A REVIEW OF THE POSSIBLE ALLERGENICITY
OF TABLE SYRUPS

JULY 1974

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by

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FOREWORD

The Federation of American Societies for Experimental Biology (FASEB) recognizes that its resources are particularly suited to marshalling the opinions of knowledgeable scientists to provide scientific assessments of topics in the biomedical sciences. The Life Sciences Research Office (LSRO), established by FASEB in 1962, provides scientific assessments of topics in the biomedical sciences. Reports of these studies are based upon comprehensive literature reviews and the scientific opinions of knowledgeable investigators engaged in work in specific areas of biology and medicine.

This technical report was prepared for the Division of Nutrition, Bureau of Foods, Food and Drug Administration, by the staff of the LSRO, FASEB, in accordance with the provisions of Contract No. 71-294, Task II, A - "Quick Response Actions on Request." The request for a quick response action precluded the normal review procedures of the Life Sciences Research Office.

The report has been reviewed by the consultants listed in Section IX; and a judicious attempt was made to incorporate the viewpoints and opinions of these consultants but the listing of their names does not imply that they endorse the conclusions of this report. Similarly, the report does not necessarily reflect the opinion of all of the individual members of FASEB constituent societies. The authors are solely responsible for the contents of this report.

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I. INTRODUCTION

In 1970, the Food and Drug Administration (FDA) proposed standards of identity for table, cane, maple, and sorghum syrups (Fine, 1970). In response to this notice the FDA received letters of comment from individuals, organizations, and manufacturers. The majority of comments from the medical community recommended that the source of sugar in each type of table syrup be labeled because it was suspected that these might be the cause of food allergies. Indeed, the issue of labeling various foods containing sugars for this reason had been recognized previously (Randolph, 1951).

To assist in their evaluation of these comments, the Division of Nutrition, Bureau of Foods, FDA requested that the Life Sciences Research Office, Federation of American Societies for Experimental Biology review the issue of the significance of source labeling for persons who may exhibit allergic or hypersensitive reactions to table syrups. Specifically requested were:

1) The opinion and recommendations of allergists with respect to the relative importance of table syrups in causation of allergic or hypersensitive reactions;

2) The available data on prevalence of and evidence for allergy and/or hypersensitivity to table syrups and their constituents; and,

3) The possible steps industry would have to take to declare sources of sugar* and other ingredients in table syrups.

The request was formalized in the establishment of Standards of Identity for Table Syrup, Maple Syrup, Cane Syrup, and Sorghum Syrup (Schmidt, 1974). The announcement stated that at this time there are no data to support a requirement of ingredient source label declaration and that the issue is being reviewed by LSRO, FASEB. This report was prepared in response to this request.

*In this report, the terms fructose and glucose are used rather than levulose or dextrose, respectively. In the food industry the latter terms are frequently used in combination with the terms sugar or syrup to refer to specific commodities (See Hart and Fisher, 1971; Junk and Pancoast, 1973).
II. DEFINITION OF THE ISSUE

A. TABLE SYRUPS

Table syrups are primarily purified, concentrated, aqueous solutions of nutritive saccharides. Commercial "corn syrups" and "corn sugar" are made by acid or enzyme hydrolysis of corn starch. Maple syrup is the product of evaporation of sap of Acer saccharum or A. nigrum. Cane syrup is the product resulting from direct evaporation of juice of Saccharum officinarum without removal of sugar. Sorghum syrup is made from the stalks of Andropogon sorghum (Hart and Fisher, 1971). The recently published Standards of Identity for table syrups (Schmidt, 1974) provide specific definitions for composition and labeling of table syrup, maple syrup, cane syrup, and sorghum syrup.

Table syrup is the liquid food consisting primarily of one or more nutritive carbohydrate sweeteners from sugar cane or sorghum juice, honey, maple sap or hydrolyzed corn starch. It must contain not less than 65% solublable sweetener solids by weight (Schmidt, 1974). When one of the sweetening ingredients is at least 80% of the total sweetener solids, the table syrup may be designated by that source of the sweetener, e.g., "corn syrup." The Standards of Identity also state that maple syrup must contain not less than 66% by weight soluble solids from Acer sp. sap; cane syrup, not less than 74% by weight soluble solids from cane juice; and sorghum syrup, not less than 74% by weight of soluble solids from the juice of sorghum cane.

The Codex Alimentarius Commission (Joint FAO/WHO Food Standards Programme, 1970a, 1970b) has published recommended international standards for glucose syrup and dried glucose syrup. These standards differ slightly from the FDA Standards of Identity with respect to total solids and dextrose equivalent content (Fine, 1973, 1974). The issue of source labeling is not addressed in these recommended international standards; glucose syrup is defined as a product of starch but the source of the starch need not be identified (Joint FAO/WHO Food Standards Programme, 1970a).

The recently published FDA Standards of Identity (Schmidt, 1974) state that for each of the four types of syrups optional ingredients are to be declared on the label. In the case of maple, cane, and sorghum syrups, the source of saccharides used in addition to the main ingredient would be noted on the label. Thus the major issue of allergy or hypersensitivity is associated with table syrups which may not be source labeled.
Such products do not contain at least 52% (80% of the required 65% total sweetener) of an identified nutritive sweetener from one source. For this reason this report focuses upon evidence of possible allergenicity and hypersensitivity reactions to table syrups and their constituents.

B. FOOD ALLERGY

Most authorities agree that food allergies are typically reagin-dependent anaphylactic hypersensitivities (Type I reactions) (Feingold, 1973; Patterson, 1972). Symptoms and signs occur immediately or may be delayed several hours. Food allergies are characterized by a wide range of symptoms and signs including cutaneous, gastrointestinal, and less frequently, respiratory manifestations. The most common signs are relatively rapid development of urticaria and angioedema.

It is possible that patterns of clinically untoward observed responses to foods in general, and table syrups in particular, are not indicative of reagin-dependent anaphylactic hypersensitivities. For example, Feingold (1973) has pointed out that reactions to foods may be both immunologic and nonimmunologic. These latter reactions, clinically similar to Type I hypersensitivity, can be the result of enzyme deficiencies, irritation of the gastrointestinal tract, toxicity of food constituents or additives, or the presence of microbial contamination.

In a recent review, Dolowitz (1974) concluded that a minimum of three mechanisms are necessary for removal of foreign proteins; specifically, antibody recognition, enzymatically mediated release of energy for the process, and chemotactic destruction or absorption of the foreign protein. Because food allergies involve immunoglobulins other than those specifically associated with Type I reactions, Dolowitz (1974) proposed that food allergies should be set apart in a new category, Type V reactions.

Goldstein and Heiner (1970) have suggested that use of the terms "food allergy" and "food hypersensitivity," should be restricted to conditions characterized by typical atopic or other allergic symptoms induced repeatedly by food ingestion or challenge and in which demonstrable immunologic reactions occur. They differentiate "food sensitivity" as a broader definition encompassing both typical food allergy and conditions in which there is a reproducible exaggerated or abnormal reaction to ingestion of specific foods. They recognized that in medical usage, the terms "food sensitivity" and "food intolerance" overlap. Randolph (1956) suggested that "food addiction" may be a more appropriate descriptive term for idiosyncratic untoward responses to foods.
While urticaria and angioedema are typical manifestations of food allergy, the possibility of systemic life-threatening reactions does exist. For example, Golbert et al. (1969) reviewed patient records of the emergency service at Northwestern University Hospitals from January to December 1967 and identified 15 cases of near-fatal anaphylactic shock resulting from ingestion of allergens. Specific food allergens were proven in eight cases and implicated in three other cases. While the total number of patients receiving emergency room services was not reported, these observations indicate that severe life-threatening reactions to specific foods can and do occur.

Most allergists would agree that subclinical food allergies exist in many individuals. Similarly, they agree that identification of food allergies in general and specific allergens in food is difficult. Standard diagnostic procedures include some form of dietary exclusion of the suspected substance with subsequent sensitivity testing or food provocations tests. Treatment is based on avoidance of the symptom inducing constituents of offending food or foods. In most cases, the identification and treatment of food allergies involve the diagnosis and treatment of unique situations requiring both physician experience and patient cooperation.

From this brief synopsis of current concepts, it should be evident that there is no unanimity of opinion among allergists as to the basic mechanism involved in food allergy. No published reports were found that clearly indicate the fundamental nature of possible reactions to table syrups and their ingredients.

With respect to table syrups and their ingredients, the published reports found in this study document symptoms and signs associated with reactions of 19 patients to ingestion of beet sugar and ingestion or injection of cane or corn sugars (Randolph and Rollins, 1950a, 1950b; Randolph and Yeager, 1949; and Randolph et al., 1950). Reactions included nausea, vomiting, gastrointestinal upset, diarrhea, headache, muscle pain, rhinitis, asthma, urticaria and angioedema. These manifestations are typical of reactions to foods which may be categorized as food sensitivity, food allergy or food hypersensitivity.
III. SCOPE OF THE REVIEW

The scientific literature on allergic and hypersensitive reactions to table syrups and their ingredients is scant. In addition to the references cited (Section VIII) and the individuals consulted (Section IX), the following information sources were surveyed for pertinent experimental studies, data, and clinical reports. These sources are listed to document the scope of this review:

A) Scientific Literature Reviews have been prepared for the review of substances that are Generally Recognized As Safe. These substantive monographs review the scientific literature from 1920 to 1970. Three of these monographs concern substances known to be present in table syrups:

1. Monograph on Corn Sugar (Informatics, Inc., 1973a). The bibliography appended to the monograph contains 4925 references; only two citations are concerned with allergy to corn sugar (Randolph and Yeager, 1949; Randolph et al., 1950).


3. Dextrin and Corn Dextrin (Food and Drug Research Laboratories, 1974). Of the 305 references in the bibliography of this monograph, four are concerned with anaphylactoid reactions in rats (Ankier, 1964a, 1964b; Ankier and West, 1968; Veilleux, 1963); one refers to nonallergic dermatitic effects of sucrose (Bender et al., 1936). Palmer (1970) discussed only the technical aspects of using glucose syrups in foods.

B) The International Sugar Research Foundation, Inc. recently prepared a bibliography of sponsored research projects for the period 1943 to 1972 (Cheek, 1974). This compilation has five references to flavor, texture, or acceptability differences with 100% sucrose versus sucrose-corn syrup blended syrups. The index contains
no references to allergy, hypersensitivity, or table syrups.

C) The computerized literature retrieval systems of the National Library of Medicine, Bethesda, Maryland were used to identify further published information. The MEDLINE searches include medical literature from approximately 1200 scientific journals for the period April 1971 to April 1974. A summary of MEDLINE searches is given in Table 1. Of the 5555 citations under carbohydrates (Search #1) and the 3827 under hypersensitivity (Search #2), only eight references appeared to be related to allergy of table syrups and their ingredients. Subsequent reading of these eight articles indicated that only two were indirectly relevant (Lanoff et al., 1973; Pemberton and Johnson, 1973). A search of TOXLINE files (1968 to current) revealed only one additional pertinent reference (Lietze, 1969).

D) The index of Annals of Allergy for 1963 through 1974 was reviewed. No additional pertinent references to allergy or hypersensitivity to sugars, syrups, or table syrups were found.

It is recognized that the paucity of literature citations may reflect either a lack of current scientific investigations or a lack of interest in publication of clinical reports of phenomena that have been documented previously.

The Life Sciences Research Office convened a meeting of immunologists, allergists, and medical specialists on May 14, 1974 to discuss allergy, hypersensitivity and other untoward reactions to ingested forms of iodine. The attendees at this meeting provided their opinions and experience with respect to allergy and hypersensitivity of table syrups. These consultants are included in the list of individuals who reviewed a draft of this report (Section IX).
<table>
<thead>
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<th>Search Details</th>
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</tr>
<tr>
<td>2</td>
<td>Dietary carbohydrate and search #4, 5, 6</td>
</tr>
<tr>
<td>3</td>
<td>Search #1 and searches for adverse effects</td>
</tr>
<tr>
<td>4</td>
<td>Search #1 and toxicology</td>
</tr>
<tr>
<td>5</td>
<td>Search #1 and positions</td>
</tr>
<tr>
<td>6</td>
<td>Search #1 and allergy</td>
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<td>Mainheadings of search #12</td>
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**Summary of Medicine Searches on Table Syrups**

**TABLE 1**

- **Term not indexed.**
- **See Section VIII, References Cited.**
- **Search #1 and #2 used only as sources of citations for subsequent searches.**
IV. POSSIBLE ALLERGENS IN TABLE SYRUPS

Soluble nutritive sweetener(s) and water constitute the major ingredients of table syrups. Optional ingredients include butter, edible fats and oils, emulsifiers, stabilizers, natural and artificial flavorings (alone or in carriers), color additives, salt, chemical preservatives, viscosity adjusting agents, acidifying, alkalizing or buffering agents, defoaming agents, and other ingredients compatible with the specific type of syrup (Schmidt, 1974). The majority of the optional ingredients are Generally Recognized As Safe (GRAS), are added to obtain desired technical effects, and would be indicated on the label panel.

The most variable of the ingredients are the soluble nutritive sweeteners, which may be derived from several sources. It has been assumed that the soluble sweeteners and related materials are the suspected allergens or substances inducing hypersensitivity reactions. In his recent textbook on clinic allergy, Feingold (1973) indicated that there is some clinical evidence that certain edible fats and oils, food colorings and emulsifiers may be allergens. However, the quantity of these substances used in table syrups is minimal; the quantity consumed is small; and, these substances are found in many foods. Therefore, it is presumed that the several types of nutritive carbohydrate sweeteners are the most suspect ingredients in table syrups that are allergenic substances.

Table syrups may contain nutritive carbohydrate sweeteners derived from corn syrup, corn sugar, cane syrup, sorghum syrup or solutions prepared from cane sugar, beet sugar, or honey. Economic considerations and the limited production of maple syrup and maple sugar suggest that these would not be used as the source of soluble sweetener in unspecified blended table syrups. In this country, potato starch is infrequently used as a source of glucose for food use.

Corn syrups are derived from hydrolysis of corn starch. Their physical and chemical properties are variable; the carbohydrate composition depends upon the method of manufacture (Anderson, 1970; Junk and Pancoast, 1973). The percentage of fructose, glucose, sucrose and other disaccharides, trisaccharides, and higher polysaccharides determines the physical properties of the syrup. The several types of corn
syrup are frequently differentiated on the basis of dextrose-equivalent, although corn syrups currently produced have sufficiently different properties to require additional classification. In addition to variable saccharide content, corn syrups contain sulfur dioxide (2 to 110 ppm), and low concentrations of inorganic chlorides, sulfates, and phosphates. Furthermore, protein (300 to 800 ppm) may also be present in corn syrup. This proteinaceous material is derived from zein and gluten in the corn starch and is carried over to the corn syrup during starch hydrolysis (Junk and Pancoast, 1973). It is logical to suggest, but there is no proof, that the proteinaceous materials may function as haptenic or allergenic substances.

Corn sugar is produced from corn starch by several methods of acid or enzyme hydrolysis. According to Hart and Fisher (1971) the term "corn sugar" as applied to glucose (dextrose) is a misnomer because sucrose is the major sugar naturally present in corn, but commercial corn sugar prepared from corn starch contains primarily glucose, or if produced enzymatically, invert sugar. In current practice, hydrolysis of 100 kg of dry corn starch will yield 95 kg of glucose and 14 kg of other sugars. The several corn sugars used in food, as with corn syrups, can be supplied with different dextrose equivalent values and saccharide composition.

Unrefined cane syrup contains primarily sucrose (32.5 to 58%), reducing sugars before inversion (31.6 to 63.8%) and other substances. No information on the nature of these other substances was found; however it is reasonable to assume that inorganic salts and nitrogenous organic compounds could be present in commercially available cane syrups.

Solutions of crystallized cane and beet sugar are relatively pure and contain less extraneous material. However, Leitze (1969) has reported that "unidentified high molecular weight substances" are present in intravenous dextrose solutions.

Honey contains a number of sugars; analyses of 490 samples indicated that honey is composed of fructose (38.2%), glucose (31.3%), sucrose (1.3%), reducing disaccharides (7.3%), polysaccharides (1.5%) and other substances in addition to water. Honey also contains gluconic acid and gluconolactone; the quantity of nitrogenous material is relatively minute (0.041%) (Hart and Fisher, 1971).

In summary, the soluble sweeteners used in table syrups are derived from plant products and contain primarily sucrose, fructose and glucose together with other saccharides in variable amounts. The actual composition of any nutritive carbohydrate solution such as table syrup is itself variable. There is evidence for occurrence of inorganic salts.
and protein in corn syrup (Junk and Pancoast, 1973). Because nitrogenous organic substances are normally present in plant sap, it is reasonable to conclude that in addition to various sugars and sugar acids, small quantities of organic nitrogenous substances could be present in commercially available syrups and sugars. The presence of dextrins in glucose solutions is well known. One consultant indicated that investigators have found small quantities of such enzymes as ribonuclease in reagent grade glucose. There is no evidence to suggest that any of these materials which could be present in table syrups are allergens. The evidence for allergenicity of nutritive sweeteners is presented in Section V, C, p 17.
V. REVIEW STUDY FINDINGS

A. PREVALENCE OF FOOD ALLERGY AND FOOD HYPERSENSITIVITY

Accurate estimates of the prevalence of food allergies are difficult to obtain. Barkin and McGovern (1966) did not report food allergy as a separate category in their review of allergy statistics. On the one hand, Patterson (1972) states that food allergy is uncommon and the incidence of food allergy decreases with age. On the other hand, Feingold (1973) and Rowe and Rowe (1972) suggest that food allergies are more common than most people appreciate.

A specific query on food allergy prevalence was directed to the National Institute of Allergy and Infectious Diseases on March 22, 1974. Their estimates of prevalence are given in Table II. The category food allergy is subsumed under the term "other." The 1973 adjusted incidence is estimated at 57.0 per 1000 population. A further breakdown of categories under "other" is not available.

In discussing the prevalence of food allergies, many clinical allergists refer to the nondescript nature and broad range of clinical manifestations as well as the difficulties associated with accurate diagnosis. These observations suggest that food allergies are more prevalent than suggested by epidemiological data alone.

No estimates on prevalence of allergy or hypersensitivity to table syrups and their major ingredients have been found.

While no pertinent incidence data are given, Feingold (1973) and Rowe and Rowe (1972) indicate that milk, eggs, cereals, and chocolate are the most common allergic foods. In the cereal group, wheat and corn are the most frequent offenders. Randolph and Yeager (1949) have reported that corn was the most frequent cause of sensitivity reactions in 200 consecutive cases of food allergy.

In summary, sensitivity or allergy to natural products that contain sugar or polysaccharides is recognized clinically; however, the prevalence of allergies to these natural products or foods derived from them is uncertain. There is no definitive information available on prevalence of allergy or hypersensitivity to table syrups per se.
**ESTIMATES OF ALLERGY PREVALENCE**

**TABLE II**

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<tr>
<td>57.4</td>
<td>11,739</td>
<td>-</td>
<td>-</td>
<td>Other allergic (excludes intermediate headache).</td>
</tr>
<tr>
<td>71.1</td>
<td>14,696</td>
<td>54.2</td>
<td>10,826</td>
<td>Hay fever, without asthma.</td>
</tr>
<tr>
<td>43.0</td>
<td>8,862</td>
<td>30.2</td>
<td>6,031</td>
<td>Asthma.</td>
</tr>
<tr>
<td>35.2</td>
<td>277</td>
<td>-</td>
<td>-</td>
<td>Allergies.</td>
</tr>
</tbody>
</table>

Prepared March 22, 1974 by the National Institute of Allergy and Infectious Diseases.
B. CONSUMPTION OF TABLE SYRUPS

Data on annual production and consumption of table, maple, cane, sorghum, and corn syrups do not appear to be readily available. The USDA Survey, Food and Nutrient Intake of Individuals in the United States, Spring, 1965 (U.S. Department of Agriculture, Agriculture Research Service, 1972) provides data on consumption of various food commodity groups. The consumption of "sugar, syrups, candies, and jellies" was estimated at 60 g per person per day. Approximately 36 to 58% of the total consumption was jelly, jam, and gelatin desserts, suggesting that less than 30 g could be from syrups and candies. The quantity of corn syrup used in foods in 1970 was approximately twice the quantity used in 1960 [Subcommittee on Review of the GRAS List (Phase II), 1972]. No estimates of use of corn syrup in table syrups were given for 1970 or 1960.

A subcommittee of the National Research Council has provided data on the use and consumption of GRAS substances in foods [Subcommittee on Review of the GRAS List (Phase II), 1972]. Calculated from the quantity used in foods, the total daily intake of sucrose, corn syrup, and glucose is approximately 119, 41, and 34 g per person per day, respectively. Possible daily intakes for children and adults (age 2 to 65+) from consumption of sweet sauces, toppings, and syrups were estimated to be 2.1 g of sucrose, 3.1 g of corn syrup, and 0.02 g of glucose. No estimates for dextrose syrup, invert sugar or invert sugar syrup were provided in the subcommittee report under sweet sauces, toppings, and syrups.

In a recent report, Chemicals and Health (National Science Foundation, Science and Technology Policy Office, 1973) the annual per capita uses of sucrose from all sources, corn syrup from all sources, and glucose from all sources were calculated from figures supplied by the USDA Economic Research Service. Recalculation of annual per capita use figures provides estimates for total sucrose, corn syrup, and total glucose of 127, 10, and 5 g per person per day, respectively. These estimates of per capita use are higher than actual per capita consumption because not all sugars used in food preparation are actually consumed.

These estimates of consumption suggest that the sugars in table syrups per se are less than 3% of the average daily intake of sucrose, corn syrup, or glucose and therefore, constitute a minor dietary source of these nutritive sweeteners.
C. EVIDENCE FOR ALLERGENICITY OF NUTRITIVE SWEETENERS

As noted previously, diagnosis of food allergies is difficult. Identification of the specific allergenic foods or allergens in foods is usually determined by elimination of suspected foods from the diet and subsequent challenge by reintroduction of those dietary items. The literature in this field consists primarily of clinical case studies and observations of experienced allergists. A significant portion of the available literature on sugar allergies was reviewed by Randolph in 1965. Currently there is little active basic research on allergy and hypersensitivity to sugars or table syrups.

1. Corn and Corn Products

It is generally agreed that corn and corn products represent a major source of allergens because many products, known to be allergenic, contain corn, corn syrup, corn sugar, corn starch, or corn oil. Corn starch is a well recognized allergen; for example, Pemberton and Johnson (1973) recently reported sensitivity to corn starch powder used in surgeons' gloves. Feingold (1973) states that 135 common foods, beverages, food packaging materials, and medications contain corn products. It is generally agreed that dietary avoidance of corn and corn products is extremely difficult in view of their widespread use.

Randolph (1965) and Randolph and Yeager (1949) concluded that ingestion of corn syrup, corn sugar and glucose prepared from corn starch will initiate symptoms of corn allergy in corn sensitive patients. Randolph et al. (1950) observed hypersensitivity reactions in five patients known to be corn sensitive when 5% glucose solution was administered intravenously. They concluded that corn sugar (glucose) was the allergen. However, a majority of the allergists consulted in this study expressed the opinion that the quantity of corn sugar or corn syrup present in a serving of table syrup would not contain sufficient corn allergen to elicit corn allergy in sensitive individuals.

Veilleux (1963) observed that intraperitoneal or intravenous administration of tapioca dextrin produced anaphylactoid reactions in rats while two potato starch dextrins were not reactive. Ankier (1964a, 1964b) and Ankier and West (1968) found that intraperitoneal or intravenous administration of dextrin produced anaphylactoid responses in both sensitized and non-sensitized rats. Administration of glucose or hydrolyzed dextrin prevented the anaphylactoid reactions. The dextrins and glucose were presumably derived from corn starch. Randolph and Yeager (1949) were unable to induce anaphylactoid reactions in guinea pigs by intravenous administration of corn sugar or corn sugar syrup.
2. **Cane Sugar**

According to Randolph and Rollins (1950a), sensitivity to cane sugar was first recognized by Duke in 1925 and subsequently by Coca in 1945. Randolph and Rollins (1950a) presented four case studies of allergic reactions in sensitive individuals induced by ingestion or intravenous administration of invert sugar from sugar cane. However, the preparations may have contained dextran (dextrin?) as well (Randolph, 1965).

3. **Beet Sugar**

Randolph and Rollins (1950b) reported four cases of beet sensitivity in which allergic symptoms were induced by ingestion of beet sugar. In three cases, allergic reactions were produced by administration of a sample of α-d-glucose derived from beet sucrose.

4. **Table Syrups**

References to case presentation or clinical observations of allergy or hypersensitivity to table syrups *per se* have not been found.

5. **Related Studies**

Lanoff *et al.* (1973) reviewed 84,589 admissions to Children's Memorial Hospital, Chicago, Illinois over a ten year period. They concluded that only nine patients were admitted for nasal polyps and that none of the nine cases was allergy related. Their study was prompted by a previous report that allergic-induced dysfunction of carbohydrate metabolism could cause nasal polyps (Smith, 1971).

Allergy textbooks (Feingold, 1973; Rowe and Rowe, 1972) and recent review articles (Goldstein and Heiner, 1970; Leitze, 1969) provide no additional reference citations.
VI. GENERAL CONCLUSIONS

Based upon the opinions of knowledgeable experts and the literature reviewed in the course of this study, the following conclusions have been reached:

1. Food allergies are relatively common but infrequently diagnosed. Identification of the precise causative agents of food allergies is difficult.

2. Table syrups contain refined nutritive sweeteners, flavorings, stabilizers, and water. In blended syrups, the source and identity of the nutritive sweeteners may vary seasonally and geographically depending primarily on economic considerations.

3. Table syrups are a small portion of the average diet in North America. They can be avoided because they are labeled as such and require personal selection.

4. The major types of nutritive sweeteners used in blended table syrups are derived from corn starch by hydrolysis or from syrups or sugars extracted from sugar cane, sugar beets, and sorghum. Potato starch or maple syrup are not sources of nutritive sweeteners used in unspecified blended table syrups.

5. The existence of allergy or hypersensitivity to table syrups per se could not be documented; but based on clinical experience, the nutritive sweeteners in table syrups are the most likely substances that could induce allergic or hypersensitivity reactions in sensitive individuals.

6. The major sugars in nutritive sweeteners are sucrose, glucose, and fructose. These saccharides occur naturally in many foods, are added to many processed foods, and may appear in certain foods adventitiously. They are Generally Recognized As Safe.

7. The nutritive sweeteners (corn syrup and corn sugar) derived from hydrolysis of corn starch are known to contain other simple sugars, polysaccharides, inorganic salts and proteinaceous material. Refined corn, cane and beet sugars may contain dextrin and probably contain inorganic salts and
nitrogenous organic materials. It is erroneous to consider the nutritive sweeteners used in manufacturing table syrups to be pure solutions of sucrose, glucose and/or fructose.

8. Most clinical allergists recognize sensitivity to corn and corn products as a common type of food allergy. Similarly, it is recognized that corn and corn products are found in a large number of dietary items and it is difficult to avoid dietary exposure to corn products. The extent to which corn sensitivity reactions may be evoked by consumption of table syrups containing saccharides from corn starch is uncertain. While a majority of allergists would agree that the probability of evoking allergic reactions is remote, some hold that sugars derived from corn starch hydrolysis are allergenic.

9. There have been few studies of specific allergies to beet sugar and cane sugar; with one exception, the available literature consists of clinical case studies and investigative determinations of the possible causes of specific food allergies.

10. No reports of hypersensitivity to maple syrup, maple sugar, sorghum syrup, or sorghum sugar were found.

11. Despite clinical evidence for allergenicity of corn syrup, corn sugar, cane sugar, and beet sugar there are no studies that demonstrate chemically pure sucrose, glucose, or fructose can function as a haptene or allergen in individuals known to be sensitive to corn, beets, or sugar cane. Similarly, there is no evidence that the other constituents or trace contaminants in nutritive sweeteners are not the allergenic substances.

12. There is little or no active research on this subject.
VII. SOURCE LABELING

The evidence and opinions cited in the report indicate that allergy or hypersensitivity to table syrups *per se* is relatively unknown. While definitive proof is lacking, there is clinical evidence that a certain small segment of the population is sensitive or allergic to specific nutritive sweeteners in table syrups.

While there is little conclusive proof of hypersensitivity to nutritive sweeteners in blended table syrups, the evidence uncovered in this study suggests it would be prudent to provide source labeling for those individuals who desire to avoid these nutritive sweeteners in their diet. First, there are a limited number of sources of nutritive sweeteners (corn sugar or syrup, cane sugar, beet sugar, honey, or maple syrup). Second, the treatment of food allergy involves primarily elimination or avoidance of foods or food constituents that induce symptoms. Third, the diagnosis and therapy of food allergies are basically specific treatment on an individual basis.

In a recent revision of 21 CFR 1.10 (Schmidt, 1974), the FDA has provided that in foods in which a blend of fats and/or oils is used as an ingredient, the listing of the common or usual names need not be in descending order or predominance if the manufacturer, because of the use of varying mixtures, is unable to adhere to a constant pattern of fats and/or oils in the product. It is suggested that similar language may be appropriate on label panels of table syrups containing blends of nutritive sweeteners. Labels could indicate that in addition to the major source ingredient, the product may contain nutritive sweeteners derived from the other sources, specifically corn, sugar cane, sugar beets, or sorghum.
VIII. REFERENCES CITED.


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