6

Final Report on the Safety Assessment of Decyl and Isodecyl Oleates

Decyl Oleate and Isodecyl Oleate are esters of oleic acid. Decyl Oleate is used in cosmetic products at concentrations ranging from ≤0.1 to >50%. Isodecyl Oleate is used at concentrations of >0.1–25%.

Animal studies have shown both Decyl Oleate and Isodecyl Oleate to possess low acute oral toxicities in rats with LD50s of >40 ml/kg. Single application dermal and eye studies with rabbits have shown these materials at 100% concentrations produce little or no irritation. Daily applications of 15% or 100% concentrations for 60 days to the skin of rabbits produced a moderate degree of irritation with both Decyl and Isodecyl Oleate. Neither of the ingredients was found to be a sensitizer when tested in guinea pigs at concentrations of 15%.

Repeated insult patch tests containing 1–5% Decyl Oleate showed no signs of sensitization. Testing with formulations containing 5.5% Decyl Oleate produced a low number of reactions in 402 human subjects in the Schwartz-Peck Prophetic Patch Test and 204 subjects with undiluted Isodecyl Oleate on nine subjects showed a total irritation score of 1.0 out of a maximum of 756.

It is concluded that, because of both the chemical similarity of these compounds and the similarity of the available animal and human data, Decyl and Isodecyl Oleates warrant a conclusion of safe in the concentrations of present practices and use in cosmetics.

CHEMICAL AND PHYSICAL PROPERTIES

Decyl Oleate and Isodecyl Oleate are esters of oleic acid. Formed by esterification of oleic acid with decyl or isodecyl alcohol, they have the following structural formulas:

Decyl Oleate- $CH_3(CH_2)_7CH{=}CH(CH_2)_7COOCH_2(CH_2)_8CH_3$

Isodecyl Oleate- $CH_3(CH_2)_7CH{=}CH(CH_2)_7COOCH_2(CH_2)_6CH(CH_3)_2$

Methyl Oleate is a compound chemically related to Decyl Oleate and Isodecyl Oleate. Its structural formula is as follows:

$$CH_3(CH_2)_7CH{=}CH(CH_2)_7COOCH_3$$

The safety of methyl oleate is not under review in this report. Information and data pertaining to this compound are included to permit a more complete appraisal of the safety of Decyl Oleate and Isodecyl Oleate.

. Some of the chemical and physical properties of these esters are given in Table 1.[1-3]

Reactivity

Unsaturated fatty acids and their esters readily undergo autoxidation.[4] Methyl oleate can serve as a model for autoxidation reactions which all the oleic acid esters exhibited. This compound undergoes autoxidation to give primarily trans-hydroperoxides,[5] which are highly unstable and readily decompose to keto and hydroxy keto acids.[6] Some hydroperoxides have been found to possess carcinogenic potential.[7] Methyl oleate undergoes photochemical decomposition in direct sunlight and in the presence of oxygen to form the ozonide of methyl oleic acid.[8] The most important secondary products of autoxidation include alpha, beta-unsaturated carbonyl compounds.[5] Hematin compounds,[9] metals,[10] and chlorinated hydrocarbon insecticides[11] accelerate the autoxidation reaction by shortening the induction period.

Analytical Methods

Methyl oleate can be generated in purities of 98% or better by repeated distillation with urea at a low temperature.[12] Analysis of this and related compounds is done by gas-liquid or thin-layer chromatography. The position of the double bond can be determined by von Rudolph's oxidation procedure. Infrared spectroscopy can be used to delineate *cis–trans* isomers.[12-14]

Although gas–liquid chromatography remains the preferred routine analytical method for fatty acid ester mixtures, utilization of high performance liquid chromatography (HPLC) is increasing; for the latter has the advantage of identifying polymerized and oxidized esters which the former does not detect.[15,16]

TABLE 1. Properties.[a]

Ingredient	*Approx. M.W.*	*Appearance*	*Solubility*	*Saponification value*	*Iodine value*	*Acid Value (Max.)*	*Specific gravity*
Decyl Oleate	422	Light yellow liquid	Soluble in alcohol Insoluble in H_2O	130–142	55–65	5.0	0.855–0.865
Isodecyl Oleate	422	NA[b]	NA	130–145	50–65	5.0	NA

[a]Data from Refs. 1–3.

[b]NA = Not found in available literature.

Impurities

The following impurities have been reported in the oleate esters under review.[2]

Ingredient	*Impurity*	*Percent Present*
Decyl Oleate	Oleic Acid	2.5 max.
Isodecyl Oleate	Oleic Acid	2.5 max.

PURPOSE AND FREQUENCY OF USE IN COSMETICS

Decyl and Isodecyl Oleates have been widely used in cosmetic products. When applied to the skin alone, they deposit a thin oily film that is neither greasy nor tacky. They have good lubrication properties and possess low viscosity.[17] Both materials are used as dispersants and lubricants in cosmetic formulations, and these are particularly important in makeup and makeup removers, in which they are used as wetting agents for iron oxide pigments; particles of such pigment are dispersed and easily suspended. The use of these ingredients facilities the application and removal of a suspension.

By virtue of its branched chain structure, Isodecyl Oleate possesses several distinct properties. It has the ability to lower the freezing point of the emulsion phase of products, as well as to control product viscosity. In dispersible bath oils, it forms a white emulsion, giving the tub water a rich and milky appearance. It also has the ability to suspend aluminum chlorohydrate, which makes it valuable for dry antiperspirant formulations. Lipstick formulations have employed Isodecyl Oleate because its coupling properties increase the hardness and strength of the product without reducing its flow characteristics.

Table 2 indicates categories of product use and concentrations of use for Decyl and Isodecyl Oleate.[18] The cosmetic product formulation computer printout which is made available by the Food and Drug Administration (FDA) is com-

TABLE 2. Product Formulation Data.[a]

Ingredient *Cosmetic product type*	*Concentration (%)*	*No. of product formulations*
Decyl Oleate		
Lotions, oils, powders, and creams	>1-5	1
Bath oils, tablets, and salts	>10-25	1
	>5-10	1
Eyeshadow	>10-25	22
	>1-5	5
Eye makeup remover	>1-5	1
Mascara	>0.1-1	1
Other eye makeup preparations	>50	2
Hair conditioners	>0.1-1	3
Hair sprays (aerosol fixatives)	>0.1-1	1
Rinses (noncoloring)	>0.1-1	1
Shampoos (noncoloring)	>0.1-1	1
Blushers (all types)	>5-10	1
	>1-5	3

TABLE 2. (Continued.)

Ingredient *Cosmetic product type*	*Concentration (%)*	*No. of product formulations*
Foundations	>5–10	2
	>1–5	6
	>0.1–1	1
Lipstick	>1–5	12
Makeup bases	>5–10	1
	>1–5	5
Other makeup preparations	>1–5	1
Other manicuring preparations	>5–10	1
Cleansing (cold creams, cleansing lotions, liquids, and pads)	>10–25	2
	>5–10	5
	>1–5	1
	≤0.1	2
Face, body, and hand (excluding shaving preparations)	>10–25	2
	>5–10	3
	>1–5	7
Moisturizing	>10–25	2
	>5–10	7
	>1–5	12
	>0.1–1	2
Night	>1–5	1
Other skin care preparations	>50	3
	>1–5	2
Suntan gels, creams, and liquids	>25–50	2
	>1–5	2
Isodecyl Oleate		
Bath oils, tablets, and salts	>5–10	1
Other bath preparations	>0.1–1	1
Eyeshadow	>1–5	8
Blushers (all types)	>1–5	1
Foundations	>1–5	2
Other makeup preparations	>1–5	2
Deodorants (underarm)	>1–5	1
Other personal cleanliness products	>1–5	1
Cleansing (cold creams, cleansing lotion, liquids, and pads)	>10–25	1
Face, body, and hand (excluding shaving preparations)	>10–25	1
	>5–10	1
Moisturizing	>5–10	2
	>1–5	2

[a]Data from Ref. 18.

piled through voluntary filing of such data in accordance with Title 21 Part 720.4 of the Code of Federal Regulations (1979). Ingredients are listed in prescribed concentration ranges under specific product type categories. Since certain cosmetic ingredients are supplied by the manufacturer at less that 100% concentration, the value reported by the cosmetic formulator may not necessarily reflect the true, effective concentration found in the finished product; the effective concentration in such a case would be a fraction of that reported to the FDA. The fact that data are only submitted within the framework of preset concentration ranges also provides the opportunity for overestimation of the actual concentration of

an ingredient in a particular product. An entry at the lowest end of a concentration range is considered the same as one entered at the highest end of that range, thus introducing the possibility of a two- to ten-fold error in the assumed ingredient concentration. The compounds are employed in a variety of cosmetics, including makeup preparations, skin care preparations, and eye-shadow. Concentrations of use range from ≤ 0.1 to $> 50\%$ for Decyl Oleate and > 0.1–25% for Isodecyl Oleate.

Products containing these two materials are applied with varying frequency to all areas of the skin. In such formulations as blushers and moisturizing creams, exposure may occur several times a day, while in other cases there may be daily (deodorants) or less frequent (rinses, hair conditioners) applications. This occasional or daily use may extend over a period of years.

BIOLOGICAL PROPERTIES

Absorption, Metabolism, and Excretion

Unsaturated fatty acids such as oleic acid penetrate the skin via the hair follicles and sebaceous glands.[17] Esters of oleic acid presumably follow a similar route of absorption. A major portion of ingested fatty acids is absorbed across the intestinal mucosa, and the ester of these are completely hydrolyzed by extracellular enzymes in the lumen of the small intestines. After the resulting free fatty acids are taken up by the villal cells, they may or may not be esterified to glycerol; they are then packaged into chylomicra. These lipoproteins leave the intestinal mucosal cells, enter the lymphatic system, and ultimately end up in the blood. Capillary endothelial cell-bound lipoprotein lipases degrade the chylomicra, freeing up their fatty acid content for cellular uptake. Depending upon nutritional and hormonal factors, intracellular enzymes then catalyze either the production of triglycerides for lipid storage or the catabolism of the fatty acids via β-oxidation.[19]

The absorptive and excretive properties of methyl oleate may be typical of other esters of oleic acid. Thirty to 120 minutes after being fed mixtures of methyl oleate (57–75 mg) that consisted of 10% methyl 9,11-octadecadienoate (Md-OD), mice were sacrificed and the stomach and intestinal contents extracted and mixed with octane. These lipid-bearing extracts were then assayed for Md-OD via ultraviolet absorption spectroscopy at 230.7 nm. The results indicate that the mouse is capable of absorbing 60 mg of the mixture administered in a single dose in a maximum of two hours. The rate of absorption was nearly constant.[20]

When rats were fed a diet containing 5% methyl oleate for 12 weeks, there was an increase in the fecal excretion of free fatty acids, hexane-soluble acid materials, and unsaponifiable matter as compared to controls fed fat-free diets.[21]

Animal Toxicology

Acute Studies

Oral toxicity

Decyl Oleate: This ingredient was administered to Wistar rats by intragastric intubation at dose levels of 2.5, 5.0, 10.0, 20.0, and 40.0 ml/kg (three male and

two female rats per dose level).[22] The animals were fasted for 24 hours prior to dosing. All animals were observed daily for 14 days following administration and no deaths were recorded. The acute LD50 of undiluted Decyl Oleate was greater than 40.0 ml/kg of body weight.

Wistar-derived rats (groups of five male, five female) were dosed by gavage with either 5.0 g/kg of undiluted Decyl Oleate or 5.0 g/kg of 20 percent Decyl Oleate, 80% mineral oil.[23] The rats were fasted for 18 hours prior to dosing. The animals were observed for signs of pharmacologic activity and drug toxicity at 1, 3, 6, and 24 hours post-dosing, after which daily observations were made for a total of 14 days. One death was recorded for male animals in the diluted sample group, and one female died following treatment with the undiluted sample. No treatment-related effects were noted in any of the surviving animals. Examination of tissues of nonsurvivors and survivors at gross autopsy revealed no abnormalities.

Isodecyl Oleate: This ingredient was administered to Wistar rats by intragastric intubation at dose levels of 2.5, 5.0, 10.0, 20.0, and 40.0 ml/kg (two female and three male rats per dose level).[24] The animals were fasted for 24 hours prior to dosing. One death was recorded at the highest dose level. The acute LD50 of undiluted Isodecyl Oleate was reported to be greater than 40.0 ml/kg of body weight.

Dermal irritation

Decyl Oleate: Draize[25] and Federal Hazardous Substances Labeling Act[22] (FHSA) methods were used to conduct primary skin irritation studies. Test samples of Decyl Oleate (undiluted, 10 percent in corn oil and 20% in mineral oil) were applied (0.5 ml) to clipped areas of intact and abraded albino rabbits skin (six animals in each group). The abrasions were longitudinal, epidermal incisions sufficiently deep to penetrate the stratum corneum, but not so deep as to disturb the dermis. Following application of the test material, the exposed area was covered with a patch and the entire experimental area was sealed with impervious sheeting. The animals were immobilized for a 24-hour period. The mean scores for 24- and 72-hour gradings were averaged to determine final irritation values. The primary irritation index (PII) for undiluted Decyl Oleate was calculated to be 0.28.[25] It was also determined that Decyl Oleate had primary irritation indices of 0.08 as a 10 percent solution in corn oil[22] and 0.05 as a 20% solution in mineral oil.[25]

A modified Draize method was used to conduct primary dermal irritation studies with undiluted and 15% Decyl Oleate diluted in polyoxyethylene sorbitan stearate (3%), a perservative (2%), and water; the material was found to be nonirritating (Table 3).[26]

Isodecyl Oleate: This ingredient (0.5 ml) was applied undiluted to the clipped intact and abraded skin of three albino rabbits. The patch area was covered with Webril patches, and the entire experimental area was sealed with Blenderm Surgical Tape. After the animals had remained in restraining stocks for 24 hours, the patches were removed and the treated skin evaluated according to the method of Draize. The skin was evaluated again 72 hours later and the primary irritation index was calculated. The Isodecyl Oleate was calculated to have a PII of 1.00 in this experiment.[24] In a summary report it was determined that undiluted Isodecyl Oleate applied to the skin of rabbits had a primary irritation index of 0.28.[27]

TABLE 3. Ocular and Cutaneous Effects in Rabbits.[a]

Compound	Concentration (%)	Irritation of the ocular mucous membrane OII[b]	Primary irritation of the skin PII[c]
Decyl Oleate	100	1 h: 2.67 24 h: 3.00 48 h: 0.33	0.13
	15		0.00
Isodecyl Oleate	100	1 h: 4.00 24 h: 0.00 48 h: 0.0	assay 1: 0.13 assay 2: 0.00
	15		assay 1: 0.00 assay 2: 0.00

[a]Data from Ref. 24.
[b]OII = Ocular irritation index; Scoring: 0–100.
[c]PII = Primary irritation index; Scoring: < 0.5 = nonirritant, 0.5–2 = slight irritant.

Primary dermal irritation studies were conducted with undiluted and 15 percent Isodecyl Oleate diluted with polyoxyethylene sorbitan stearate (3%), a preservative (2%), and water. A modified Draize method was used, and the material was found to be nonirritating (Table 3).[26]

Eye irritation

Decyl Oleate: Decyl Oleate (0.1 ml) was instilled into the right eyes of rabbits at concentrations of 15 percent in corn oil,[28] 20% in mineral oil and 100%.[25] Under the Draize eye irritation procedure, the animals' left eyes served as the experimental controls. Primary eye irritation scores were 0.0 for the undiluted material, 0.0 for the 20% in mineral solution, and 1.0 for the 15% in corn oil solution.

Employing a modified Draize method, Guillot et al.[26] tested Decyl Oleate at a 100% concentration for ocular irritancy in rabbits. Irritation readings were made at 1 hour and at 1, 2, 3, 4, and 7 days. Scores (presented in Table 3) indicate that the material is at most a very slight irritant.

Isodecyl Oleate: Draize eye irritation studies were undertaken with undiluted Isodecyl Oleate and 15 percent Isodecyl Oleate in corn oil. The 15% solution had an eye irritation score of 0.3,[24] while the undiluted solution had a score of 0.0.[27] Using a modified Draize method, Guillot et al.[26] tested Isodecyl Oleate at a 100% concentration for ocular irritancy in rabbits. Irritation readings were made at 1 hour and at 1, 2, 3, 4, and 7 days. Scores (presented in Table 3) indicated that the material is at most a very slight irritant.

Subchronic

Oral toxicity

When fed to five male and five female rats for 12 weeks as 5% of their diet, pure methyl oleate and two other methyl esters of fatty acids caused the females to lose considerably more body weight than the test animals that were fed corn

oil (Table 4). Food intake and food efficiency were not altered, but symptoms of essential fatty acid deficiency (as seen by "scaliness of the tail") were evident as early as the 7th week of the experiment.[21]

Dermal irritation

Decyl Oleate: Decyl Oleate was applied daily for eight weeks to the skin of rabbits; the FHSA method was used with slight modifications. Undiluted or 15% Decyl Oleate diluted in polyoxyethylene sorbitan stearate (3%), a preservative (2%), and water were used. Reactions were evaluated daily, and at the end of the eight-week period, two skin samples were examined histologically. The compound produced irritation at the 15% and 100% levels (Table 5). Following a seven-day rest period, a challenge patch was applied to determine whether observed reactions were allergic or irritant in origin; the results indicated that they were the latter.[26]

The Landsteiner and Jacobs guinea pig sensitization procedure was utilized to evaluate Decyl Oleate at a 15% solution in corn oil.[28] Hair on the backs of 10 white male guinea pigs weighing 300–500 g each was clipped prior to the study's initiation and whenever it was subsequently necessary. A 0.1% solution of the Decyl Oleate was intracutaneously injected three times a week into the shaved back areas of the animals. These injections, which continued until a total of 10 had been made, consisted of 0.05 ml of test solution for the first injection and 0.1 ml for the remaining nine. Two weeks after the tenth injection, a challenge injection of 0.05 ml of freshly prepared solution was made just below the region of the sensitizing injections. The control, corn oil (0.1%) in physiological saline, was given in the same amount as the test material. Twenty-four hours following injection, scorings were recorded for the diameter, height, and redness of any reactions, and the average scores for the 10 sensitizing injections were compared with the scores for challenge injections. If the challenge score is substantially higher than the average value, sensitization would be reported. Because Decyl Oleate failed, upon challenge, to exhibit higher values, it is considered to be a nonsensitizer (its score was 0.0).

TABLE 4. Body Weight, Food Consumption and Food Efficiency of Rats Fed Methyl Oleate for 12 Weeks.[a]

	Body weight (g)		*Food eaten (g)*		*Food efficiency (g)*	
Fat in diet	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*
None	194	146	779	803	0.202	0.140
Methyl Oleate (5% of diet)	192	134	688	601	0.234	0.172
Methyl-11-Eicosenate (5% of diet)	191	139	701	607	0.227	0.178
Methyl Erucate (5% of diet)	170[b]	138	595	590	0.245	0.186
Corn Oil (5% of diet)	195	157	693	632	0.238	0.192

[a]Data from Ref. 21.

[b]Although it appears that methyl erucate retarded the growth of the males, statistical analysis showed that this difference was not significant at P = 0.05.

TABLE 5. 60-Day Cumulative Cutaneous Effects in Rabbits.[a]

Compound	Concentration (%)	60-Day Cumulative Irritation Scores: Macroscopic evaluation	60-Day Cumulative Irritation Scores: Histological evaluation	Interpretation of tolerance
Decyl Oleate	100	Poorly tolerated; skin thickening in the three rabbits, vesicles in one animal.	Pathological reaction: congestive dermis.	Poor
	15	Relatively well tolerated; some papulae or vesicles.	No significant pathological reaction.	Good
Isodecyl Oleate	100	Poorly tolerated; vesicles in one animal.	Congestive dermis with pericapillary imflammatory infiltrates; pathological reaction.	Poor
	15	Relatively well tolerated; episodical macules, papulae and vesicles.	No significant pathological reaction.	Poor

[a]Data from Ref. 26.

Isodecyl Oleate: When Isodecyl Oleate at a 15% concentration was tested according to the Landsteiner and Jacobs guinea pig sensitization procedure, it was determined to be a nonsensitizer (its score was 0.0).[24]

Isodecyl Oleate was applied daily for eight weeks to the skin of rabbits; the FHSA method was used with slight modifications. Undiluted or 15% Isodecyl Oleate diluted in polyoxyethylene sorbitan stearate (3%), a preservative (2%), and water were used. Reactions were evaluated daily, and at the end of the eight-week period two skin samples were examined histologically. The compound produced a moderate degree of irritation at the 100% level (Table 5). Following a seven-day rest period, a challenge patch was applied to determine whether observed reactions were allergic or irritant in origin. Results indicate that they were the latter.[26]

Clinical Assessment of Safety

Decyl Oleate: A human repeated insult patch test was conducted on 103 subjects with a skin conditioner containing 1–5% Decyl Oleate. Patches containing approximately 0.2 ml of undiluted sample were applied on Monday, Wednesday, and Friday for three consecutive weeks. Fourteen days after the final insult patch, challenge patches containing the undiluted skin conditioner were applied, and results were graded 48 and 96 hours later. No evidence of sensitization was found; no information on irritation potential was reported.[29]

Four formulations of a foundation containing Decyl Oleate (5.5%) were tested in the Schwartz–Peck Prophetic Patch Test and the Draize–Shelanski Repeated Insult Patch Test. "Virtually zero reactions occurred in 402 subjects in the Schwartz–Peck Test and 204 subjects in the Draize–Shelanski Test."[23]

Isodecyl Oleate: A single insult (24-hour) occlusive patch test was conducted on 19 human subjects with undiluted Isodecyl Oleate. The test material did not elicit any erythematous reactions. A summary report of the study concluded that

Isodecyl Oleate exhibits an acceptably low incidence of primary skin irritation under occlusive patch test conditions.[27]

According to an industry raw material evaluation, a procedure was undertaken with Isodecyl Oleate under the conditions of a Maibach-type Cumulative Irritancy Assay. When Isodecyl Oleate was applied undiluted under patch conditions to the skin of nine subjects for 21 consecutive days, it was found to have a total irritation score of 1.0 out of a maximum possible 756.[30]

SUMMARY

Decyl Oleate and Isodecyl Oleate are esters of oleic acid. Decyl Oleate is used in cosmetic products at concentrations ranging from ≤0.1 to >50%. Isodecyl Oleate is used at concentrations of >0.1–25%.

Animal studies have shown Decyl Oleate and Isodecyl Oleate to possess low acute oral toxicities in rats; both have LD50s of >40 ml/kg. Single application dermal and eye studies with rabbits have shown that these materials in concentrations up to 100% produce little or no irritation. When 15% or 100% concentrations were applied to the skin of rabbits daily for 60 days, both Decyl Oleate and Isodecyl Oleate produced moderate degrees of irritation. Neither ingredient was found to be a sensitizer when it was tested in guinea pigs at concentrations of 15%.

Repeated human insult patch tests on 103 subjects with a skin conditioner containing 1–5% Decyl Oleate showed no signs of sensitization. Industrial testing with formulations containing 5.5% Decyl Oleate produced a low number of reactions in 402 human subjects in the Schwartz–Peck Prophetic Patch Test and in 204 subjects in the Draize–Shelanski Patch Test. Repeated insult patch tests with undiluted Isodecyl Oleate on an unspecified number of human subjects showed a total irritation score of 1.0 out of a possible maximum of 756. A single insult occlusive patch test on 19 human subjects with undiluted Isodecyl Oleate produced a low level of primary skin irritation.

No chronic, oral subchronic, carcinogenicity, mutagenicity, or teratogenicity animal testing data were available to the Panel. Nor were there any phototoxicity or photosensitization studies in humans.

CONCLUSION

The Panel concludes that because of both the chemical similarity of the compounds and the similarities among the available animal and human data, Decyl and Isodecyl Oleates warrant a conclusion of safe in the concentrations of present practices and use in cosmetics.

REFERENCES

1. ESTRIN, N.F. (Editor). (1974). *CTFA Standards: Cosmetic Ingredient Descriptions*. Washington, DC: Cosmetic, Toiletry and Fragrance Association, Inc.
2. CTFA. (1979). Submission of data by CTFA. Cosmetic ingredient descriptions for Decyl Oleate, Isodecyl Oleate, Oleyl Oleate, Butyl Oleate, Isopropyl Oleate and Methyl Oleate.*
3. WINDHOLZ, M. (ed.). (1976). *The Merck Index*, 9th ed. Rahway, NJ: Merck.

4. GORTNER, R.A. (1949). *Outlines of Biochemistry*, 3rd ed. New York: John Wiley and Sons.
5. SWERN, D. and COLEMAN, J.E. (1955). Reactions of fatty materials with oxygen. XX. Recent developments in the autoxidation of methyl oleate and other monounsaturated fatty materials. J. Am. Oil Chem. Soc. **32,** 700–3.
6. WHITE, A., HANDLER, P., and SMITH, E. (1973). *Principles of Biochemistry*, 5th ed. New York: McGraw-Hill Book Co. p. 65.
7. HIATT, H.H., WATSON, J.D., and WINSTEN, J.A. (1977). Origins of Human Cancer Book A: Incidence of Cancer in Humans. Cold Spring Harbor: Cold Spring Laboratory. p. 231.
8. KITAHARA, K. (1961). Unsaturated fatty acids. III. Investigation by gas chromatography of the photochemical conversion of unsaturated fatty acids. Yakugaku Zasshi **81,** 126–9.
9. TAPPEL, A.L. (1953). The mechanism of the oxidation of unsaturated fatty acids catalyzed by hematin compounds. Arch. Biochem. Biophys. **44**(2), 378–95.
10. YAMADA, T. and MOCIDA, Y. (1969). Effect of metals on the autoxidation of methyl oleate. Kanagawa Daigaku Kogakubu Kenkyu Hokoku **1969**(7), 136–45.
11. BENCZE, K. and WILDBRETT, G. (1971). Effect of chlorohydrocarbon insecticides on radical reactions of methyl oleate. Fette Seifen Antrichm **73**(3), 157–60.
12. GUNSTONE, F.D., MCLAUGHLAN, J., SCRIMGEOUR, C.M., and WATSON, A.P. (1976). Improved procedures for the isolation of pure oleic, linoleic, and linolenic acids or their methyl esters from natural sources. J. Sci. Food Agric. **27**(7), 675–80.
13. ALLEN, R.R. (1969). Determination of trans isomers in GLC (gas-liquid chromatographic) fractions of unsaturated ester. Lipids **4**(6), 627–28.
14. LIE KEN JIE, M.S.F. and LAM, C.H. (1976). Fatty acids. IX. the thin-layer chromatographic behavior of all the *cis, cis-* and *trans-*, trans-dimethylene-interrupted methyl octadecadienoates and methyl octadecadiynoates. J. Chromatogr. **124**(1), 147–51.
15. SCHOLFIELD, C.R. (1975). High performance liquid chromatography of fatty methyl esters: preparative separations. Anal. Chem. **47**(8), 1417–20.
16. SCHOLFIELD, C.R. (1975). High performance liquid chromatography of fatty methyl esters: Analytical separations. J. Am. Oil Chem. Soc. **52,** 36–7.
17. STRIANSE, S.J. (1972). Hand creams and lotions, vol. 1, in: *Cosmetics: Science and Technology*, 2nd ed., 3 vols. M.S. Balsam and E. Sagarin (eds.). New York: Wiley-Interscience. pp. 193–95.
18. FDA. (Aug. 31, 1976). Cosmetic product formulation data. Computer printout. Washington, DC: Food and Drug Administration.
19. LEHNINGER, A.L. (1976). *Biochemistry*, 2nd ed. New York: Worth, 1975. LIE KEN JIE, M.S.F. and LAM, C.H. Fatty acids. IX. The thin-layer chromatographic behavior of all the cis, cis- and trans, trans-dimethylene-interrupted methyl octadecadienoates and methyl octadecadiynoates. J. Chromatogr. **124**(1), 147–51.
20. MEAD, J.F., DECKER, A.B., and BENNETT, L.R. (1951). The effect of x-irradiation upon fat absorption in the mouse. J. Nutr. **43,** 485–99.
21. MURRAY, T.K., CAMPBELL, J.A., HOPKINS, C.Y., and CHISHOLM. M.J. (1958). The effect of mono-enoic fatty acid esters on the growth and fecal lipides of rats. J. Am. Oil Chem. Soc. **35,** 156–58.
22. CTFA. (1976). Submission of data by CTFA. Decyl Oleate, 19.4b 2a.*
23. CTFA. (1975). Submission of data by CTFA. Decyl Oleate, 19.4b 6b.*
24. CTFA. (1977). Submission of data by CTFA. Isodecyl Oleate, 19.4b 2c.*
25. CTFA. (1975). Submission of data by CTFA. Decyl Oleate, 19.4b 3.*
26. GUILLOT, J.P., MARTINI, M.C. and GIAUFFRET, J.Y. (1977). Safety evaluation of cosmetic raw materials. J. Soc. Cosmet. Chem. **28**(7), 377–93.
27. CTFA. (1977). Submission of data by CTFA. Isodecyl Oleate, 19.4b 5a.*
28. CTFA. (1976). Submission of data by CTFA. Decyl Oleate, 19.4b 2b.*
29. CTFA. (1976). Submission of data by CTFA. Oleyl Oleate, 19.4b 6a.*
30. CTFA. (1976). Submission of data by CTFA. Isodecyl Oleate, 19.4b 5b.*

*Available upon request: Administrator, Cosmetic Ingredient Review, Suite 810, 1110 Vermont Ave., NW, Washington, DC 20005.