EVALUATION OF THE HEALTH ASPECTS OF TALL OIL AS IT MAY MIGRATE TO FOODS FROM PACKAGING MATERIALS

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
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Life Sciences Research Office
Federation of American Societies for Experimental Biology
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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 on 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.

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I. INTRODUCTION

This report concerns the health aspects of using tall oil as an ingredient of food packaging materials. 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, an announcement was made in the Federal Register of April 22, 1976 (41 FR 16848 and 16849) 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 tall oil as an ingredient of food packaging materials. The Select Committee received no requests for such a hearing on tall oil.

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 CFR 121.1, 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 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. 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

*The document (PB-228 556/7) is available from the National Technical Information Service, U.S. Department of Commerce, P.O. Box 1553, Springfield, Virginia 22161.
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 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 tall oil 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

Tall oil is basically the sap of the pine tree. The tall oil of commerce however, is a byproduct derived from the waste liquors of the pinewood pulp mills in the kraft or sulfate process of paper manufacture (1, 2). It consists mainly of a mixture of fatty and resin (or rosin) acids, and varies in composition and properties depending upon the source of the wood and the processing methods used. The resin acids and fatty acids (tall oil) are removed from the wood and converted to soaps by the highly alkaline pulping chemicals. Crude tall oil, recovered when the skimmings are acidified, is separated through distillation into resin and fatty acid fractions (3). A large portion of the resin acids is used in the paper industry, and most of the fatty acids in the paint and detergent industries.

Crude tall oil is composed of two major fractions, tall oil resin acids and tall oil fatty acids, and a minor fraction consisting of a mixture of unsaponifiable or "neutral" substances (3). The bulk of the resin acids, comprising about 42 percent of tall oil, consists of diterpenoid monocarboxylic derivatives of alkylated hydrophenanthrenes of the abietic and pimaric acid types. A typical analysis of tall oil resin shows an abietic acid content of 34 percent; dehydroabietic acid, 24 percent; palusttric acid, 9 percent; isopimaric acid, 6 percent; dihydroabietic acid, 5 percent; pimaric acid, 5 percent; and neoabietic acid, 5 percent (1).
The fatty acid fraction constitutes about 51 percent of the tall oil. Oleic and linoleic acids, in approximately equal percentages, comprise about 80 percent of this fraction, and cis-5, 9, 12-octadecatrienoic acid accounts for about 10 percent. The remaining 10 percent consists of small amounts of various acids including myristic, palmitic, stearic, palmitoleic, linolenic, and a number of saturated and mono-, di-, and triunsaturated acids, ranging from C17 (straight and branched chain) to C20 (straight chain). The locations of the double bonds in the octadecatrienoic and eicosatrienoic acids of tall oil differ from those of the seed fats (4). The characteristic compounds of the former are cis-5, 9, 12-octadecatrienoic and cis-5, 11, 14-eicosatrienoic acids.

The unsaponifiable fraction accounts for about 7 percent of tall oil (2). It consists mainly of hydrocarbons, sterols, including α- and β-sitosterol and stigmasterol, and some of the higher alcohols. Sitosterol, identified by several workers as largely β-sitosterol, makes up from 70 to 75 percent of this fraction (1). This sterol has been of medical interest because of its reported anti-cholesterolemic properties (5, 6). Recent work by Conner and Rowe (7) on the composition of the neutral fraction of southern pine tall oil confirms that sitosterol is the major single compound of more than 80 compounds found in this fraction. Their tall oil sample contained 4.8 percent neutral substances by weight, and all of the compounds that comprised 0.1 percent or more were identified. These included 0.3 percent α-terpineol, 2.5 percent diterpene hydrocarbons, 8.1 percent resin alcohols, 10.0 percent resin aldehydes, 0.5 percent resin methyl esters, 1.2 percent norditerpene alcohols, 16.8 percent labdane diterpenes, 2.1 percent other diterpenes, 32.4 percent steroids (78 percent sitosterol), 0.6 percent triterpenes, 0.7 percent polyphenols, 6.1 percent wax alcohols, 5.7 percent stilbenes, 4.4 percent lubricating oil, and 8.6 percent minor (<0.1 percent) constituents.

Tall oil fractions, e.g., distilled tall oils and tall oil light ends ranging in color from pale to dark, are available on the market under a number of trade names; composition and properties vary depending on conditions of manufacture (1).

Tall oil appears on the GRAS list [21 CFR 121.101(i)] among substances migrating to food from cotton and cotton fabrics used in dry food packaging and as a prior sanctioned substance [21 CFR 121.205] employed in the manufacture of food packaging materials (8). This report is confined to such uses. The Select Committee has no information on the composition of the substance used in dry food packaging, but considers that the products most likely to be used would be acid-refined and distilled tall oil, rather than crude tall oil (3).
Tall oil can also be used as a defoaming agent in the manufacture of paper and paperboard intended for use in packaging, transporting, or holding food [21 CFR 121.2519] and as a substance generally recognized as safe for use as a component of adhesives [21 CFR 121.2520]. Constituents or fractions of tall oil, e.g., oleic and linoleic acids, tall oil rosin and dark tall oil rosin, tall oil pitch, and tall oil soaps [CFR 121.1237, 121.2520, 121.2514, and 121.2592] may be used in foods, as defined in these regulations, or in the manufacture of articles or components of articles intended for use in producing, manufacturing, packing, processing, preparing, treating, packaging, transporting, or holding food (8).

Reports of the Select Committee have been or are being prepared on some of the constituents of tall oil, because they are either GRAS substances themselves or are constituents of other GRAS substances. Among these are reports on glycerides (9), tallow and stearic acid (10), hydrogenated fish oil (11), hydrogenated soybean oil (12), coconut oil, peanut oil, oleic acid and linoleic acid (13), and sodium salts of fatty acids (14). The details and conclusions of these reports will not be repeated here. Emphasis in the present report is placed on additional observations involving components or fractions more characteristic of tall oil.

III. CONSUMER EXPOSURE DATA

No data are available to the Select Committee on the actual consumption of tall oil due to its migration to food from packaging materials. Use of tall oil for all purposes in the United States rose from 86 million pounds (about 39 million kg) in 1960 to 117 million pounds (about 53 million kg) in 1965 and then dropped to 75 million pounds (about 34 million kg) in 1970 (15). On this basis, if all the tall oil production were used for direct food purposes, consumption would be about 0.4 g per person per day. However, consumer exposure for purposes of this report is limited to amounts that might migrate to foods from food packages. The Select Committee has found a relevant paper by Davison et al. (16) who studied the migration of rosin components from sized paper to foods and concluded that foods stored up to several weeks in such packaging materials contain on the average, no more than 9 ppm of rosin. The papers used contained up to 7 percent rosin. While this study concerned migration of rosin from sized paper, it seems logical to assume that the level of consumer exposure to tall oil resins, fatty acids and unsaponifiable components migrating to foods from food packaging materials, generally would be of the same order of magnitude and, that in either case, the quantities involved would be very small.
IV. BIOLOGICAL STUDIES

No feeding studies specifically designed to determine the safety of crude (whole) tall oil have been reported. However, Sunde (17) observed a reduction in the growth of chicks fed 5 percent crude tall oil (about 6.3 g per kg per day) in the diet as compared to chicks fed oleic, linoleic, or linolenic acids at the same level. Chicks on the tall oil diet grew as well as those fed butyric acid at the same level.

In man, tall oil and the resin acids have been found to be slightly irritating to the skin and the mucous membranes (18,19). Abietic acid, a major constituent of tall oil, was moderately toxic when ingested (dose not indicated), and large doses (up to 0.5 g per kg per day) of $\beta$-sitosterol, a major constituent of the unsaponifiable fraction of tall oil, apparently caused anorexia, gastrointestinal cramps, and diarrhea in some patients (5).

Resin fraction

Acute toxicity tests of tall oil resin have been conducted on several species of animals. When "pale tall oil resin" was administered (route unspecified, but presumably oral) as a 30 percent solution in corn oil, the LD$_{50}$ values were found to be 7.6 g per kg for rats, 4.6 g per kg for mice, and 4.6 g per kg for guinea pigs (20).

Longer term studies showed no differences between controls and young albino rats fed 0.01 percent, 0.05 percent, and 0.2 percent pale tall oil resin (about 10 to 200 mg per kg per day) for 90 days in their diets. Observations included appearance, growth, food intake, hematology, urinalysis, and gross pathologic examinations of the liver, kidneys, spleen, gonads, heart, and brain. Histopathologic examinations of these organs and the stomach, small intestine, colon, pancreas, urinary bladder, adrenals, thyroid, parathyroids, lymph nodes, lungs, bone marrow, muscle, prostate and uterus were also made. When 1 percent tall oil resin was fed (1 g per kg per day), growth and food consumption were depressed during the first two weeks, but normal growth rate returned after two weeks. Hematologic findings and urinalyses were normal. No significant differences were noted at autopsy and upon histologic examination of the viscera except for a slightly greater liver weight than in the controls. When 5 percent tall oil resin was fed (5 g per kg per day), rapid weight loss followed and all of the rats died within two weeks (20).

Tall oil resins were fed to young albino rats and young beagle dogs at dietary levels of 0.05 and 1.0 percent for two years. The 0.05 percent level amounted to about 50 mg per kg per day for the rats and about 40 mg per kg per day for the dogs. In addition, the resins were fed to rats at a level of 0.2 percent (200 mg per kg per day) for two years (20). Observations included gross signs, mortality, food intake, body weight, hematology, urinalysis,
liver and kidney function tests, and tumor incidence. Observations at necropsy included organ weights for liver, kidneys, spleen, gonads, brain, heart, thyroid, and adrenals. Histopathologic examination of these organs and the aorta, gall bladder, peripheral nerves, and spinal cords of the dogs revealed no significant differences between those animals fed tall oil resins at the 0.05 and 0.2 percent levels and their controls. However, at the 1.0 percent level, food consumption of the rats was 10 percent below that of the control animals and their growth rates were slightly depressed. Food consumption and growth rates for dogs receiving 1 percent tall oil resin in the diet were not significantly different from the controls. Likewise, no significant differences were found in the hematology, urinalyses, and liver and kidney function tests between the experimental and the control animals. There was liver enlargement but histologically, the organ was within normal limits; all other organs were comparable to those of the controls. Histopathologic findings and tumor incidence in test and control animals did not differ significantly (20).

Fatty acid fraction

When the glycerol esters of the fatty acid distillate of tall oil provided 30 percent of the calories in the diet of rats, Seppänen (4) found that over 95 percent of the fatty acid glycerides was absorbed. In the same work, it was observed that at a level of 15 percent in the diet, tall oil fatty acid glyceride margarine supported a longer life span in female rats than butter-fed controls. Further, at a level of 15 percent of the dietary calories, tall oil fatty acids and their ethyl and glyceryl esters produced the same growth rate in weanling male and female rats, as compared with controls on a soybean diet. Those receiving 60 percent of their calories as tall oil fatty acid distillate had diarrhea, skin and fur disorders, decreased growth rate, and increased mortality. Hydrogenation of the tall oil fatty acid glycerides (to iodine value 70) seemed to decrease the injurious effects when fed at this high level. When experiments on reproduction with rats were carried out over three generations with 30 percent of their calories from tall oil fatty acid glyceride margarine, as compared with an ordinary margarine control, no significant differences in reproduction or survival were observed. Histopathologic comparison of the lungs, heart, thyroid, adrenals, liver, kidney, stomach, and intestine in experimental animals and controls also showed no significant differences, except for hepatic parenchymal degeneration and "swollen renal tubule cells," which were also observed in rats fed tall oil fatty acid glyceride margarine at 30 percent and 60 percent levels in a fat-absorbability experiment.

Antila (21) added the ethyl esters of the fatty acids of tall oil to the fodder of milk cows at a level of 3 percent (500 mg per kg). Milk yield was not adversely affected. Iodine value of the milk fat was increased as was the proportion of conjugated diethenoids. When the tall oil fatty acid distillate was added at a 10 percent level (22), the iodine value of the milk fat and the relative proportion of $C_{18}$ acids were increased.
At a concentration of 2.3 to 2.6 percent (1 g per kg per day) in the dry feed mixture fed to hens, Antila et al. (23) observed that ethyl esters of the fatty acids of tall oil appeared to increase the egg production. However, a concentration of 4.3 to 4.8 percent (about 1.8 g per kg per day) in the feed lowered egg production. The fertilizability and hatchability of the eggs were "normal."

Miscellaneous constituents

In order to determine the role of cis-5,9,12-octadecatrienoic acid as a possible growth-retarding factor, pine seed oil, which contains twice as much of this compound as tall oil fatty acid distillate, was fed by Seppänen (4) to rats weighing about 50 g over a 16-day period. At a dietary fat level of 30 percent of the calories (amounting to about 4 g of the octadecatrienoic acid per kg of body weight), a statistically insignificant reduction in weight gain was observed, as compared to weight gain on a diet containing the same level of soybean oil.

Altschul (24) reported that the feeding of 0.3 g (150 mg per kg per day) of stigmasterol daily to rabbits for 73 to 116 days did not produce cholesterol-like arteriosclerotic changes.

No studies concerning the teratogenicity, mutagenicity or carcinogenicity of tall oil have come to the attention of the Select Committee.

V. OPINION

Because tall oil as a GRAS or prior sanctioned substance is currently restricted to use in dry food packaging materials or in their preparation, it can be assumed that the amount of tall oil consumed in food through migration from or abrasion of these materials is minute.

There have been no reports of significant harmful biological effects of tall oil when fed to animals even at levels that are considerably greater than could conceivably be consumed by man as tall oil is now used in packaging materials.

In the light of these considerations, the Select Committee concludes that:

There is no evidence in the available information on tall oil that demonstrates, or suggests reasonable grounds to suspect, a hazard to the public when it is used in food packaging materials as now practiced, or as it might be expected to be used for such purposes in the future.
VI. REFERENCES CITED


13. Select Committee on GRAS Substances. 197-. Evaluation of the health aspects of coconut oil, cottonseed oil, peanut oil, oleic acid, and linoleic acid as food ingredients. Life Sciences Research Office. Federation of American Societies for Experimental Biology, Bethesda, Md. (Report in preparation.)


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