SUCROSE ESTERS:

THEIR IMPACT ON SOYBEAN OIL UTILIZATION

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WHAT ARE SUCROSE ESTERS?

Sucrose polyesters (SPE) are not the newest class of food additives on the market but they may well prove to be among the most versatile and controversial. Sucrose itself is unique in its physical and chemical properties; it is a non-reducing disaccharide that is extremely stable except to hydrolysis at the glycoside linkage. It contains eight hydroxyl groups; 3 are primary (C1', C6', C6) and 5 are secondary, giving ample opportunity for substitution (Table 1). It is highly soluble in water. It is the lowest cost polyhydric alcohol readily available and has the world's highest production of any single pure organic chemical (Parker et al., 1977). Sucrose and its by-products have been used to make ethanol, butanol and acetone by fermentation, and wallboard and paper from sugarcane bagasse, which has also served as a raw material for furfural production (Hass, 1977). Figure 1 depicts the structure of a sucrose octaester; all eight hydroxyl groups are substituted.

Table 1. The number of isomers of sucrose derivatives of varying substitution from one (mono) to eight (octa) (Hough, 1977).

SUCROSE	ISOMERS	SUCROSE	ISOMERS
Mono	8	Penta	56
Di	28	Hexa	28
Tri	56	Hepta	8
Tetra	70	Octa	1

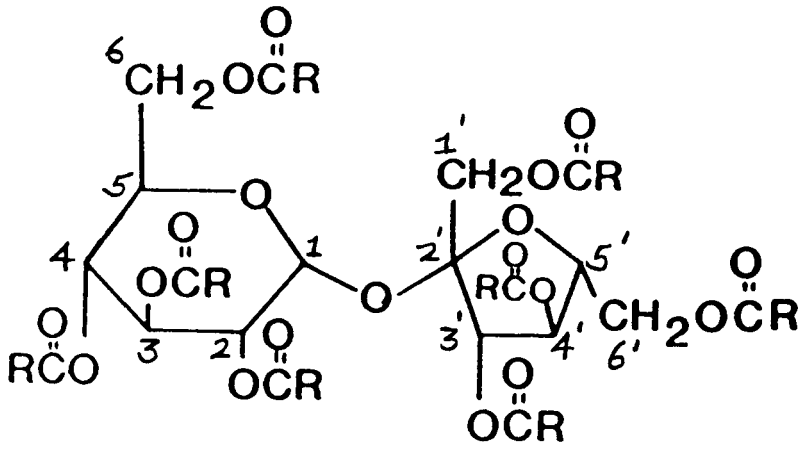

Figure 1. Structure of sucrose octaester; R = fatty acid.

THE HISTORY OF SUCROSE ESTERS

The concept of sucrose polyester production in the U.S. was probably initiated in 1952 when Dr. Henry B. Hass, then president of the Sugar Research Foundation, urged Dr. Foster D. Snell to investigate the possiblity of "hanging a fat tail" on sucrose to make detergents (Hass, 1968). Due to the hydrophilic nature of sucrose and the lipophilic nature of fatty acids, the esterified derivative could act as a surfactant. It was hoped that the new product would be easily synthesized and purified, produced at a reasonable cost and biodegradable under both aerobic and anaerobic conditions.

HOW ARE SUCROSE ESTERS MADE?

A great deal of research has been done on SPE since 1952 and today they are formulated depending on the desired physical properties and functional application. They are esters of sucrose and long or short chain fatty acids that may be saturated or unsaturated. The sucrose moiety can be esterified at eight positions; the primary hydroxyl groups are approximately ten times more reactive than the secondary hydroxyls (Rowland et al., 1966). Gee and Walker (1961) determined the most reactive sites to be the 6 position of glucose, with appreciable substitution at C4 of glucose and C1' of fructose. The C6' of fructose was observed to be relatively lower in activity. However, this is not in agreement with more recent studies showing that C6, C1' and C6' are the most reactive sites with C1' of minor importance due to steric hindrance (Chung et al., 1980). Research on the cyclic acetals of sucrose and their derivatives has allowed selective reactions with previously inaccessible hydroxyl groups, specifically at C2, C3, C3' and C4' (Khan, 1977). As esterification proceeds from the mono to an octa ester form, the originally hydrophilic compound becomes increasingly lipophilic (Figure 2). In addition, the nature of a sucrose ester can be altered by changing the constituent fatty acids; the shorter and more unsaturated they are, the more hydrophilic the SPE (Kawase, 1981).

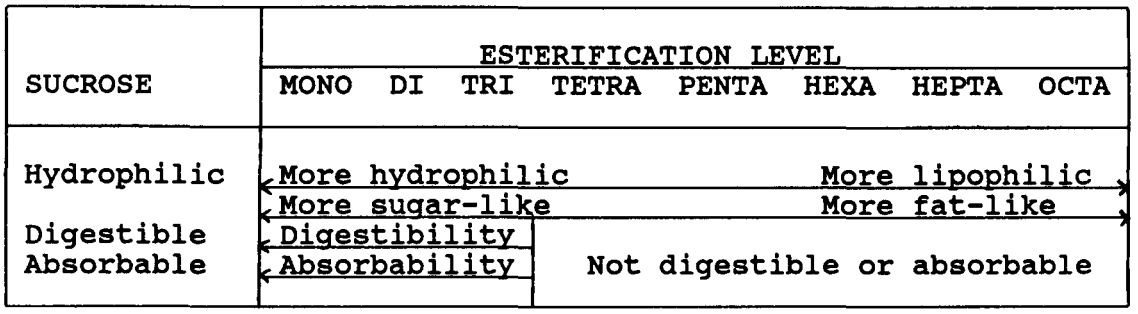

Figure 2. Some properties of SPE associated with esterification level.

The original patent for "Low Calorie Fat-Containing Food Compositions" was granted to Procter & Gamble Co. in 1971 for products developed in their laboratories by Fred H. Mattson and Robert A. Volpenhein. The company has proposed "olestra" as the generic name for these products. The patent describes preferred substitution patterns of sucrose and other sugars and sugar alcohols. The SPE should contain at least 4 fatty acid esters, and preferrably not more than 2 unesterified hydroxyl groups. Fatty acids in the C8 - C22 range are suitable to esterify sucrose; however long-chain fatty acids of C14 - C18 are preferred. Esters of glucose, sorbitol, erythritol and xylitol have also received considerable attention. A method of synthesizing undecoesters of raffinose was recently described (Akoh and Swanson, 1987). Sources of suitable and preferred fats and oils and their fatty acids appear in Table 2 (Mattson and Volpenhein, 1971).

Table 2. Suitable and preferred* fatty acids and sources for use in low calorie fat-containing food compositions as described in U.S. Patent 3,600,186.

FATTY ACID	SOURCES
Caprylic	Coconut oil
Capric	Palm kernel oil
Lauric	Babassu oil
*Myristic	*Corn oil
Myristoleic	*Olive oil
*Palmitic	Palm oil
Palmitoleic	Peanut oil
*Stearic	Safflower seed oil
*Oleic	Sunflower seed oil
Ricinoleic	Sesame seed oil
*Linoleic	*Soybean oil
Linolenic	*Cottonseed oil
Oleostearic	*Tallow
Arachidonic	*Lard
Behemic	Rapeseed oil

Myristic, palmitic, stearic, oleic and linoleic acids are preferred and the preferred sources are soybean oil, corn oil, cottonseed oil, olive oil, tallow and lard. Most of the published research in the U.S. has utilized soybean, cottonseed and olive oils. Workers in the U.K. and Japan have studied tallow and palm oils, respectively.

Table 3 lists the fatty acid profiles and iodine numbers of fats and oils preferred for SPE syntheses by Mattson and Volpenhein (1971). Myristic, palmitic and stearic acids are saturated, whereas the unsaturated ones, oleic and linoleic, have one and two double bonds, respectively. The vegetable oils tend to be high in unsaturated fatty acids, the animal fats are relatively higher in saturated fatty acids. Thus, the functionality of any SPE can be influenced by the choice of fatty acids and/or the oil or fat used as a fatty acid source. A total median preferred fatty acid percentage of about 85% or more appears to be necessary in order for a fat or oil to be considered as a raw material for SPE synthesis. Overall saturation to unsaturation ratio is reflected in the median iodine numbers; the higher the value the greater the degree of unsaturation.

Table 3. Fatty acid profiles and iodine numbers of the preferred fats and oils[1] for SPE production under U.S. Patent 3,600,186 (Mattson and Volpenhein, 1971).

FATTY ACID(%)	SOYBEAN	CORN	COTTONSEED	OLIVE	TALLOW	LARD
Myristic, C14	0.3	0.9	1.0	0.6	5.0	2.5
Palmitic, C16	9.0	10.0	21.5	11.5	30.5	24.0
Stearic, C18	4.0	3.5	2.0	2.0	21.5	9.5
Oleic, C18	24.0	34.0	29.0	75.0	45.0	46.0
Linoleic, C18	49.5	48.0	48.0	9.5	3.0	8.5
Total preferred fatty acids	86.8	96.4	101.5	98.6	105.0	90.5
Iodine number	127	118	104	86	41	58

1. Percentages are median values from ranges published in Bailey's Industrial Oil and Fat Products (Swern, 1979).

The synthesis and purification of SPE has evolved from a solvent process to a solventless process since their first production. Dr. Foster Snell initially responded to the inquiry of Dr. Henry Hass by interesterifying sucrose with methyl esters of fatty acids in the presence of an alkaline catalyst, using dimethylformamide (DMF) as the solvent, since both sucrose and fatty acids are sufficiently soluble in it. The Snell process was patented in 1959 (U.S. Patent 2,893,990) and assigned to the Sugar Research Foundation (SRF). The same process was patented by Procter & Gamble Co. in 1958 (U.S. Patents 2,831,854,-5,-6) and caused great consternation among officers of the SRF member companies. Also in 1958, a chemist from Dainippon Sugar Mfg. Co.

Ltd. (parent to the Ryoto Co. Ltd.) came to the Sugar Research Foundation and negotiated a license for the Snell process; SPE was approved as a food additive in Japan in 1959 (Hass, 1968). The Snell proces was also licensed in 20 foreign countries, including companies in Germany, France, Italy and Brazil.

However, the mutual solvent DMF was expensive, had an offensive odor and left a toxic nitrogen residue in the esters. As a result, the FDA set a zero-tolerance level for DMF and did not permit SPE produced by the Snell process to be used in edible food products (Hennessey et al., 1971). Therefore, the Nebraska-Snell process was developed. The State of Nebraska cooperated in an attempt to use its surplus raw materials, in particular, sugar beets and tallow. This process did not involve a mutual solvent but a single solvent, propylene glycol, favoring the sucrose molecule. A micro emulsion was formed with dissolved sucrose in propylene glycol, the methyl ester of the appropriate fatty acid was added with potassium carbonate as catalyst, and the mixture was combined with a suitable emulsifying agent to give a transparent emulsion. As the propylene glycol was gradually distilled the SPE was produced, resulting in complete conversion of the methyl ester to sucrose ester. After purification, the reaction product was 85% sucrose monoester and 15% diester (Osipow and Rosenblatt, 1967). This method was improved upon in Japan by Daiichi Kogyo Seiyaki Co. Ltd., who succeeded in industrializing it by using water instead of propylene glycol as the solvent (Kosaka and Yamada, 1977).

The solventless process in the U.S. was reported in 1970 by workers in the USDA Southern Regional Research Laboratory. The method was known as the USDA process, for which Ryoto Co. Ltd. of Japan has an exclusive license; a similar method developed in Germany was known as the Zimmer method. The USDA solvent-free interesterification of sucrose required that it be in the molten state (m.p. 185 C) due to its ability to remain fluid and not recrystallize readily once the temperature was decreased. The fatty acid esters and various soaps (lithium, potassium, sodium) were added as catalysts and solubilizers, the mixture was heated to 170-180 C and then subjected to reduced pressure which brought the reaction to equilibrium in less than 12 minutes. The soaps, combinations of soaps and types of fatty acid esters employed differed markedly in performance and yield of SPE (Feuge et al., 1970). The solventless process has been improved steadily over the years by many researchers and manufacturers, making synthesis of SPE more economical. Applications of SPE have expanded as a result.

USES AND POTENTIAL USES OF SUCROSE ESTERS

Table 4 lists the major approved uses and potential uses in the U.S., pending approval by FDA. Industrialization of SPE synthesis has been studied by at least ten companies throughout the world but, while some are continuing their research, very few have begun commercial production of SPE.

Table 4. Approved uses of SPE in foreign countries and the U.S. and uses pending FDA approval*.

MANUFACTURER	COUNTRY	APPROVED OR POTENTIAL* USES
Ryoto Co. Ltd.	Japan	Anti-bacterial in dried foods
"	"	Lubricant for tablet candy
"	"	Anti-caking agent in dry mixes
"	"	Viscosity reducer in chocolate
"	"	Foam suppressant in tofu making
Tate & Lyle Ltd.	U.K.	Surfactant and emulsifier
"	"	Protective coatings for fruit
Rhone-Poulenc	France	Reconstituted milk for calves
"	"	Human food additives
Gist-Brocades	U.S.A.	Protective coating for fruit
Procter & Gamble Co.	"	*Low calorie fat substitute
Velsicol Chem. Corp.	"	Food packaging adhesives
Intl.Sugar Res.Fdtn.	"	*Dough conditioner in breadmaking
"	"	*Epoxy ester type resins
Eastman Chem.Prod.Co.	"	*Coatings, paints, varnishes
Dow Chemical Co.	"	*Rigid urethane foams
Olin Research	"	*Rigid urethane wood foams
Colonial Sugar Co.	"	*Cosmetics and toiletries
Gillette Res. Inst.	"	*Surfactant
E.I. DuPont & Co.	"	*Herbicide sprays
Daiichi Kogyo Seiyaku Co. Ltd.	"	*Ice cream
Company unknown	"	*Texture improver for surimi
"	"	*Anti-fungal and anti-bacterial
"	"	*Emulsifier for baked goods

It is interesting to note that industrialization of SPE has occurred in Japan which is totally dependent on imports of the main raw materials, sugar and edible fats, and whose per capita consumption of emulsifiers is lower than that of Europe or of the U.S. The Japanese market is dominated by Ryoto Co. Ltd. which was formed in 1972 as a result of the joint venture between a Japanese chemical supplier, Mitsubishi Chemical Industry Ltd. (MCI) and the Dainippon Sugar Manufacturing Co. Ltd., licensee of the Snell process since 1958. They have developed the MCI process, a solvent-based synthesis of SPE that produces a solvent-free product (Kosaka and Yamada, 1977).

MCI is the world's largest producer of sucrose esters, with 70% of the world's sales. The largest application of SPE in Japan is inhibition of heat-resistant spore-forming bacteria in hot canned drinks sold in vending machines. SPE are also used as lubricants for producing tablet candy in molds, as anti-caking agents in dry soup mixes and as viscosity reducers in chocolate manufacturing (Anonymous, 1987a).

Tate & Lyle Ltd. have developed the TAL solventless process

for sucrose-derived surfactants to meet the demands for low cost non-petroleum detergents and emulsifiers. These SPE products have been shown to be biodegradable, non-toxic, non-allergenic and non-irritating with low foaming power. Such properties allow for SPE application in the textile and wood industries, as well as in foods, pharmaceuticals, dispersal of oil slicks, cosmetics, toiletries and household cleaners (Parker et al., 1977).

Rhone-Poulenc continues to use the Snell process (DMF < 5ppm in finished SPE product) for manufacture of sucroglycerides used mainly in the animal feeding market as ingredients in reconstituted milk for calves. Sucroglycerides are mixtures of mono- and diesters of sucrose combined with mono and diglycerides. They have applied them to the human food additive market as emulsifiers for margarine manufacture, in non-alcoholic beverages to incorporate aromatics and to obtain homogeneous preparations of difficult to mix components (Bobichon, 1977).

REGULATORY STATUS OF SUCROSE ESTERS

The history of SPE approval as a food additive began in Japan in 1959. In 1969, the Joint Food and Agriculture/World Health Organization (FAO/WHO) Expert Committee on Food Additives approved usage; in 1980 they evaluated the acceptable daily intake (ADI) for humans as 0-10 mg/kg body weight on the basis of establishing a no-effect level in the rat of 500 mg/kg body weight (Shigeoka et al., 1984). Within the framework of the "horizontal" European Economic Community guidelines for emulsifiers, the sucrose ester was recommended for general admission in 1974.

Table 5 lists some of the U.S. Patents that have been issued for SPE synthesis and usage. Among them is the principal Procter & Gamble (P & G) patent for olestra (discussed earlier) which is due to expire in August, 1988. Originally SPE was the product of research to determine which fats might be easily digested by premature infants. The research resulted in an "180 degree turn" according to Fred Mattson, researcher and co-author of the patent, when it was discovered that SPE were less, rather than more, digestible than triglycerides (Haumann, 1986).

Table 5. A partial listing of the U.S. Patents issued covering SPE synthesis and usage.

PATENT NO.	DATE	ASSIGNEE	USE
3,600,186	1971	Procter & Gamble	Low calorie fat substitute
3,808,200	1974	USDA	Surfactant and emulsifier
3,963,699	1976	Proctor & Gamble	Low calorie oil
3,996,206	1976	Tate & Lyle Ltd.	Surfactant
4,298,730	1981	Talres Devel.	Surfactant
4,334,061	1982	Ethyl Corp.	Process for SPE
4,338,342	1982	Gist-Brocades	Treatment of bananas
4,345,933	1982	Velsicol Chem.	Viscosity reducer
4,395,365	1983	Nissan Motor Co.	Metal cleaning composition

Patent information regarding the background of the invention described research on reducing the absorbability of triglycerides by altering the alcohol moiety instead of the fatty acid groups. The desirable physical properties of the edible fat must be maintained as well as the palatability of the product. The sucrose ester, with the required minumim of at least 4 fatty acid esters, each fatty acid containing from 8-22 carbon atoms, was not absorbed in the digestive tract and therefore was described as being low calorie. According to Haumann (1986), SPE containing more than five ester groups are not digested and not absorbed. The primary P & G patent (Mattson and Volpenhein, 1971) pointed out that SPE having 1 or 2 ester groups were absorbed in rat feeding studies much like the triglyceride triolein. Reviews by Boggs (1986), LaBarge (1988) and Toma et al. (1988) described the proposed commercial SPE products as being mixtures of hexa, hepta and octa esters and as being non-absorbable and non-caloric. Studies with rats fed ^{14}C-sucrose hexaoleate or ^{14}C-sucrose octaoleate showed that less than 0.01 and 0.1% were absorbed, respectively (Mattson et al., 1977).

P & G has tested olestra's safety in over 100 studies. Results from these studies have drawn criticism and questionable conclusions. The company has worked closely with the FDA for several years preparing documentation for government approval of olestra and responding to agency questions about the low calorie and cholesterol free fat substitute. The FDA, which accepted Procter & Gamble's petition for approval in May 1987, allowed them to seek clearance for olestra as a food additive rather than as a drug, a shorter and less expensive process.

Although human clinical tests are not mandated by the FDA, P & G has done 27 of them involving about 1800 people. Several tests have indicated that SPE impairs the absorption of cholesterol; in some human studies blood cholesterol levels have been cut by as much as 20%. Other studies have indicated a reduction in absorption of vitamins A and E. Researchers have noted a laxative effect at higher dosage levels of SPE. P & G claims to have solved these problems by reformulation; they have added a vitamin E supplement to actually increase vitamin E intake and have dealt with the problem of bowel leakage at recommended levels of use (Solomon and Koenig, 1987).

P & G has requested that the FDA allow olestra to be used as a replacement for up to 35% of the fat in cooking oils and shortenings used in homes and restaurants, and up to 75% of the oils and shortenings used in the deep-frying of snack foods. Table 6 compares the calorie contents of several snack foods fried under normal conditions in triglyceride fat and in fat containing olestra at a 75% replacement level. The reduction in calories for each of these products was at least 32% and ranged as high as 56% (Schiller, 1988).

Table 6. How olestra cuts calories.

FRIED FOOD	CAL/SERVING CONTROL	CAL/SERVING OLESTRA*	% REDUCTION
Onion rings	279	120	56
Donuts, yeasted	250	140	43
Fried fish	265	165	38
French fries	325	215	34
Corn chips	145	95	32

*Fried in oil containing 75% olestra.

In December 1987, the Center for Science in the Public Interest (CSPI), an activist consumer group in Washington, requested that the FDA not approve olestra until additional studies have been carried out (Anonymous, 1987b). The group has stated that the FDA was irresponsible in allowing P & G to do cancer studies on only one species of animal instead of the customary two. Since P & G claimed that SPE is not absorbed into the blood, the FDA waived its usual requirement for a second carcinogenicity study on a different rodent species. CSPI pointed out that, in the case of FDA approval of sucralose, even though it is poorly absorbed, the FDA urged that it be tested in 2 rodent species because some carcinogens are positive only in the rat or the mouse but not in both.

In addition, CSPI maintained that olestra should be tested more thoroughly because it may well be consumed over a lifetime at high levels. They also urged the FDA to consider the testing of compromised animals since marginally toxic chemicals are likely to have a greater effect on humans who are young or elderly and who may also be obese, diabetic, hypertensive or alcoholic. CSPI cited other problems with SPE; according to P & G's own test data, the additive caused cancer, liver damage in female rats, premature deaths in male rats, and deformed and stillborn offspring. P & G claimed that these test data reflected a normal incidence of disease and mortality in the rats used in the lifetime feeding study. Examination of the rats produced no special explanation for the greater number of male deaths. In a recently completed study not cited by CSPI, the male rats fed olestra lived at least as long if not longer than those on a diet without it. Furthermore, the liver changes in some female rats did not occur in studies of other animals.

The FDA is now considering whether to ask P & G to repeat six studies performed for the company by Cincinnati physician Charles Glueck that tested the effectiveness of olestra on human subjects. Discrepancies in other research performed by Dr. Glueck have led the Health and Human Services Department to initiate proceedings that could bar him from receiving federal research funds for three years. P & G claims they could repeat Glueck's work in six months if the FDA requests it. It should be emphasized, however, that there is no evidence of impropriety in any of the olestra studies conducted for P & G by Dr. Glueck. Approval of olestra is estimated to take at least 2 more years (Schiller, 1988).

THE FUTURE OF OLESTRA

Salzman and Ostroff (1985) estimated the size of the non-beverage diet food market to be $750 million to $1 billion at retail, including snack foods, nutrient products and frozen dinners. P & G, with sales in fiscal 1986-87 of $17.0 billion, is confident of olestra's future in the low calorie food market, so confident that they have established an olestra marketing division. Jack Salzman, a Goldman Sachs vice-president speaking at the Calorie Control Council's 20th annual meeting in October 1987, predicted olestra's possible after tax profits of $150 million by 1992. He claimed FDA approval was possible by 1989 whereas approval of olestra in the U.K., for a broader array of products, could come as early as late 1988. On the day the petition for olestra was filed with the FDA, P & G's stock rose 7 points and the following day it rose another 4 points (Anonymous, 1987c). The ultimate future of olestra, of course, hinges on whether or not FDA will grant clearance for it to be used as a food additive.

P & G is not alone in eyeing the low calorie products arena; Unilever has been working on SPE for some time and PepsiCo's Frito-Lay division was granted a patent on April 15, 1986, for a substance with properties similar to olestra. This patent (U.S. 4,582,927) is for synthetic cooking oils containing "dicarboxylic acid esters," which can be used in the preparation of fatty-oil containing food products or for use in frying foods. More specifically, these products are esters of aliphatic alcohols and dicarboxylic acids, e.g., malonic acid (Salzman and Ostroff, 1986). Nutrasweet Division of Monsanto has recently announced the development of a fat substitute; although the exact chemical nature of this product was not divulged, food analysts reportedly have speculated that it is derived from a milk protein and that it would be more easily cleared by FDA than olestra (Sims, 1988). A spokesman for Nutrasweet (Dr. Vernon Young) explained on ABC Nightline on January 27, 1988 that the product, which will be called "Simplesse," consists of dairy or egg protein that has been physically modified to impart a fat-like mouthfeel. As such, it is not expected that FDA approval will be required. Nutrasweet expects to have the product on the market in 12-18 months. The food formulation uses will be limited to dairy products such as ice cream, cream cheese, sour cream and dips and salad dressings, mayonnaise and products of that type which will not have to undergo extensive heating. It can not be used as shortening or for frying (Wall, 1988).

Although this paper has focused on the food additive uses of SPE products, there are several potential therapeutic drug applications (Salzman and Ostroff, 1985). These would require separate approval by FDA which P & G is not presently pursuing. Clinical tests have shown SPE to be effective in lowering blood serum triglyceride and lipoprotein cholesterol levels, particularly the low density lipoprotein (LDL) which is considered to be the principal fraction contributing to cardiovascular

disease. They could be prescribed as drugs for weight reduction. They have potential as detoxifying agents for persons or animals who have ingested lipophilic toxins such as pesticides or other industrial chemicals. They could be used for their stool softening and laxative effects; the U.S. retail laxative market is estimated at about $500 million annually. Finally, bile acids such as chenodoxycholic acid (CDCA) could be administered in conjunction with SPE as a non-surgical means of removing gallstones. Salzman and Ostroff (1985) believed that this usage could not be cleared without a very lengthy FDA review process because evidence exists that CDCA and similar compounds can cause liver damage.

IMPACT OF OLESTRA ON SOYBEAN UTILIZATION

What will be the impact on soybean utilization if FDA eventually clears the way, as is expected, for the marketing of olestra? The best information available now strongly suggests that the overall utilization of soybean oil would be expanded, perhaps substantially. Much of the following reasoning for this opinion is based on recent discussions with P & G research scientists.

First of all, P & G is a leader in the commercial fats and oils market with such popular brands as Crisco and Puritan. The 150-year old company is not likely to be so foolish as to cannibalize these existing markets. Olestra sales and use would, for the most part, be in addition to, not at the expense of, triglyceride products (glycerol triesters) now used as ingredients and for frying. Calorie conscious and health conscious consumers would be able to enjoy the really rich and calorie-laden goodies that they are now denied. Remember that on an equal weight basis, fats and oils contain 2.25 times as many calories as carbohydrates and proteins. At present, the emphasis in development of low-calorie or diet foods of all types is on the replacement in formulated foods of nutritive carbohydrate sweeteners (e.g., sugars) and bulking of thickening agents (e.g., starches) with non-nutritive ones, e.g., saccharin or cellulose, respectively.

Second, in most of the P & G research and development work on olestra, soybean oil has been the primary source of fatty acids. This is because of its favorable fatty acid profile, as indicated above, and because it is readily available and cost effective. For many applications, esterification of sucrose with the normal mixed bag of soybean oil fatty acids produces an olestra with the desired physical and functional properties. When the properties desired in olestra are more similar to those associated with a higher degree of saturation, P & G would rather produce it via hydrogenation of soybean oil fatty acids than by using tallow or some of the more saturated vegetable oils. Incidentally, the likelihood of P & G or any other company using synthetic fatty acids (e.g., from petrochemicals), is practically nil.

How much soybean oil is normally used in the production of a unit weight of olestra? This will vary with the degree of esterification (DE) in the final product. Although the DE can range from the monoester to octaester forms, the olestra products will be at the high end of this range because generally five or more of the eight hydroxyl groups on the sucrose molecule must be esterified in order to impart the desired functionality and lack of absorbability. P & G scientists have pointed out that commercial products will be high in octaester content (80-95%) with almost no hexaester content. The conversion ratio for soybean oil in these products is about 1.3:1; that is, it requires 1.3 pounds of soybean oil to produce one pound of olestra. The quantity of soybean oil eventually consumed in the manufacture of olestra will depend first on FDA clearance and then on public acceptance of the product. Advantages and disadvantages of SPE consumption by human beings have recently been reviewed (LaBarge, R.G., 1988; Toma et al., 1988).

In all likelihood, the primary P & G patent (US 3,600,186) will expire before FDA clearance is granted. This will allow for some competition from other companies; however, they too are likely to select soybean oil as a fatty acid source for the same reasons that appeal to P & G. Competitors will have their work cut out for them because P & G has made it a habit to be Number One in market share and the olestra market will probably not be an exception.

What is the bottom line? Introduction of olestra will be much more beneficial than detrimental to soybean growers and processors. In terms of the theme of this symposium - soybean utilization - we view olestra as an opportunity rather than a threat.

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