EVALUATION OF THE HEALTH ASPECTS OF STERCULIA GUM

AS A FOOD INGREDIENT

MARCH, 1973

Prepared for

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

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Life Sciences Research Office
Federation of American Societies
for Experimental Biology
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Bethesda, Maryland 20014
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 (LSRO) of the Federation of American Societies for Experimental Biology (FASEB) under contract with the Food and Drug Administration (FDA) 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 experience 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.

C. Jelleff Carr, Ph.D., Director
Life Sciences Research Office
FASEB
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I. INTRODUCTION

Under terms of FDA Contract 72-85, FASEB's Life Sciences Research Office was requested to evaluate the health aspects of using sterculia gum as a food ingredient, primarily on the basis of information contained in a monograph furnished by FDA (1), summarizing the world's scientific literature from 1920 through 1970, and in certain supplemental documents available as of March, 1973. Sterculia gum is one of the food substances that has been generally recognized as safe (GRAS) under the provisions of the Code of Federal Regulations (21 CFR 121.101, revised April 1, 1973).

As indicated in the Food, Drug, and Cosmetic Act [21 USC 321(s)], GRAS substances are exempt from the requirement of premarketing clearance for food additives. It is stated in 21 CFR 121.1 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 of credible 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. It is recognized 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 accord 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, and realizes that a conclusion, based on such reasoned judgment, is expected even in instances where the available information is qualitatively or quantitatively limited. The Committee is also aware that biological testing, like all of science, is dynamic. Accordingly, the Committee's conclusions, based as they are on the information now available, cannot anticipate and be guided by experiments not yet done or by the results of tests that may be reconducted, using new technologies that are continually being evolved. 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 Sterculia gum and submits its interpretation and assessment in this report, which is intended for the use of FDA in determining the future status of this substance under the Federal Food, Drug, and Cosmetic Act.

II. BACKGROUND INFORMATION

Sterculia gum (also called gum karaya, gum kadaya, Indian trag-acanth, and India gum, and by other names) is the dried exudate of Sterculia urens, a tree native to the mountainous regions of central and eastern India. Native collectors tap or drill the trees, and after several days collect the exudate in the form of large, irregular tears that may weigh up to several pounds. The best quality gum is collected during the hot spell (May to June) that precedes the monsoon. The collectors sell the product to dealers who clean and fragment the tears and sort the gum before putting it into export markets. Processors in the United States further purify the gum to remove bark, wood fiber, and soil, then grind, size, and blend the material to obtain uniform grades of gum (1, 2, 3).

Sterculia gum is also produced from various other species of Sterculia found in India, Africa, Australia, China, and Indochina, but the product is apparently not available separately in commercial amounts. These other gums may be mixed with that from S. urens. Another related gum is produced by species of Cochlospermum (1).

Sterculia gum is a complex polysaccharide with a high molecular weight of about 9.5 million. The molecule is reported to consist of units of D-galacturonic acid, D-galactose, and L-rhamnose in proportions of 43, 13, and 15 percent, respectively. It has a high acetyl content, with acid numbers reported at between 13.4 and 22.7; on aging or heating, the molecule may split off free acetic acid (2). This observation is consistent with reports that the gum has a slightly acetoxy odor (4).

Sterculia gum absorbs water rapidly to form viscous mixtures at low concentrations; up to 4 percent may be hydrated in cold water to form heavy, viscous pastes. A one percent mixture may have a viscosity
of 3,330 centipoises. Viscosity decreases with heating and aging (2). It is used as an emulsifier and food stabilizer.

In its specifications for sterculia gum, the Food Chemicals Codex includes the following limitations on impurities: arsenic, not more than 3 ppm; acid-insoluble ash, not more than 1.0 percent; lead, not more than 10 ppm; heavy metals (as lead), not more than 40 ppm; insoluble matter, not more than 3.0 percent. The material must be free from other gums and starch (4).

Sterculia gum appears in the GRAS list (5) with no limitations on its use in food products. Current use of the substance in the food industry, according to a recent survey by a National Research Council subcommittee (6), is as follows:

<table>
<thead>
<tr>
<th>Food category</th>
<th>Usual use</th>
<th>Maximum use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>percent</td>
<td>percent</td>
</tr>
<tr>
<td>Milk products</td>
<td>0.0200</td>
<td>0.0200</td>
</tr>
<tr>
<td>Frozen dairy products</td>
<td>0.0074</td>
<td>0.1498</td>
</tr>
<tr>
<td>Meat products</td>
<td>0.0001</td>
<td>0.0015</td>
</tr>
<tr>
<td>Soft candy</td>
<td>0.1091</td>
<td>0.8046</td>
</tr>
<tr>
<td>Nonalcoholic beverages</td>
<td>0.0010</td>
<td>0.0015</td>
</tr>
</tbody>
</table>

Sterculia gum came into general use in the United States during World War I, as an inexpensive substitute for gum tragacanth (2). It later was found to have its own superior qualities as an emulsifier and stabilizer. The total poundage used in foods is reported to have increased by 25 percent between 1960 and 1970, the two years for which comparable
figures are available (6)*. However, the Select Committee has no information to indicate whether the sterculia content of the foregoing food categories has changed significantly over the same period.

III. CONSUMER EXPOSURE DATA

The National Research Council subcommittee has provided information on the possible daily human intake of sterculia gum in the total diet, as shown in the following table for individuals in various age groups (6). The Select Committee has converted these figures to possible intakes per kilogram of body weight.

<table>
<thead>
<tr>
<th>Age group</th>
<th>Possible daily intake</th>
<th>Per kilogram of body weight(^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Average : Maximum : Average : Maximum</td>
</tr>
<tr>
<td></td>
<td>mg : mg : mg : mg</td>
<td></td>
</tr>
<tr>
<td>0-5 mos.</td>
<td>1.4 : 4.2 : 0.3 : 0.8</td>
<td></td>
</tr>
<tr>
<td>6-11 mos.</td>
<td>15.8 : 70.2 : 2.0 : 8.8</td>
<td></td>
</tr>
<tr>
<td>12-23 mos.</td>
<td>16.4 : 61.9 : 1.5 : 5.6</td>
<td></td>
</tr>
<tr>
<td>2-65+ yrs.</td>
<td>17.2 : 95.7 : 0.3 : 1.6</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\)Calculations based on an average weight of 60 kg for an adult (6) 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 (9).

*The significance of this reported increase is uncertain, inasmuch as Census Bureau figures of U. S. imports of sterculia gum for all purposes, for the years 1965-1972 inclusive, are fairly constant (7). Apart from a high of 9.1 million pounds in 1965 and a low of 6.8 million pounds in 1969, the annual figures are quite close to the nine-year average of 7.5 million pounds.
It is recognized that the figures calculated for the daily intake of sterculia gum per kilogram of body weight for a specific individual in the age group 2-65+ years could be low, since many individuals from age 2 to maturity will weigh less than 60 kg; thus the daily intake of sterculia gum per kilogram for a 20 kg child could be higher by a factor of three than the figures indicated in the table.

The figures in the table must also be considered in the light of total production and use of sterculia gum. The NRC subcommittee has pointed out that its figures for intakes in most cases are overstated, often by considerable margins. * That human intakes are undoubtedly overstated in the case of sterculia gum is borne out by the following calculation.

The NRC subcommittee has provided data (6) to show that the use of sterculia gum for food purposes in the United States was 294,966 pounds (134,075 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 (491,610 pounds or about 223,500 kg) and a U. S. population of 200 million, the per capita average daily intake would be only 3.1 mg rather than the 17.2 mg given in the foregoing table.

On the basis of these considerations, the Select Committee regards the figures given in the table as levels that are unlikely to be achieved by any of the age groups.

IV. BIOLOGICAL STUDIES

The LD₅₀ of sterculia gum in laboratory animals apparently has

*An explanation for such overstatements is detailed in Section XI, "Significance and Use of Data in Safety Evaluations," of the NRC subcommittee report (6). 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."

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not been reported. However, the Stanford Research Institute (10) determined that sterocilia gum, given orally to groups of five male rats as a suspension in corn oil, in doses of 5 to 10 g per kg of body weight each, caused only transient depression and no deaths.

Sterculia gum is apparently not appreciably "disintegrated" in the alimentary tract when fed to dogs (11). Other undocumented reports state that the gum is not digested or absorbed by humans (12).

Hoelzel et al. (13) fed sterocilia gum to a group of nine male hooded rats, as a 10- to 25-percent component of the diet, for their entire life span. "Serious intestinal lesions" were found in three of five test subjects that were fed the gum for from 396 to 711 days. At the higher concentrations of the gum, marked depression of the growth rate occurred. In a subsequent report, the same workers (14) fed sterocilia gum to three male and three female Wistar rats, as a 10- to 25-percent component of the diet, for their entire life span. The rats exhibited a depressed food intake and growth rate; however, contrary to the previous findings, no cecal ulcerations were observed.

In a Wisconsin Alumni Research Foundation study (15) 10 weanling male Sprague-Dawley rats were fed a basal diet of 5 g per day plus 3 g per day of either sterocilia gum or cornstarch. At the end of a week, the rats fed sterocilia gum appeared to be bloated, with intestinal weights considerably larger than those of controls, and the animals showed a significant depression in growth rate. It was considered that sterocilia gum had only 30 percent of the available caloric value of cornstarch.

Kratzer and co-workers (16) have studied the nutritive value of sterocilia gum in poultry feeds, in comparison with other sources of carbohydrate. When day-old Arbor-Acres chicks were given 2 percent sterocilia gum in their diet for 21 days, some growth depression occurred; however, this was not considered to be statistically significant.

Ivy and Isaacs (11) fed 5 g of unprocessed sterocilia gum to three dogs daily for 30 consecutive days. The feces of the dogs showed increased bulk and moisture; but no irritating effect was observed.

There are few human studies available. Ivy and Isaacs (11) studied the laxative effect of sterocilia gum by feeding about 7 g daily to 89
human subjects over a four-week period. They observed that because of its water-absorbing properties, the gum increased the bulk and moisture content of stools; they considered it to be a useful, harmless laxative.

Hoelzel et al. (13) reported that they had personally ingested small amounts of powdered sterculia gum from time to time between 1919 and 1936 (presumably as a laxative), but regarded it as an unpalatable, highly fermentable, and irritating type of non-nutritive material.

Various reports on allergic reactions to sterculia gum have appeared in the literature, beginning in 1934. Figley (17) in 1940 reported on 16 cases where the allergen had been contacted by ingestion and surface contact as well as by inhalation. The chief symptoms were perennial hay fever, asthma, atopic dermatitis, and gastrointestinal distress. Figley cautioned against the indiscriminate use of sterculia gum as a laxative.

In 1943 and 1949 Gelfand (18, 19) published comprehensive reviews of the allergenic hazards of gums tragacanth, sterculia, and arabic. He estimated the possible per capita daily exposure of the three gums combined to be as much as 300 mg. He concluded that "widespread employment of these gums in food and other industries is a hazard for the sensitive individual from ingestion, inhalation, and surface contact of these gums." He recommended that the three gums be replaced by other less hazardous gums, natural or synthetic.

In connection with work on the fetotoxicity of gum tragacanth, Frohberg et al. (20) made comparative studies of various other gums. Their procedures on sterculia were as follows:

(1) An 0.2 ml dose of a 1 percent aqueous mucilage of the substance was injected intraperitoneally into pregnant mice, on the 11th through 15th days of gestation;

(2) An 0.2 ml dose of a 1 percent aqueous mucilage was injected intraperitoneally into pregnant mice, on the 4th through 8th days of gestation;

(3) An 0.5 ml dose of both 1 percent and 10 percent aqueous suspensions was fed orally to pregnant mice, on the 11th
through 15th days of gestation.

In all of these tests, sterculia gum had no influence on fetal development.

In recent teratology studies (21), pregnant animals were fed by oral intubation with suspensions of sterculia gum at the following levels:

- Mice, 170 mg per kg of body weight for 10 consecutive days, beginning on the sixth day of gestation;
- Rats, 900 mg per kg for 10 consecutive days, beginning on the sixth day of gestation;
- Hamsters, 600 mg per kg for 5 consecutive days, beginning on the 6th day of gestation.

At these levels, there was no clearly discernible effect on nidation or on maternal or fetal survival. The number of abnormalities seen in either soft or skeletal tissues of the test groups did not differ from the number occurring spontaneously in the sham-treated controls.

In a concurrent group of mice dosed at a level of 800 mg per kg for 10 consecutive days, a significant number of maternal deaths occurred (9 out of 28). The surviving dams appeared completely normal and bore normal fetuses with no effect on the rate of nidation or survival of live pups in utero. It was concluded that sterculia gum was not a teratogen to mice under the conditions of the test (21). No reasons were advanced to explain the maternal deaths.

Studies of mutagenic effects of sterculia gum have been reported (10). Sterculia gum did not produce any measurable mutagenic response or alteration in the recombination frequency for Saccharomyces cerevisiae in either the host-mediated assay or the associated in vitro tests. Sterculia gum exhibited no adverse effect on either metaphase chromosomes from rat bone marrow or anaphase chromosomes from in vitro cultures of human embryonic lung cells at any of the dose levels or time periods tested. No consistent responses occurred to suggest that sterculia gum is mutagenic to the rat as a result of the dominant lethal test procedure.
V. OPINION

While the literature on biological effects of sterculia gum is not extensive, it does permit of several observations on the health aspects of the substance as a food ingredient.

Sterculia gum can cause allergic reaction in sensitive individuals. What proportion of the population is so affected is not known. A statistically-significant survey, conducted by practicing allergists, would help to determine whether significant numbers of persons are being placed in a state of receptiveness to cross-reactive allergies based upon lifelong daily exposures to sterculia gum and the other two gums alleged to be allergenic: gum arabic and gum tragacanth.

Growth-depressing properties have been attributed to sterculia gum when it is fed in large amounts to laboratory animals. However, it is to be expected that the unpalatability of the gum in any diet to which it is added at a high level would ultimately affect consumption and hence the growth curve.

While no fetotoxic effects were reported in teratologic tests, the data indicated that sterculia gum fed at a level of 800 mg per kg of body weight for 10 days resulted in maternal deaths of one-third of the pregnant mice. The Select Committee has noted the same type of result in other reports by this institution, using high doses of a variety of vegetable gums, tested on a variety of laboratory animals. The doses of gum were generally much higher than those to which humans are likely to be exposed. Nevertheless, these tests should be repeated, in due course, to determine the cause of the maternal toxicity.

With due consideration for the foregoing observations, the Select Committee concludes that:

There is no evidence in the available information on sterculia gum that demonstrates or suggests reasonable grounds to suspect a hazard to the public when it is used at levels that are now current and in the manner now practiced. However, it is not possible to determine, without additional data, whether a significant increase in consumption would constitute a dietary hazard.
VI. REFERENCES CITED


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