reports are approved and transmitted to FDA by the Executive Director of FASEB.

While this is a report of the Federation of American Societies for Experimental Biology, it does not necessarily reflect the opinion of all of the individual members of its constituent societies.

C. Jelleff Carr, Ph.D., Director
Life Sciences Research Office
FASEB
<table>
<thead>
<tr>
<th>CONTENTS</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Introduction</td>
<td>1</td>
</tr>
<tr>
<td>II. Background information</td>
<td>2</td>
</tr>
<tr>
<td>III. Consumer exposure data</td>
<td>4</td>
</tr>
<tr>
<td>IV. Biological studies</td>
<td>8</td>
</tr>
<tr>
<td>V. Opinion</td>
<td>11</td>
</tr>
<tr>
<td>VI. References cited</td>
<td>13</td>
</tr>
<tr>
<td>VII. Scientists contributing to this report</td>
<td>16</td>
</tr>
</tbody>
</table>
I. INTRODUCTION

This report concerns the health aspects of using dextrin and corn dextrin as food ingredients. It has been based partly on the information contained in a scientific literature review (monograph) furnished by FDA (1), which summarizes the world's scientific literature from 1920 through 1973.* To assure completeness and currency as of the date of this report this information has been supplemented by searches of over 30 scientific and statistical reference sources and compendia that are generally available; use of new, relevant books and reviews and the literature citations contained in them; consideration of current literature citations obtained through computer retrieval systems of the National Library of Medicine; searches for relevant data in the files of FDA; and by the combined knowledge and experience of members of the Select Committee and the LSRO staff. In addition, announcement was made in the Federal Register of August 29, 1975 (40 FR 39917 and 39918) that opportunity would be provided for any interested person to appear before the Select Committee at a public hearing to make oral presentation of data, information, and views on the health aspects of using dextrin and corn dextrin as food ingredients. The Select Committee received one request for such a hearing but this request was withdrawn.

As indicated in the Food, Drug, and Cosmetic Act [21 USC 321(s)], GRAS substances are exempt from the premarketing clearance that is required for food additives. It is stated in the Code of Federal Regulations 21 CFR121.1, revised April 1, 1975 that GRAS means general recognition of safety by experts qualified by scientific training and experience to evaluate the safety of substances on the basis of scientific data derived from published literature. This section of the Code also indicates that expert judgment is to be based on the evaluation of results ofcredible toxicological testing or, for those substances used in food prior to January 1, 1958, on a reasoned judgment founded in experience with common food use, and is to take into account reasonably anticipated patterns of consumption, cumulative effects in the diet, and safety factors appropriate for the utilization of animal experimentation data. FDA recognizes further (21 CFR 121.3) that it is impossible to provide assurance that any substance is absolutely safe for human consumption.

The Select Committee on GRAS Substances of LSRO is making its evaluations of these substances in full recognition of the foregoing provisions. In reaching its conclusions on safety the Select Committee, in accordance with FDA's guidelines, is relying primarily on the absence of substantive evidence of, or reasonable grounds to suspect, a significant risk to the public health. While the Select Committee realizes that a conclusion based

*The document (PB-228 539/3) is available from the National Technical Information Service, U.S. Department of Commerce, P.O. Box 1553, Springfield, Virginia 22161.
on such reasoned judgment is expected even in instances where the available information is qualitatively or quantitatively limited, it recognizes that there can be instances where, in the judgment of the Select Committee, there are insufficient data upon which to base a conclusion. The Select Committee, aware that biological testing is dynamic, bases its conclusions on information now available; it cannot anticipate the results of experiments not yet conducted or those of tests that may be reconducted, using new technologies. These conclusions will need to be reviewed as new or better information becomes available.

In this context, the LSRO Select Committee on GRAS Substances has reviewed the available information on dextrin and corn dextrin and submits its interpretation and assessment in this report, which is intended for the use of FDA in determining the future status of these substances under the Federal Food, Drug, and Cosmetic Act.

II. BACKGROUND INFORMATION

Dextrins are polymers of \(\alpha\)-D-glucose. Like the starches from which they are prepared, the anhydroglucose units in dextrins are linked mainly through carbon atoms 1 and 4; other linkages may be present depending on the starch from which the dextrin is prepared and the method of preparation (2, 3). In commercial practice the term "dextrin" refers to products produced by dry heating or roasting unmodified starch with or without an acid or alkaline catalyst (2). More specific names are pyrodextrins, pyrofaction and torrefaction dextrins. This report is concerned only with these products.

Not evaluated in this report are a number of starch products referred to as dextrins in the literature. The term "dextrin" has been applied broadly to enzymatic or acid hydrolysis products of starch intermediate in molecular weight between maltose and native starch as well as to the dry-roasted starches (2, 3). Residues of the action of acid (4) or enzymes (5) on starch are referred to in the older literature as amylopectins. In more recent literature the term "maltodextrin" has been applied to low molecular weight fractions of hydrolyzed starch containing up to 90 anhydroglucose units (6-8). The starch processing industry classifies as maltodextrins starch hydrolyzates for which the dextrose equivalent (reducing sugar content expressed as dextrose in percentage of dry solids) is less than 20 (9). The maltodextrins of commerce are closely related to corn syrups in composition, physical form and production methods. They are considered as corn syrups in a forthcoming Select Committee report, "Evaluation of the Health Aspects of Corn Sugar and Corn Syrup as Food Ingredients." Another group of commercial starch products included under the broad definition of dextrins is
the acid-modified starches. These products result from the partial acid hydrolysis of starch in an aqueous slurry with the retention of granular form of the starch. The acid-modified starches are classified as "food starch-modified" under CFR 121.1031 and appear on the list of substances generally recognized as safe (GRAS), 21 CFR 121.101(h) that may migrate to food from paper and paperboard used in food packaging (10). They will be considered in a forthcoming Select Committee report, "Evaluation of the Health Aspects of Starches and Modified Starches as Food Ingredients."

Cyclic polymers of 6 to 12 anhydroglucose units joined through α-1, 6-linkages formed from starch by the action of Bacillus macerans amylase are called Schardinger dextrans (II). Residues of starch molecules which represent the limit of action by various enzymes have been termed limit dextrans (2) and are characteristic of the particular enzyme and the previous treatment of the starch. Neither the Schardinger dextrans nor the limit dextrans are marketed as commercial products and will not be considered in this report.

Dextrin is a GRAS substance, 21 CFR 121.101(h), that may migrate to food from paper and paperboard products used in food packaging (10). Corn dextrin is cited among the GRAS substances that may migrate to food from cotton and cotton fabrics used in dry food packaging, 21 CFR 121.101(i). Dextrin also is on the list of GRAS substances which was included in the Food Additive Hearings, 85th Congress (12). Under regulations 21 CFR 20.1 and 21 CFR 17.1 dextrin is permitted in ice cream and bread, respectively (10).

The pyrodextrans are classified into three primary categories according to the conditions for their preparation and their properties. These are the white dextrans, yellow or canary dextrans and the British gums as given in Table I. Primary raw material for the production of dextrans in the United States is corn starch although dextrans produced from waxy maize and waxy milo starches have been marketed. Dextrins are produced also from potato, tapioca and sago starches; these products are largely imported and are used in much smaller amount than domestic corn dextrans. Each dextrin product category represents a range of products depending on the specific temperature, acid concentration and time of reaction employed. Product properties also depend on the starch source. About 4 percent of the anhydroglucose units in common starches carry branches attached at carbon atom 6; the number of such branched units may be increased in the dextrinization process and linkages may be introduced at carbon atoms 2 and 3. In addition, dextrinization reduces the molecular weight of native starches and generally increases their solubility in water (2).

The principal reaction occurring in the production of white dextrans, particularly low-conversion products, appears to be hydrolytic scission of starch molecules as indicated by increase in reducing value and by the results of periodate oxidation analyses (13). Concurrent increase in solubility and decrease in viscosity reflect the disruption in granule structure...
and reduction in molecular size of the amylose and amylopectin components of the unmodified starch. It has been suggested, but no direct experimental evidence presented in support, that under certain conditions for white dextrin production glucosan or inner ether structures might be created and trans-glycosidation reactions occur leading to the formation of new types of glucosidic linkages (13).

### TABLE I

Classifications of Dextrins (2)

<table>
<thead>
<tr>
<th>Manufacturing conditions</th>
<th>White dextrins</th>
<th>Canary dextrins</th>
<th>British gums</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usual catalyst</td>
<td>HCl</td>
<td>HCl</td>
<td>none or alkali</td>
</tr>
<tr>
<td>Temperature, °C</td>
<td>79-121</td>
<td>149-190</td>
<td>135-190</td>
</tr>
<tr>
<td>Time, hr</td>
<td>3-7</td>
<td>6-20</td>
<td>10-24</td>
</tr>
<tr>
<td>Product characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Color</td>
<td>white to light</td>
<td>buff to dark</td>
<td>buff to</td>
</tr>
<tr>
<td></td>
<td>cream</td>
<td>yellow or brown</td>
<td>dark brown</td>
</tr>
<tr>
<td>Solubility in water, %</td>
<td>1-98</td>
<td>95-100</td>
<td>1-100</td>
</tr>
</tbody>
</table>

Conditions for production of yellow or canary dextrins lead to the breakdown of starch molecules and formation of structures more highly branched than the amylopectin component of the original starch (14, 15). In a commercial corn dextrin, additional 1,6-glycosidic linkages were formed and new 1,3- and 1,2-glycosidic linkages introduced (14).

New glycosidic linkages also are introduced in starch during conversion to British gums (14, 16). Thompson and Wolfram (16) isolated the following compounds from partial acid hydrolyzates of a dextrin made by roasting amylose under conditions similar to those for commercial production of British gums from starch: maltose, isomaltose, gentiobiose, sophorose, and 1,6-anhydro-β-D glucopyranose, the latter occurring as chain terminal units.

### III. CONSUMER EXPOSURE DATA

A survey by a National Research Council (NRC) subcommittee has provided information on the level of addition of dextrins to foods in several food categories as given in Table II (17). Information on food uses of dextrin was not requested but was volunteered by some of the respondents to the
survey. For this reason the data collected were not as extensive as that for most other GRAS substances. Based on information supplied by those manufacturers who reported adding the substance to at least one food in a category, a weighted mean was calculated for the usual and maximal addition of the substance to foods in that category. For a given category, the mean of the usual addition levels reported by a manufacturer was weighted by the ratio of total pounds used by that manufacturer in all categories to the total pounds of dextrin reported used by all manufacturers that reported use in the category. Only the weighted means of the usual level of addition are reported in Table II.

**TABLE II**

**Level of Addition of Dextrins to Foods by Food Category (17)**

<table>
<thead>
<tr>
<th>Food category</th>
<th>Weighted mean* percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baked goods, baking mixes</td>
<td>0.62</td>
</tr>
<tr>
<td>Milk, milk products</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Frozen dairy desserts, mixes</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Soft candy</td>
<td>0.10</td>
</tr>
<tr>
<td>Sugar, confections</td>
<td>0.30</td>
</tr>
<tr>
<td>Gelatins, puddings, fillings</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Beverages, nonalcoholic</td>
<td>0.01</td>
</tr>
<tr>
<td>Nuts, nut products</td>
<td>3.10</td>
</tr>
<tr>
<td>Gravies, sauces</td>
<td>1.20</td>
</tr>
<tr>
<td>Hard candy</td>
<td>0.13</td>
</tr>
<tr>
<td>Chewing gum</td>
<td>0.19</td>
</tr>
<tr>
<td>Sugar substitutes</td>
<td>94.25</td>
</tr>
<tr>
<td>Seasonings and flavors</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

*Level of addition of dextrins is the weighted mean of the levels reported by manufacturers as their usual addition to one or more products in a food category. For discussion of weighted mean see text, also Section X and Exhibit 50 of reference 17.

The NRC subcommittee also computed possible daily average human intakes of dextrins (Table III) for each of the food categories based on the level of addition given in Table II, data from the Market Research Corporation of America on the frequency of eating foods in these food categories by individuals in four age groups, and USDA data on mean portion size. The Select Committee has converted these figures into possible intakes per kilogram of body weight. It should be noted that dextrin intake figures in
**TABLE III**

Possible Daily Average Intake of Added Dextrins by Food Category and Age Group\(^a\)(17)

<table>
<thead>
<tr>
<th>Food category</th>
<th>0-5 months mg</th>
<th>0-5 months mg/kg(^b)</th>
<th>6-11 months mg</th>
<th>6-11 months mg/kg(^b)</th>
<th>12-23 months mg</th>
<th>12-23 months mg/kg(^b)</th>
<th>2-65+ years mg</th>
<th>2-65+ years mg/kg(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baked goods, baking mixes</td>
<td>96</td>
<td>19</td>
<td>178</td>
<td>22</td>
<td>340</td>
<td>31</td>
<td>851</td>
<td>14</td>
</tr>
<tr>
<td>Milk, milk products</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>1</td>
<td>&lt;1</td>
<td>1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Frozen dairy desserts, mixes</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>1</td>
<td>&lt;1</td>
<td>1</td>
<td>&lt;1</td>
<td>1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Soft candy</td>
<td>6</td>
<td>1</td>
<td>8</td>
<td>1</td>
<td>7</td>
<td>1</td>
<td>11</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Sugar, confections</td>
<td>1</td>
<td>&lt;1</td>
<td>2</td>
<td>&lt;1</td>
<td>8</td>
<td>1</td>
<td>10</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Gelatins, puddings, fillings</td>
<td>1</td>
<td>&lt;1</td>
<td>1</td>
<td>&lt;1</td>
<td>1</td>
<td>&lt;1</td>
<td>1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Beverages, nonalcoholic</td>
<td>2</td>
<td>&lt;1</td>
<td>2</td>
<td>&lt;1</td>
<td>4</td>
<td>&lt;1</td>
<td>7</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Nuts, nut products</td>
<td>12</td>
<td>2</td>
<td>344</td>
<td>43</td>
<td>180</td>
<td>16</td>
<td>338</td>
<td>6</td>
</tr>
<tr>
<td>Gravies, sauces</td>
<td>13</td>
<td>3</td>
<td>37</td>
<td>5</td>
<td>84</td>
<td>8</td>
<td>160</td>
<td>3</td>
</tr>
<tr>
<td>Hard candy</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>1</td>
<td>&lt;1</td>
<td>3</td>
<td>&lt;1</td>
<td>7</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Chewing gum</td>
<td>***</td>
<td>***</td>
<td>2</td>
<td>&lt;1</td>
<td>1</td>
<td>&lt;1</td>
<td>1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Sugar substitutes</td>
<td>***</td>
<td>***</td>
<td>189</td>
<td>24</td>
<td>94</td>
<td>9</td>
<td>660</td>
<td>11</td>
</tr>
<tr>
<td>Seasonings and flavors</td>
<td>***</td>
<td>***</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

\(^a\) The figures in this table apply only to individuals who ate foods in the particular food category one or more times during the 14-day survey period, not to figures based on the amounts of food consumed by the entire survey population. The figures are valid for any particular substance on an individual food category basis only. They are not cumulative across all food categories, since no person could be expected to eat foods from all categories in any single day at the consumption levels shown.  

\(^b\) Calculated intake, mg/kg body weight, was based on an average weight of 60 kg for an adult (18) and the following estimated weights of infants by age groups: 0-5 mo, 5 kg; 6-11 mo, 8 kg; and 12-23 mo, 11 kg (19). Asterisks (*** in the table mean that there were insufficient data on which to base an estimate.
Table III are not additive across food categories for the reasons given in the table footnote. Insufficient data were available to permit the NRC subcommittee to estimate dextrin intake from the total diet.

U.S. production and imports of pyrodextrins for several of the years from 1951 to 1971 are given in Table IV (2). Not included in Table IV are imported sago, arrowroot, corn, rice and wheat starch dextrins which, together with starches from the same sources, were imported in total amounts ranging from 10 to 26 million pounds (4.5 to 11.8 million kg) yearly. The major uses for dextrins are as an adhesive in paper products and as a sizing and printing paste component for textiles; these would include food packaging applications. Direct food applications served by the white and yellow or canary dextrins represent a minor use. This distribution of products is supported by Russell (20) who reported that 150 million pounds (67 million kg) of dextrins were sold for industrial (nonfood) applications in 1972. If it is assumed that 150 million pounds of dextrins also were used in nonfood applications in 1971, then about 30 million pounds (13.6 million kg) were available for direct food uses. This quantity would represent a daily per capita consumption of about 180 mg. Comparison with the intake figures in Table III suggests that values for several of the categories may be overestimates. The NRC subcommittee has recognized that its intake figures represent overestimates, often by considerable margins.*

TABLE IV

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn (domestic)</td>
<td>188</td>
<td>169</td>
<td>182</td>
<td>169</td>
<td>187</td>
<td>188</td>
<td>171</td>
</tr>
<tr>
<td>Potato (imported)*</td>
<td>3</td>
<td>5</td>
<td>8</td>
<td>11</td>
<td>11</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>191</td>
<td>174</td>
<td>190</td>
<td>180</td>
<td>198</td>
<td>202</td>
<td>183</td>
</tr>
</tbody>
</table>

*Imports of other starch dextrins, mainly tapioca, sago, arrowroot, rice, corn and wheat also may contribute in minor quantities to the U.S. supply.

*An explanation of such overstatements is detailed in Section XI, "Significance and Use of Data in Safety Evaluations" of the NRC subcommittee's report (17). The Select Committee finds this explanation reasonable and concurs in the first recommendation in 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."

- 7 -
No information is available on the quantity of dextrins used in the manufacture of food packaging materials or on the fraction of that used which enters food within the package as a result of migration. The Select Committee estimates, however, that the quantity of dextrins which enters the diet from this source is severalfold less than that from direct food uses.

IV. BIOLOGICAL STUDIES

Absorption and metabolism

Booher et al. (21) determined the weight gain and digestibility in rats of wheat and potato starch dextrins and their parent starches. The starches were dextrinized by heating thin layers of dry starch in a rotary shelf oven at 191 °C for 95 minutes which resulted in the loss, or very rapid fading, of blue coloration on addition of iodine. These products could be considered as low conversion British gums because no catalyst was used. A dextrin similar to a commercial white dextrin was prepared by autoclaving wheat starch moistened with 0.1 percent citric acid for 6 hours at 15 pounds steam pressure (120 °C). Using matched feeding techniques the dextrins and their parent starches were fed at a level of 63.7 percent (approximately 60 g per kilogram body weight) in a diet containing 18.8 percent casein to weanling male rats, initial weight 45 to 60 g, for 21 to 28 days. Digestibility and assimilability of the wheat starch "British gum" were not significantly different from those of untreated wheat starch whereas the digestibility of the wheat starch "white dextrin" was somewhat lower. The "British gum" prepared from potato starch gave a higher body weight gain and digestibility coefficient than the parent starch; this was attributed to disruption of the starch granule structure by the dextrinization process making the granule less resistant to enzymatic attack.

Short-term studies

Reussner et al. (22) compared protein efficiency values and rat growth data obtained from feeding a series of starches, modified starches, disaccharides and monosaccharides to groups of 10 male Wistar rats, (50 to 55 g) in diets at two levels of protein and carbohydrate. The diets contained 6 and 15 percent protein from casein and 77 and 66 percent carbohydrate (approximately 75 and 65 g carbohydrate per kg body weight), respectively. The diets also contained 10 percent corn oil and vitamin and mineral supplements. The corn dextrin fed was a commercial product "prepared from corn starch which was heated in the presence of mineral acid" and thus was probably a white or canary dextrin. After 28 days protein efficiency and weight gain per gram of dry food were significantly lower for corn dextrin than for corn starch but were greater or equal to
values for dextrose. The corn dextrin diets caused a slight diarrhea and also enlarged ceca to about twice the weight of those in rats fed unmodified corn starch. Corn dextrin diets caused no untoward effects on liver weight or liver fat content.

Harper et al. (23) investigated the influence of various carbohydrates including dextrins on the utilization of protein and liver fat deposition. Sprague-Dawley rats, initial weight 40 to 50 g, were fed for periods of 2 to 12 weeks diets containing 81.6 percent carbohydrate, 9 percent casein, 5 percent corn oil and vitamin and mineral supplements. Two dextrins were fed: Dextrin A was a laboratory product prepared by heating dry corn starch in an oven at 145 °C for 10 hours; dextrin M was described only as a commercial product. Both gave red-violet colors with iodine indicating the presence of short- or branched-chain molecules. Rates of gain with dextrin A and dextrin M (approximately 80 g dextrin per kg body weight) over a four-week period were about 15 percent less than that for autoclaved corn starch. The latter rate was about double that when the carbohydrate source was glucose or sucrose. The authors attributed the greater growth response for the dextrins and autoclaved starch to concurrent absorption of carbohydrate and amino acids over a longer period of time and to possible differences in intestinal flora. Liver fat deposition was less for dextrin M, corn starch or glucose than for sucrose as the carbohydrate source. Values were not reported for dextrin A.

Hundley (24) used Sprague-Dawley and Osborne-Mendel weanling rats, weighing 40 to 50 g, in a study of the influence of starch, dextrin, and other carbohydrates on the niacin requirement of the rat. Diets consisted of 81 percent carbohydrate (about 80 g per kg body weight), 9 percent casein, 3 percent gelatin, 3 percent corn oil, 0.15 percent L-cystine and supplemental minerals and vitamins. The dextrin was described as a white dextrin, National Formulary V (Merck). Weight gain for a four-week period with niacin supplementation was the same for dextrin, starch and glucose as carbohydrate sources; without niacin, growth rate fell about 40 percent for starch and dextrin diets as compared to 60 percent for glucose as the carbohydrate source, indicating a lesser niacin requirement on the starch and dextrin diets.

Long-term studies

Cohen et al. (25) reported physiologic effects of different dietary carbohydrates fed to male Sprague-Dawley rats for 18 months, beginning at 2 months of age. Diets consisted of a rat chow (basal diet -- 57 percent carbohydrate, 23 percent protein, 5 percent fat) mixed with 20 percent by weight of the various carbohydrates (approximately 10 g experimental carbohydrate per kg body weight) including a dextrin, sucrose and cereolose (dextrose). The dextrin was described only as a commercial product prepared from corn starch by roasting in the presence of HCl. Protein
efficiency ratios after 6 months feeding were approximately equal for the
dextrin, cerelose and sucrose diets and significantly higher than that for the
rat chow diet; weight gain at 20 months was about 5 percent less for
dextrin than for cerelose or sucrose but about 5 percent more than on the
basal rat chow. Compared to the basal diet the testicle/body weight ratio
was greater for rats on the dextrin diet and less on the other carbohydrate
diets; liver/body weight ratios did not differ. The toxicological significance
of the observation on testicle weight is not apparent.

Special studies

Several diets which differed only in the carbohydrate source were
used by Guerrant et al. (26) to study the effect of type of carbohydrate on
the synthesis of the B-vitamins in the digestive tracts of rats. Diets con-
tained 18 percent casein, 71 percent carbohydrate, 3 percent butterfat, cod
liver oil and salt mixture. Carbohydrates included corn starch, dextrin-
ized corn starch, glucose, lactose and sucrose. The dextrin was prepared
by moistening starch with a 0.1 percent solution of citric acid, autoclaving
for 4 hours at 15 pounds pressure (120 °C), drying and pulverizing. Rats
were placed on experimental diets at 21 days of age. Animals on all diets
with access to their feces, but without supplemental B-vitamins, showed
low or declining growth rates after two weeks except for the group fed the
dextrin diet. Growth rates were increased in all groups after receiving
feces of the dextrin-fed group. Rats fed the dextrin diet had enlarged ceca.
Cecectomized rats with access to their feces lost weight when fed a dextrin
diet; supplementation with Baker's yeast resulted in weight gain. The
authors concluded that the peculiar property of dextrinized corn starch was
not due to retained B-vitamins, but rather to the formation of these vitamins
in the lower part of the digestive tract of the rat as a result of incomplete
digestion of this particular carbohydrate.

Fournier (27) investigated the effect of starch, dextrin, caramel,
and glucose in the diet of rats on calcium retention, serum calcium levels
and cecal size. The dextrin was prepared by heating corn starch in an
oven at 190 °C for 5 hours. The ochre powder obtained was only slightly
soluble in water and yielded 2 percent maltose in a pancreatin test as com-
pared to a 20 percent yield from corn starch. Wistar rats, weighing 62
to 74 g, were fed a low calcium diet (50 mg Ca per 100 g diet) for 18 days
after which groups of six rats were placed on diets containing 15 percent
casein, 1.5 percent calcium carbonate and 45.5 to 70.5 percent experi-
mental carbohydrate supplemented with cereal grain to bring total
carbohydrate to about 70 percent. Estimated intakes per kg body weight
are 70 g starch, 46 g dextrin, 59 g glucose and 59 g caramel. Calcium
balance was determined during the 3rd to 5th days; after 10 days the rats
were sacrificed and serum calcium determined. Observations on cecal
enlargement were made after feeding for 2 weeks a diet containing
73.5 percent carbohydrate, 12 percent casein, 8 percent peanut oil, 3 percent salt mixture and 0.5 percent TiO₂.

Calcium intake was nearly the same for all diets but calcium retention for the dextrin and caramel diets was about double that for the starch and glucose diets; serum calcium levels also were greater for the dextrin and caramel diets. Dry cecal weights of rats fed dextrin and caramel were double or more those fed the starch and glucose diets. The author suggested that dextrin and caramel were less easily metabolized than their parent substances, starch and glucose, respectively, and that this property was related to the effects observed.

No reports were found on the allergenicity, carcinogenicity, teratogenicity, mutagenicity or fetotoxicity of dextrins.

The Joint FAO/WHO Expert Committee on Food Additives (28) regarded the white and yellow dextrins as intermediates of normal digestion of starch and as normal constituents of foods. The Committee commented that because of the nature of the applications of the white dextrins as well as their flavor, their use in food is restricted; also that the yellow dextrins are used in foods in limited quantities as adjuvants in flavor encapsulation and similar minor uses. The Committee recommended no limitation on the use of these dextrins except for good manufacturing practice.

V. OPINION

The dextrins covered by this report are those produced by the dry heating of unmodified starch under the range of conditions specified in the body of the report as representative of commercial practice for this class of products. Included are the white dextrins, yellow or canary dextrins and the British gums. The dextrins are similar to their parent starches in that they are composed principally of α-D-anhydroglucose units joined through 1,4-linkages; they differ in that dextrinization reduces the molecular weight and, particularly in case of the yellow or canary dextrins and the British gums, increases branching in the molecules. Dextrinization slightly reduces the digestibility of corn and wheat starch, probably attributable to the more highly branched structure of the dextrins.

Animal feeding studies have shown dextrins to be digested and metabolized to a limited degree without toxic effects when fed at levels many times greater than those present from use of these products as a direct food additive, or at levels that are orders of magnitude greater than might occur by migration from food packaging materials containing dextrins.
The Select Committee concludes that:

There is no evidence in the available information on dextrin and corn dextrin that demonstrates or suggests reasonable grounds to suspect, a hazard to the public when they are used at levels that are now current or that might be reasonably expected in the future.
VI. REFERENCES CITED


VII. SCIENTISTS CONTRIBUTING TO THIS REPORT

1. Members of the Select Committee on GRAS Substances:

Joseph F. Borzelleca, Ph.D., Professor of Pharmacology, Medical College of Virginia, Health Sciences Division, Virginia Commonwealth University, Richmond, Va.

Harry G. Day, Sc.D., Professor of Chemistry and Special Assistant to the Vice Chancellor for Research and Development, Indiana University, Bloomington, Ind.

Samuel J. Fomon, M.D., Professor of Pediatrics, College of Medicine, University of Iowa, Iowa City, Iowa.

Bert N. La Du, Jr., M.D., Ph.D., Professor and Chairman, Department of Pharmacology, University of Michigan Medical School, Ann Arbor, Mich.

John R. McCoy, V.M.D., Professor of Comparative Pathology, New Jersey College of Medicine and Dentistry, Rutgers Medical School, New Brunswick, N.J.

Sanford A. Miller, Ph.D., Professor of Nutritional Biochemistry, Massachusetts Institute of Technology, Cambridge, Mass.

Gabriel L. Plaa, Ph.D., Professor and Chairman, Department of Pharmacology, University of Montreal Faculty of Medicine, Montreal, Canada.

Michael B. Shimkin, M.D., Professor of Community Medicine and Oncology, School of Medicine, University of California, San Diego, La Jolla, Calif.

Ralph G.H. Siu, Ph.D., Consultant, Washington, D.C.

John L. Wood, Ph.D., Distinguished Service Professor, Department of Biochemistry, University of Tennessee Medical Units, Memphis, Tenn.

George W. Irving, Jr., Ph.D. (Chairman) Research Associate Life Sciences Research Office, Federation of American Societies for Experimental Biology, Bethesda, Md.
2. LSRO staff:

C. Jelleff Carr, Ph.D., Director
Kenneth D. Fisher, Ph.D., Associate Director
Richard G. Allison, Ph.D., Research Associate
Samuel B. Detwiler, Jr., Research Associate
Andrew F. Freeman, Research Associate
Frederic R. Senti, Ph.D., Research Associate
John M. Talbot, M.D., Research Associate

Report submitted by:

December 12, 1975
Date

George W. Irving, Jr., Chairman
Select Committee on GRAS Substances