Report of the Literature Review Committee

21st Annual Review of the Literature on Fats, Oils, and Detergents. II.

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Nutrition and Biochemistry

REVIEWS. The subjects treated in general discussions and reviews pertinent to this division were: role of fat in nutrition (Kummerow—*Bordens' Rev. Nutr. Res. 15,* 16 pp.; Esh—*J. Sci. Club, India, 6,* 133), nutritive value of fats (Magar—*Oils & Oilseed J. India 5,* No. 10/12, 72; Cattaneo—*Ciencia e invest., Buenos Aires, 9,* 258, 308), parenteral administration of fats (Freeman—*Bull. Northwestern Univ. Med. School 28,* 113), choline (Harris *et al.—The Vitamins 2,* 2), vitamin D group (Harris *et al.—Ibid.* 132), inositols (Harris *et al.—Ibid.* 322), essential fatty acids (Harris *et al.—Ibid.* 267; Neumann—*Seifen-Öle-Fette-Wachse 80,* 421; Wagner—*Forschungen u. Fortschr. 26,* 130), essential fatty acids for pharmaceutical purposes (Poggi *et al.—Chimica, Milan, 8,* 315, 345), digestion and absorption of fat (Reiser—*J. Am. Oil Chemists' Soc. 31,* 292), fatty acid metabolism in animal tissues (*Ann. Repts. Prog. Chem. 50,* 301), decomposition of fats in the animal organism (Brouwer—*Chem. Weekblad 50,* 449), nutritional inducement of fatty liver (Beauvallet—*Ann. nutr. et aliment. 7,* C15), fatty liver resulting from hormonal unbalance (Hedon & Macabies — *Ibid.* C41), biochemical components of fatty liver (Clement—*Ibid.* C267), types of fatty livers (Bernhard—*Ibid.* C253), normal and abnormal fat resorption (Frazer—*Die Medizinische 1953,* 1317), role of coenzyme A in fatty acid metabolism (Mahler—*Fed. Proc. 12,* 694; Jencks—*Ibid.* 703), succinylcoenzyme A and its role in phosphorylation (Kaufman—*Ibid.* 704; Jones—*Ibid.* 708), enzymes of fatty acid metabolism (Lynen & Ochoa—*Biochim. et Biophys. Acta 12,* 299), mechanism of β-oxidation of fatty acids (Lynen—*Bull. soc. chim. biol. 35,* 1061), phosphorylation reactions associated with fatty acid oxidation (Lardy—*J. Lancet 73,* 254), acetoacetate formation from short-chain fatty acids (Brown & Chaikoff—*Biochim. et Biophys. Acta 11,* 37), use of food cholesterol in the animal body (Okey—*J. Am. Dietetic Assoc. 30,* 231), lipoproteins (Oncley—*Symposium Conjugated Proteins Ann. Conf. Protein Metabolism Rutgers Univ. 9,* 55), lipoproteins, coronary heart diseases, and atherosclerosis (Gofman *et al.—Physiol. Revs. 34,* 589), atherosclerosis (Page—*Circulation 10,* 1), mechanism of steatorrhea (Diaz—*Bull. Inst. Med. Res. Univ. Madrid 6,* 1), lipoxidase (Fukuba—*J. Oil Chemists' Soc. Japan, 3,* 103), relationship of dietary fat and riboflavin to the carcinogenic activity of *p*-dimethylaminoazobenzene (Jackson—*Univ. Microfilms Pub. 6954,* 35 pp.), agents modifying thyroid function and fattening of domestic animals (Hennaux *et al.—Bull. inst. agron. et stas. recherches Gembloux 21,* 58).

FAT NUTRITION. The fat nutrition problems studied pertain to the desirability in human diets and animal rations, amount compatible with good nutrition, essential fatty acids, nutritive value, and relationships to other dietary constituents.

Fat supplements in the nutrition of critically ill patients induced a sense of well being; weight gain, resistance to infection, and acceleration of wound healing (Mindrum—*J. Clinical Nutr. 1,* 503).

The production of fat in excess of demand in recent years has resulted in efforts to use the excess in animal and poultry rations. Nutritional investigations were reported on the economy of these outlets, especially for the animal fats. With baby pigs, supplementation of the ration with fat required increases in dietary protein for optimum growth, and best results were obtained when the ration was high in both fat and protein (Peo *et al.—J. Animal Sci. 13,* 995). Addition of four percent more fat to commercial dog foods improved growth, reproduction and lactation (Siedler & Schweigert—*J. Nutr. 53,* 187). However, other work showed that fat in dog rations could be successfully increased to 20% provided protein or methionine level was increased to a level compatible with the amount of fat fed (Campbell & Phillips—*Food Tech. 8,* No. 2, 22). Similarly, relationships of ratio of fat to protein and economy of growth were observed in tests on poultry (Bieley & March—*Poultry Sci. 33,* 1220). In this work, addition of 5-7.5% tallow to a 28% protein ration containing aureomycin induced fastest growth up to seven weeks of age. Addition of 5-10% tallow or cottonseed oil to broiler rations did not affect the storage quality of the carcasses (Darrow & Essary—*Ibid.* 1053). Other poultry tests indicated that the added fat with antioxidants improved feed efficiencies, whereas, without the antioxidants it did not (Combs and Romoser—*Ibid.* 1053). The most comprehensive work on utilizing oversupplies of animal fats in livestock ration was a series of papers presented at a symposium on the problem (Kraybill, *chairman—J. Am. Oil Chemists' Soc. 31,* 46). Papers were read describing investigations which demonstrated that supplementation of rations with animal fats improved feed utilization of chickens and turkeys (Sunde—*Ibid.* 49), of poultry and dogs (Schweigert & Siedler—*Ibid.* 52), of beef cattle (Matsushima & Dowe—*Ibid.* 54), and of broilers, ducks, turkeys and swine (Rice *et al.—Ibid.* 56). In most of these, but most especially in the latter, cost of gains,

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manufacture of the feed, palatability, stability, etc., were discussed. Addition of fat to dairy cow rations, by including fat containing palm seed and coconut chips to the feed, did not induce increase in butterfat or milk production (Witt—*Arch. Tierernähr. 3,* 80).

Rats fed a fat free diet since weaning had 64% of normal plasma lipides, and higher plasma phospholipides (Mead & Fillerup—*Proc. Exptl. Biol. Med. 86,* 449).

Some studies were on relationship of fat to other constituents of the diet. With fat levels of 5-12% in rabbit diets, gains were increased on supplementing with potassium, sodium, or calcium; the latter two inducing greater gains than the potassium (Wooley & Mickelsen—*J. Nutr. 52,* 591). Tocopherol absorption was greater in fat-containing than in fat-free diets, but was greatest when the fat and tocopherol were emulsified in aqueous solution (Pomeranze & Lucarello—*J. Lab. Clin. Med. 42,* 700). Tocopherol supplementation of capon rations induced greater deposition of subcutaneous fat (Usuelli *et al.*—*Boll. soc. ital. biol. sper. 28,* 1674). When low-fat, high-fat diets were administered to healthy adults during successive weeks, the riboflavin level in the blood remained normal, while the amount of riboflavin excreted in the urine during the low-fat diet was lower (Satoyoshi—*Vitamins, Japan 5,* 506). New tests have demonstrated that high-fat diets do not inhibit thiamine losses of the body or tissues (Gershoff & Hegsted—*J. Nutr. 54,* 609). Addition of fat to mice diets containing mineral oils inhibits the weight loss ordinarily caused by the mineral oil diet (Ershoff & Greenberg—*Am. J. Dig. Dis. 21,* 363).

New communications reflected a continued interest in essential fatty acid nutrition and biochemistry. The sequences of development and regression of histological changes in the skin of dogs during production and cure of fatty acid deficiency were illustrated (Hansen *et al.*—*J. Nutr. 52,* 541). Such lesions in the rat were distinguished from those produced by vitamin A deficiency (Kolah & Rao—*Current Sci., India, 22,* 207). Essential fatty acid deficiency has been produced in guinea pigs for the first time, and the symptoms and their regression during cure with linoleic acid were described (Reid—*Proc. Soc. Exptl. Biol. & Med. 86,* 708). The minimum amount of linoleic acid necessary in rat diets for normal hair growth was found to be 20 mg. daily (Rokkones—*Intern. Z. Vitaminforsch. 25,* 86). Tests have shown that essential fatty acids are not required by female rats for conception and completion of pregnancy but are needed for the survival of young and satisfactory lactation (Deuel *et al*—*J. Nutr. 54,* 193). Their protective action against x-irradiation injury has been confirmed, and was found to be greater when rats received commercial fat-free casein than when on diets of vitamin-test casein (Cheng *et al.*—*Ibid. 52,* 637; *54,* 201). Bernhard & Gloor (*Helv. Physiol. et Pharmacol. Acta 11,* 323) reported that addition of stearolic, 9,10-dihydroxystearic or 9,10-diketostearic acid to a rat diet devoid of essential fatty acids has a curative effect as measured by the growth and life expectancy of the young of rat mothers fed the diet. They suggested that linoleic acid may be formed from these compounds. However, Thomasson (*Nature 173,* 452) was unable to improve survival time, tail lesions, or growth of essential fatty acid-deficient rats with stearolic acid; on the contrary, it affected the rats adversely. Holman & Ener (*J. Nutr. 53,* 461) recommended urea-complex compounds of essential fatty acids as a means of supplementation in rations, because in this form the acids are protected against autoxidative rancidity, and steady dosages can be provided. Linoleate peroxide, reduced linoleate peroxide, decomposed linoleate peroxide and conjugated linoleate did not cure essential fatty acid deficiency in rats (Holman & Greenberg—*Arch. Biochem. & Biophys. 49,* 49). In this work stimulation of arachidonic acid synthesis was the main criterion for essential fat activity. This criterion was used to demonstrate that injection as the route of administration simplified studies on essential fat metabolism (Abu-Nasr & Holman—*Ann. Rept. Hormel Inst. 1952-3,* 35).

A newly observed early symptom of unsaturated fatty acid deficiency is a decrease in di-, tetra-, and pentaenoic acids together with a 4-6 fold increase in trienoic acid in the subcellular particles of livers (Klein & Johnson—*Arch. Biochem. & Biophys. 48,* 380). In rats these alterations occur six weeks before the onset of external symptoms of fat deficiency. Clinival investigations have revealed that the sera of poorly nourished babies contain higher than normal levels of trienoic acids with low levels of di-, tetra-, and hexaenoic acids (Wiese *et al.*—*J. Nutr. 52,* 355; Hansen & Wiese—*Ibid.* 367). This deviation from normal is corrected by essential fatty acid administration.

In fatty acid deficiency in rats the liver uptake of phosphorus is decreased (Klein & Johnson—*J. Biol. Chem. 211,* 103). This was believed to be the result of a dissociation of oxidation from phosphorlyation accompanying the oxidation of the intermediates of the Krebs cycle. Essential fatty acid deficiency also results in lower than normal blood cholesterol levels and increased levels in liver and adrenal glands (Alfin-Slater *et al.*—*Arch. Biochem. & Biophys. 52,* 180).

Lard added to a vitamin A-free diet shows marked vitamin A potency if added in the amount of 30% of the diet (Nieman—*Voeding 15,* 232). The vitamin A equivalent, according to growth tests, was estimated at 0.7 I. U. per gram of fresh lard. Another report on this activity of lard indicated that the lard by itself was inactive but showed considerable vitamin A activity when fed together with purified casein (Le Gallic—*Compt. rend. soc. biol. 147,* 302). An unidentified chick-growth factor has been reported to be present among unsaturated fatty acids (Carver—*Iowa State Coll. J. Sci. 28,* 290; Carver & Johnson—*Poultry Sci. 33,* 543). Wheat germ oil, corn oil, and oleic acid concentrates are sources of the factor. The factor has been shown to be distinct from linoleate, "liver L" and "Biopar C" factors.

A synthetic milk for nursing babies contained (dry basis) 28% lipides of 60% olein content (Nicola & Bono—*Minerva nipiol. 3,* 16). Metabolism studies with the product showed a high percent of fat absorption and good retention of nitrogen.

The fat component of synthetic and filled milks used in raising calves was investigated. Butyrated lard in filled milks induced better growth of three-day old calves than did filled milks containing normal lard (Hopper *et al.*—*J. Dairy Sci. 37,* 431). In another investigation comparing coconut oil and lard as the fat component, the former was digested better during the early weeks but after four weeks the lard was superior (Cunningham & Loosli—*Ibid.* 453). The above works suggested that during the first few weeks calves may require short chain acids. A synthetic calf diet recommended by Lambert *et al.* (*J. Animal Sci. 13,* 991) contained 1.8% butter oil and 0.2% lecithin as the fat components. On this diet there was no fat deficiency symptoms, growth was good, and incidence of diarrhea was very low. Another calf diet designed by this group (*J. Nutr. 52,* 259) contained hydrogenated soybean oil plus lecithin as the fat components. In tests on synthetic diets versus milk in feeding of calves, substitution of hydrogenated cottonseed oil for the fat caused some variations of patterns of blood lipide composition during five hours after eating; however, greatest changes occurred if glucose was substituted for lactose in the diet (Ramsey *et al.* —*J. Dairy Sci. 37,* 1357). A review and economic discussion on substitute fats in calf raising was written by Classen (*Fette u. Seifen 56,* 688).

Parenteral nutrition has been studied with respect to emulsified fat as a caloric supplement. Inclusion of fat in such nutrition prevented weight losses and induced better utilization of the protein components (Cannon *et al.*—*J. Lab. Clin. Med. 44,* 250). Merely adding essential fatty acids to such an emulsion can prevent pathological changes due to their deficiency but cannot promote body-weight gain and preserve a sense of well-being as well as does added fat (Meng & Youmans—*J. Clin. Nutr. 1,* 372). Administering such emulsions too rapidly produced toxic manifestations (Kinsell *et al.*—*Calif. Med. 81,* 218). Becker *et al.* (*J. Lab. Clin. Med. 43,* 752) have speculated that toxic response, such as thermogenicity, from intravenous fat emulsions might be due to coarse particle size or low stability of the emulsified fat in the plasma. Addition of heparin to the fat emulsion intravenously administered into rats resulted in a marked increase in the rate of disappearance of the fat from the blood and a decrease in the accumulation of fat in the spleen and liver (Grossman & Strub—*Proc. Soc. Exptl. Biol. & Med. 85,* 356). In this work it was also observed that the heparin decreased the turbidity resulting from fat in the blood. The rate of clearing of fat emulsions *in vitro* brought about by heparin in various concentrations and under different conditions has been recorded (Meng *et al.*—*Am. J. Physiol. 179,* 314).

The fish and marine animal oils available to the Japanese were investigated for their relative nutritive value. The work of Kaneda *et al.* (*Bull. Japan, Soc. Sci. Fisheries 14,* 285; *15,* 745; *17,* 173; *18,* 85; *19,* 171, 700; *20,* 50; *J. Japan Soc. Food Nutr. 5,* 78; *Sci. Papers Inst. Phys. Chem. Res., Tokyo 44,* 74; *J. Biochem., Japan 41,* 327) indicates that: (a) the very fresh oils are in general just as nutritious as vegetable oils; (b) due to presence of highly unsaturated acid, spontaneous oxidation readily occurs resulting in toxicity: (c) hydrogenation to eliminate polyunsaturation reduces their nu-

tritive value; (d) polymerization or oxidation in processing is deleterious, the latter being most injurious to the nutritive value; and (e) fatty alcohol-fatty acid esters from certain whale oils are absorbed by rats but cause seborrhea. Results similar to various portions of the above list appeared also in other Japanese reports (Matsuo—*J. Biochem., Japan 41*, 481; Higashi *et al.—Bull. Japan Soc. Sci. Fish. 19*, 537; Fujii *et al.—Repts. Res. Lab. Nippon Suisan Co. 6*, 1, 10, 18; Kakinuma *et al.—J. Japan Soc. Food Nutr. 3*, 156). The lesser nutritive value of Japanese margarine as compared to butter for growth and reproduction of mice was presumed to be due to the lower contents of essential fatty acids and lecithin in the former (Mori—*Med. & Biol., Japan, 27*, 89).

Schürch (*Problems in Nutr. Res. 1952*, 146) suggested that toxicity of heat polymerized oils may be due to cyclic or branched monomers. Recent use of polymerization in processing of fish oils for edible uses together with the doubt regarding their safety has instigated development of analytical methods for their detection in food fats (Hugel—*Fette u. Seifen 55*, 544). The method is based on solubility in propyl alcohol and is a modification or one proposed a decade ago by Jakobsen.

Mono-, di-, and triglycerides, as measured by growth in pair-feeding technique, appear to be nutritionally equivalent, calorie for calorie (Harris & Sherman—*Food Res. 19*, 257). In a comparison of vegetable versus animal fats in diets of obese subjects, there was no difference in effect on body weight but the diets containing the vegetable fats induced lower concentration of free and esterified cholesterol, and lower phospholipides in the sera of the subjects (Ahrens *et al.—Proc. Soc. Exptl. Biol. & Med. 86*, 872).

A comprehensive investigation on positional- and stereoisomers that are formed in hydrogenation of oils demonstrated that the isomers are physiologically used as nutrients and that hydrogenated fats compare favorably with natural fats of comparable firmness in serving as a source of essential fatty acids (Melnick & Deuel—*J. Am. Oil Chemists' Soc. 31*, 63). Conversely, Aaes-Jorgensen & Dam (*Brit. J. Nutr. 8*, 281, 285, 290, 296, 302) have published data which indicate that natural fats are better nutritionally than hydrogenated fats; some of the disparity is eliminated with administration of linoleic acid with the latter. They also observed that fluid intake of animals on the hydrogenated fat diets is greater.

Tumors have been produced in rat stomachs during long term feeding experiments with over-heated cottonseed oil; however, the heat applied to the oil exceeded that attained in processing or culinary treatment (Chalmers—*Biochem. J. 56*, 487; Peacock & Beck—*Acta Univ. Intern. contra Concrum 7*, 612). The ovalbumin of eggs from hens fed crude cottonseed oil migrates from the white to the yolk (Evans *et al.—J. Agr. & Food Chem. 2*, 1077). This transfer increases the size of the yolk and reduces the amount of egg white.

FAT ABSORPTION. Voet (*J. Med., Buenos Aires 7*, No. 167, 5) proposed tests and a method of calculation for determining the amount of fat an individual is capable of absorbing. The result expressed as fatty acids per kilogram of body weight per hour was named "the lipolytic and fat utilization potential" and is calculated from the excretion rate of pancreatic juice as determined in a secretin test and from the lipase activity present in this juice. Clinical application of the test is demonstrated.

Experiments by Hecker & Andrews (*Brit. Med. J. 1954*, 1131) have indicated that fat in a diet of milk alone is 94% utilized. In a series of rat tests stearic acid, tristearin or tripalmitin was absorbed from the ration to a slight extent, oleodistearin in amounts three times that of tristearin, and trimyristin almost completely (Scribante & Favarger—*Helv. Physiol. et Pharmacol. Acta 12*, 74). A broad conclusion of this entire work was that absorption is not wholly related to the melting point of the fats. Work with chicks as compared to animals has indicated that their normally higher body temperature does not confer advantages in the digestion of high melting point fats (Duckworth *et al.—J. Agr. Sci. 40*, 39).

Several new investigations have added new evidence to support a non-relationship between fats eaten and fats excreted via the feces. Norcia & Lundberg (*J. Nutr. 54*, 491) reported that the presence of various fats in the diet is without effect on the nature and the quantity of excreted non-dietary fatty acids. The observation that triolein is changed on incubation in fecal material was interpreted to indicate that at least part of the fecal fatty acids are derived from the metabolism of the intestinal flora (Chipault—*Ann. Rept. Hormel Inst. 1952-3* 21). In the presence of terramycin, some of the changes are repressed but others take place. Monasterio *et al.* (*Riv. gastroenterol 5*, 63) in clinical work found fecal fat excretion is minimum on a fat free diet and only moderately above on normal diet or after a fat diet. Administration of antibiotics did not affect the amount of fat excreted. The findings were discussed with regard to the endogenous origin of fecal fat. From similar work by Lewis & Partin (*J. Lab. & Clin. Med. 44*, 91), the data also are consistent with the belief that fecal lipides represent excretion by the intestinal mucosa. Magee (*Am. J. Physiol. 177*, 285) found that fecal fat excretion on high-protein diets is less than on isocaloric high-carbohydrate diets.

A new method of determining the degree of fat absorption is based on the height of the plasma vitamin A level at the end of five hours after administration of vitamin A dissolved in the test fat(Legerton *et al.—Gastroenterology 23*, 477). The absorption of vitamin A from an oily vehicle is said to parallel the degree of fat absorption.

Most striking of the new reports on fat absorption are those pertaining to the behavior of the fats in the intestine, for they need reconciliation with the present theories on the mechanism of fat absorption. Bergström (*Fette u. Seifen 56*, 771; *Biochim. et Biophys. Acta 13*, 491; *Arch. Biochem. Biophys. 49*, 268) produced data which do not wholly confirm either the theories of complete or partial hydrolysis in the intestines. By use of labeled fatty acids and glycerol, and chromatographic separations of phospholipides, free fatty acids, mono-, di-, and triglycerides he showed that there is partial splitting and considerable interchange of fatty acids among the glycerides and the phosphatides in the intestines. The final distribution of the fatty acids differs according to the acids present. Thus feeding triolein with five percent, respectively, of stearin, palmitin, and myristin produced lymph lipides of considerable differences in composition. With glycerol and free fatty acid administration there is no resynthesis to fat. Similar work with slightly different technique was done by Favarger & Gerlach (*Helv. Physiol. et Pharmacol. Acta 11*, 239) and the results were also discussed in relation to the mode of absorption of fats and the participation of phospholipides in this mechanism. In another investigation, the presence of diglycerides in human intestinal contents during fat digestion was demonstrated by countercurrent distribution analytical technique (Blankenhorn & Ahrens—*J. Lab. & Clin. Med. 44*, 770). Mattson *et al.* (*J. Nutr. 52*, 575) also recorded data pertinent to the mechanism of hydrolysis in the intestines. They found that the quantity and isomeric form of the monoglycerides found in the lumen are similar regardless of whether dietary fatty acids have 18 or 10 carbon atoms; these intestinal lipides are not affected by administration of relatively large amounts of 1- or 2-mono-glycerides; but fatty acid feeding induces a marked rise in the free fatty acid content.

Pontremoli and Montini (*Boll. soc. ital. biol. sper. 29*, 1480; *Atti accad. nazl. Lincei Rend.; Sci. fis., mat. e nat. 11*, 112) have demonstrated in both *in vivo* and *in vitro* tests that some desaturation of fatty acids occurs during its passage across enteric mucosa. For example lipides ranging from 49 to 54 iodine value were recovered from a thoracic-duct fistula after administration of methyl palmitate emulsion into a surgically segregated part of the duodenum.

The belief that significant portions of dietary phospholipides are absorbed before they undergo complete hydrolysis has been confirmed by labeled atom technique (Bloom *et al.—Am. J. Physiol. 177*, 84).

Intestinal lymph lipides in absence of bile or absence of both bile and pancreatic juice are about one fifteenth of that for normal animals sustained on fat-free diet (Kim & Bollman—*Arch. Surg. 69*, 247). During absorption of lipides the mean size of fat particles in the lymph increases, and their phospholipide content decreases (Borgström & Laurell—*Acta Physiol. Scand. 29*, 264). During absorption of fat in rats there is a transient development of clearing activity in the plasma which was associated with interaction of chyle and plasma (Jeffries—*Quart. J. Exptl. Physiol. 39*, 77). Fat absorption was also associated with increase of lipase in blood plasma (Pittoni & Pasetto—*Atti e mem. accad. patavina Sci lettere ed arti 64*, 70). Each of the above findings was interpreted with regard to the source of lymph lipides and the lymph behavior in serving as a transport media for fat from the intestines.

INTERMEDIARY METABOLISM. Many of the newly published reports on investigations on this pertain to metabolism in the

liver. Many involve abnormal metabolism which induces fatty livers and factors which are required to prevent this abnormality. An investigation for industrial production of fatty livers in geese showed that a corn diet low in choline is successful; but that increased liver weights are obtained in less time by replacing half the corn with a mixture of peanut cake and meat meal (Fleuret—*Ann. nutr. et aliment 7*, C97). Also in this work it was found that traces of antimony or arsenicals, and administration of agents that block ovarian activity of the female enhance the ability of liver to accumulate glycerides. Work with ducks has shown that high-fat diets are less inducive to fatty livers than high-carbohydrate diets (Duchesne & Bernard—*Can. J. Med. Sci. 31*, 474). In this work choline on a high fat diet had no lipotropic effect, and on fat-free, choline-free basal diet a considerable increase in liver fat is obtained by adding 1% cholesterol. Rats on 75% corn diets accumulated fat in the portal areas of the liver; whereas when the only protein was casein they developed a centrolobular type fatty liver (Shils & Steward—*Proc. Soc. Exptl. Biol. & Med. 85*, 298). Such accumulations of fat were decreased with methionine, choline, and vitamin B_{12}; the effect of the latter was irregular. A diet of rice containing 30% cow ghee induced doubling of the fat content of rat livers (Bose & Subrahmanyan—*Bull. Central Technol. Res. Inst. Mysore 2*, 236). In a search for an ideal diet for studies of lipotropic phenomena, one low in methionine was more suitable for inducing fatty livers than one completely free from it (Best *et al.*—*Ann. N. Y. Acad. Sci. 57*, 646).

The relative efforts of protein and lipotropic substances on nutritional fatty livers were studied. A series of studies by Harper *et al.* (*J. Biol. Chem. 206*, 151; *209*, 159, 165, 171) have indicated that a secondary lipotropic effect of protein, the sparing of choline by methionine being the primary effect, is not a choline-sparing action but one which results in providing certain amino acids, deficiencies of which cause fat to accumulate in the liver. This effect is apparent only when the diet contains either choline or methionine in amounts approaching what is considered to be the requirements. It is indicated that threonine may be required to inhibit excess liver-fat deposition. Amino acid mixtures equivalent to 30% casein in the diet are equal to the casein for liver repair (Patek *et al.*—*Ann. N. Y. Acad. Sci. 57*, 772). Fatty livers, cirrhosis type, in three Nigerian tribes and one group of wealthy African traders were not alleviated with essential amino acids or labile methyl in the diet, but was cured with natural animal and vegetable proteins (Nicol—*Ibid.* 764). It is suggested that the natural proteins contain an unidentified factor involved in the protection.

In investigations by Drill (*Ibid.* 654) on lowering of fat in fatty livers a combination of choline, vitamin B_{12}, and folic acid was most effective, but there was no effect if any one of these agents was omitted. Addition of inositol and aureomycin was without further liver-fat lowering action. Fat, deposited in excessive amounts in the liver of alcoholic patients suffering from tuberculosis, may be mobilized by streptomycin therapy (Girard—*Ann. nutr. et aliment 7*, C197).

The mechanism of lipotropic action was studied with *in vitro* tests. Liver preparations from rats on low protein diets with added guanidinacetic acid produced less labeled carbon dioxide from labeled fat material than did preparations from rats on stock diets (Artom—*J. Biol. Chem. 205*, 101). *In vitro* addition of choline, betaine aldehyde, betaine or phosphorylcholine did not stimulate production of labeled carbon dioxide. It is concluded that the lipotropic effect of choline may result from enhancement of fatty oxidation in the liver under action of some substance formed *in vivo* from choline. Similar work with carbon labeled acetate and labeled glycerol showed that the choline deficiency reduced synthesis of fatty acids and formation of glycogen (Bernhard *et al.*—*Helv. Chim. Acta 37*, 1439). Here it was also suggested that choline was indirectly related to the liver-fat metabolism. In other work, because choline decreased ketone bodies and increased oxygen consumption by the liver, it was believed that choline increases oxidation of the fatty acids to form ketone bodies and stimulates synthesis of glucose from these; whereas lipocaic has no influence on the breakdown of fatty acids (Pittoni & Rossi—*Arch sci. biol., Italy, 38*, 26, 47). Methionine, inositol, and choline were said to have only one effect in common, namely, to stimulate formation of glucose from ketone bodies; whereas lipocaic inhibited transformation of glucides into lipides.

Experimental dietary liver cirrhosis and necrosis had been shown to be two distinct processes morphologically. With a basal diet that produces both, addition of choline and a small amount of cystine prevented cirrhosis but not necrosis; another small amount of cystine prevented necrosis but increased cirrhosis; and additional amounts of both prevented both lesions (Daft—*Ann. N. Y. Acad. Sci. 57*, 623). The importance of proteins in preventing necrosis and cirrhosis was demonstrated. Liver necrosis appeared in rats fed fat free diet but appeared irregularly (McLean & Beveridge—*J. Nutr. 52*, 499). It was supposed that intestinal organisms may have had some influence.

In chronic choline deficiency, liver tumors may occur along with the cirrhosis when the diet is free of vitamin B_{12} (Salmon & Copeland—*Ann. N. Y. Acad. Sci. 57*, 664). In infants with fatty livers the enzyme system of the liver was not affected (Waterlow & Patrick—*Ibid.* 750). *Meso*-inositol and *meso*-inositol with lipocaic were lipotropic for fatty livers produced by carbontetrachloride, but *meso*-inositol with choline was not (Balduni *et al.*—*Arch. sci. biol., Ital., 36*, 581). Choline and methionine in similar experiments produced a sharp fall in the cholesterol content of the livers (Bernardini & Caltabiano —*Boll. soc. ital. sper. 28*, 806). In another investigation dietary dihydrocholesterol reduced liver cholesterol in cholesterol type fatty livers (Beher & Anthony—*J. Nutr. 52*, 519).

Repeated ingestion of lipocaic by human subjects resulted in a decrease in blood lipides and an increase in blood cholesterol (Briskas *et al.*—*Compt. rend. soc. biol. 147*, 1196).

Much of the work on the oxidative breakdown and on the synthesis of fats in the body was done with a technique involving labeled carbon. Details for a rapid method for determining lipide-C^{14} in liver slices which have been incubated with C^{14} labeled compounds has been published (Baruch & Chaikoff—*Proc. Soc. Exptl. Biol. & Med. 86*, 97). A new method for determining rates of synthesis of fatty acids and cholesterol in the intact rat was based on calculations from respiratory labeled carbon dioxide shortly after single tracer injection (Hutchens *et al.*—*Arch. Biochem. & Biophys. 52*, 261). Work on incorportion of octanoate-1-C^{14} into respiratory carbon dioxide, acetoacetate, long- and short-chain fatty acids, and cholesterol in liver slices indicated that long-chain fatty acid synthesis was inversely related to the amount of acetoacetate formed; that there may be some linkage between cholesterol synthesis and respiratory activity; and that the presence of malonate with pyruvate, succinate, or fumarate diverted acetate units from acetoacetate and short- and long-chain fatty acids (Lyon & Geyer—*J. Biol. Chem. 208*, 529). Labeled octanoate studies have shown that liver slices convert the carboxyl carbon into carbon dioxide at about twice the rate of that observed for the seventh carbon (Brown *et al.*—*Arch. Biochem. & Biophys. 50*, 221). This was interpreted to indicate that the terminal fragment of octanoate is limited in its ability to condense with oxalacetate to form citrate for entrance into the oxidative Krebs tricarboxylic acid cycle. Other work by this group (*J. Biol. Chem. 209*, 537) with labeled palmitates show that, as judged from incorporation of C^{14} from labeling at different carbons into acetoacetate and carbon dioxide, there exists four metabolicly distinct carbons in palmitic acid.

Labeled atom technique was used to study the oxidizing system in animal tissues. All acids from C_2 to C_{17}, excepting acetic and propionic acids, were oxidized at vigorous rates by oxidase fractions from rat livers; those with even number of carbons, with the exception of acetic acid, were converted quantitatively to acetoacetate, whereas those with an odd number of carbons yielded slightly more than one mole of acetoacetate per mole of fatty acid oxidized (Witter *et al.*—*J. Biol. Chem. 207*, 671). The enzyme which mediates the first oxidative step in the oxidation of lower fatty acids was isolated from beef liver (Beinert—*J. Biol. Chem. 205*, 575; Green *et al.*—*Ibid. 206*, 1; Mahler—*Ibid.* 13; Wakil & Mahler—*Ibid. 207*, 125; Wakil *et al.*—*Ibid.* 631; Goldman—*Ibid. 208*, 345; Mii & Green—*Biochim. et Biophys. Acta 13*, 425; Mahler—*Fed. Proc. 12*, 694). Because the enzyme reacts at a maximal rate with butyryl coenzyme A, it was named butyryl coenzyme A dehydrogenase. In this work β-hydroxyacyl coenzyme A dehydrogenase and a β-ketoacetyl coenzyme A cleavage enzyme were also concentrated, and the mechanisms involving these in the fatty oxidizing system were discussed. Ethylene reductase, another enzyme of the fatty acid cycle was concentrated from sheep-liver extracts and shown to be a flavoprotein but distinct from fumarate reductase (Seubert & Lynen—*J. Am. Chem. Soc. 75*, 2787). The participation of coenzyme A in oxidation, by a mechanism of acylation in activating and thiolysing steps, and liberation from the acylated form by condensation reactions involving acetyl-coenzyme A, was dis-

cussed with regard to providing an ideal example of the catalytic functioning of coenzyme A in the living organism (Lynen —*Nature 174,* 962). Brown & Scholefield (*Biochem. J. 58,* 368) published evidence which indicates that alkyl thio fatty acids are oxidized in a manner analogous to the oxidation of unsubstituted fatty acids. These alkyl thio fatty acids form coenzyme A derivatives and produce an inhibitory effect on acetoacetate synthesis only after formation of the coenzyme A derivative (Avigan & Scholefield—*Ibid. 58,* 374). The effect of fluoro-fatty acids upon fatty acid metabolism in fluoro-acid poisoning was discussed in the light of specific fatty enzyme systems (Hendershot & Chenoweth—*J. Pharm. & Exptl. Therap. 110,* 344). In conversion of labeled acetate, *in vitro,* to long-chain fatty acids by pigeon liver extracts, cytochrome C, diphosphopyridine nucleotide and magnesium stimulated the system, whereas calcium and fluorine were inhibitory (Brady & Gurin—*Brookhaven Symposia Biol. No. 5,* 162, 173). In this work acetyl coenzyme A was less efficiently utilized as a precursor for fatty acids than acetate.

Technique with labeled compounds was used to demonstrate that there is no significant difference in the distribution of bio-synthesized fatty acids between neutral fat and phospholipide fractions of various fats in fed and 72-hour fasted rats (Coniglio *et al.—Am. J. Physiol. 177,* 69). In this work intestinal phospholipide contained more labeled fatty acids than the neutral fat; intramuscular fat had a labeled/unlabeled ratio different from subcutaneous fat; and labeling occurred in the total carcass fat of the fasted animals. The data were discussed in relation to disposition of biosynthesized fatty acids. Linolenic acid was synthesized during incubation of the egg (Cielens—*Latvijas PSR Zinatnu Akad. Vestis 1950,* No. 10, 57). This conclusion resulted from tests showing only traces of the acid in eggs, but measurable amounts in chicks just after hatching. It was suggested that the C_{20} and C_{22} polyene acids of glycerol phosphatides and from fish oills are formed from linoleic and linolenic acids, and the first double bonds counting from the terminal methyl group are in the same position as those in the precursors (Klenk *et al.— Naturwissenschaften 41,* 68). Evidence to support this hypothesis was derived by feeding rats labeled acetate, analyzing the highly unsaturated body acids by oxidation and identifying the products to establish the position of the double bonds. Similar work, in which labeled acetate was injected into mice and the resulting synthesized fatty acids were analyzed, indicated that most of the palmitic acid is synthesized from two-carbon units, and only a small amount by elongation of pre-existing fatty acids (Dauben *et al.—J. Am. Chem. Soc. 75,* 2347). Stearic acid seemed to be synthesized from palmitic acid. The biosynthetic incorporation of labeled carbon from carbon dioxide into linolenic acid was accomplished in two steps; first, the photosynthesis of labeled sugar by *Canna indica* leaves and second, the microbial synthesis of the acid from the sugar by means of *Trichosporon pullulans* (Reinius— *Ann. Acad. Sci. Fennicae Ser. A 11, No. 49,* 7). In this work fat deficient rats deposited linoleic acid at a greater rate than did normal rats.

New fats are synthesized *in vitro* by adipose tissue of rats when the medium also contains phosphate and chopped liver (Favarger & Gerlach—*Helv. Physiol. et Pharmacol. Acta 12,* C15). Adipose tissue converts only negligible amounts of acetate into cholesterol, is as active as liver in forming fat from acetate, and oxidizes acetate to carbon dioxide at a rate one-third to one-fourth that of liver tissue (Feller—*J. Biol. Chem. 206,* 171). An oxidase enzyme preparation from adipose tissue of chickens was capable of oxidizing octanoic, myristic, palmitic, stearic, oleic, and linoleic acids (Morrison *et al.— Poultry Sci. 33,* 401). This action and the growth patterns of chick adipose tissue have suggested that adipose tissue has organ-like characteristics (Liebelt & Eastlick—*Ibid.* 169).

Mammary gland preparations have the ability to synthesize fats containing fatty acids of all chain lengths (Popjak & Tietz—*Biochem. J. 56,* 46). In the mammary tissue, all synthesized fatty acids appear only as neutral fat, and free fatty acids are never detectable (Hatziolos *et al.—J. Dairy Sci. 37,* 924).

Some work pertained to body fat compositions. An investigation on the influence of dietary fat on the glyceride structure of animal fats indicated that: (a) endogenous rat fats conform to the "random" type distribution of acids among the glycerides; (b) fats ingested by rats are resynthesized in a manner that tends to redistribute the fatty acids; and (c) chicks tend to produce simple or "mono-acid" glycerides in which the percentage of trisaturated glycerides is higher than expected from random distribution (Reiser & Dieckert—*J. Am. Oil Chemists' Soc. 31,* 625). The results were supposed to be influenced by differences in the selectivity of the enzyme systems and the higher body temperature of birds. Backfat of pigs fed equal parts of lard and cod-liver oil can be segregated into two portions by crystallization from acetone at −40°, the solid portion resembling lard and the liquid portion cod-liver oil (Garton & Duncan—*Biochem. J. 57,* 120). A comparison of depot fat after maintaining rats on diets containing peanut, hydrogenated peanut, and cow ghee oils, respectively, as the sole fats showed that: linoleic deposition is high from peanut oil; arachidic acid content of body fats on each fat diet is the same but greater than that of nonfat fed controls; oleic acid content is practically the same in all groups; isooleic acid from hydrogenated oil feeding is deposited in the body fat; and the amount of saturated acids is of the same order in all groups (Bose & Subrahmanyan— *Ann. Biochem. & Exptl. Med., India, 11,* 207). Elaidic acid is incorporated into neutral fats and cholesterol esters in livers of rats fed trielaidin (Levy & Legrand—*Arch. sci. physiol. 7,* 311). Norcia & Lundberg (*J. Nutr. 54,* 509) conditioned rats to olive oil and tripalmitin, respectively, and observed body fat alterations on changing the dietary fat. Most striking alteration is the ready deposition of linoleic acid in rats conditioned with fat lacking this essential fatty acid. Tove *et al.* (*J. Nutr. 54,* 49) observed that replacement of pure protein in rat diet with fat-free soybean or cottonseed meal increased diethenoid acids and decreased monoethenoid acids of the carcass fats. An intravital coloring of fat occurring in corn-fed ducks is bleached by giving aqueous solutions containing 0.1% potassium permanganate instead of drinking water one week before slaughter (Olbrycht *et al.—Med. Meterynar, Poland 8,* 394). Administration of adrenocorticotropin or cortisone to guinea pigs induces rapid catabolism of body fats (Notario & Caspani—*Arch. sci. med. 96,* 656). In clinical investigations a highly significant positive correlation was found between the surface fat and plasma cholinesterase (Berry *et al.—Brit. J. Nutr. 8,* 79). The fatty acid content of spleen blood is 30% higher than that in the serum of peripheral blood Goreczky— *Biochem. Z, 325,* 477). Human milk, like cow's milk, increases in fat content during suckling (Whittlestone & Perrin—*J. Dairy Res. 21,* 204).

A diet which supports good growth and reproduction in rats may not be adequate to meet the nutritional requirements of older animals, and some of the symptoms of a fatty acid deficiency may appear (Klein & Johnson—*Arch. Biochem. Biophys. 48,* 172). Lack of pyridoxine in the diet causes a decrease in the percentage of total body fat in the carcass which could be prevented by giving linoleic acid (Desikachar & McHenry— *Biochem. J. 56,* 544). Aged spring herring contain more muscle fat than the young fish, and the iodine value of the fat was lower in the aged fish (Zaina & Ichinoe—*Bull. Japan, Soc. Sci. Fisheries 17,* 57).

PHOSPHATIDES. Chromatographic analytical technique was applied to the estimation of serine and choline content of human serum phospholipides, and the results indicate that choline-containing phosphatides represent the major constituents (Gertler *et al.—J. Biol. Chem. 207,* 165). Group lipides of human liver consist of two moles of α-glycerolphosphoric acid, one to two moles of ethanolamine, two moles of glutamic acid, one mole each of glycine and serine, four moles of mannose and chondrosamine and some fatty acids (Masamune *et al.—Tohoku J. Exptl. Med. 58,* 216). Phosphatides of the brain contain four different C_{20} and six different C_{22} unsaturated acids (Klenk & Bongard—*Hoppe-Seylers' Z. physiol. Chem. 291,* 104). In this report the structures of all of these C_{20} and C_{22} acids were determined. A single injection of labeled phosphate given to rats after partial hepatectomy shows that in regenerating livers the contents of trienoic and tetraenoic fatty acids decrease and dienoic acids increase (Johnson *et al. —Arch. Biochem. & Biophys. 51,* 170). These occur coincident with uptake of phosphorus by the phospholipides. Labeled phosphate technique was used to determine factors affecting the incorporation of phosphates into the phospholipides of slices of cat brain (Strickland—*Can. J. Biochem & Physiol. 32,* 50). Various carbohydrates affected the mechanism differently; pyruvate and lactate increased; while succinate, L-glutamate, D-glutamate, α-ketoglutarate, citrate and L-malate failed to support the labeled phosphate incorporation. Inositol phosphatide feeding results in no increase in inositol phosphatide concentration in human blood plasma, but it decreased neutral fat in the plasma (McKibbin & Berwer—*Proc. Soc. Exptl. Biol. &*

Med. 84, 386). Injection of adrenocorticotropic hormone into animals containing labeled phosphates increases the labeled phosphorus content of the brain phospholipides 31% in less than 15 minutes without significantly modifying the labeled phosphorus content of other phosphorous containing fractions (Torda—*Am. J. Physiol. 177,* 179). The results indicate that brain phospholipides are utilized during cerebal activity. A lipide anticoagulant in beef brain was found to be associated with the cephalin fraction of phosphatides (Goldsmith *et al.*—*J. Biol. Chem. 211, 163,* 169).

CHOLESTEROL METABOLISM. New modifications of methods of determining cholesterol in blood were designed by Jancic (*Bull. soc. chim. repub. pop. Bosnie et Herzegovine 2,* 89), Pollak & Wadler (*J. Lab. Clin. Med. 39,* 791), Marques (*Rev. quim. e farm., Rio de Janeiro 14,* 471), and Sasaki *et al.* (*Folia Pharmacol. Japan. 48,* 94). In demonstrating the new procedures, Pollak & Wadler showed that normal total blood cholesterol in humans was 120-200 mg. per 100 ml.; Marques found an average value of 210 mg. per 100 ml. in the blood of men of 25-35 years of age; and Sasaki reported the following concentrations (mg./100 ml.) in animals: rabbit, 87, rabbit after feeding lanolin, 332; man, 130; dog, 136; beaver, 92; horse, 133; ox, 110; and pig, 101.

Tests on peoples existing on different dietaries show that serum cholesterol level is unrelated to cholesterol intake, but is significantly higher in people on diets relatively high in fat (Keys *et al.*—*Brit. J. Natur. 8,* 138). Similar results were also observed in clinical tests (Mayer *et al.*—*Am. J. Clin. Nutr. 2,* 316).

Rats deficient in cholesterol absorbed 40-60% of administered C^{14}-labeled cholesterol, excreted 20-25% and destroyed 20-35% (Bugnard *et al.*—*J. Physiol., Paris, 45,* 413). The primary cause of susceptibility of the rabbit to hypercholesterolemia as compared to rats was supposed to be a greater difficulty in ridding plasma of cholesterol absorbed from the diet (Friedman & Byers—*Amer. J. Physiol. 179,* 201). This difficulty in turn appeared to be due to a relative inability of the hepatic reticulo-endothelial system of the rabbit to remove cholesterol-containing chylomicra from the plasma. Friedman *et al.* (*Am. J. Physiol. 177,* 77; *Proc. Soc. Exptl. Biol. & Med. 85,* 530) also developed considerable evidence indicating that the reticulo-endothelial system plays an essential role in the disposition of exogenous cholesterol.

The following new reports on modifying serum cholesterol contents are not entirely consistent with each other and do not agree with some of the findings among the reports cited in the preceding paragraphs. Kinsell (*J. Am. Dietetic Assoc. 30,* 685) reported that diets containing large amounts of fat of vegetable origin are associated with a major fall in the level of cholesterol and phospholipides in the plasma and suggested that this is due either to a lack of dietary cholesterol or to some constituent of vegetable lipide diet responsible for the changes. In the work of Peterson *et al.* (*J. Nutr. 53,* 451) with chicks, increases of serum cholesterol were inhibited with soybean sterols; fatty acid esters of ergosterol or dihydrocholesterol did not prevent increases in tissue; and fatty acid cholesterol esters lowered plasma and liver levels of cholesterol. Work with rabbits with elevated tissue levels of cholesterol by Beher & Anthony (*Proc. Soc. Exptl. Biol. & Med. 86,* 589) indicated that feeding dihydrocholesterol increased mobilization of cholesterol from the liver, and soybean sterols did not reduce plasma cholesterol. According to Swell *et al.* (*Ibid.* 295), ingestion of soybean sterols inhibited the increase in blood cholesterol of rats fed a diet containing two percent of cholesterol and one percent of taurcholate. Putignano (*Boll. soc. ital. biol. sper. 28,* 1154) finds that by feeding olive oil to rabbits the blood cholesterol is increased and by feeding rancid oil the effect was accentuated. Okey & Lyman (*J. Nutr. 53,* 601) found that usage of food cholesterol was reduced by egg albumin; DL-methionine decreased liver cholesterol; whereas L-cystine increased it. Results of investigations by Frantz *et al.* (*J. Biol. Chem. 206,* 465) show that rats fed one percent cholesterol in a diet have large rises in the concentration of liver cholesterol, but only minimal rise of serum cholesterol. Other results in this work indicate no evidence that inhibition of cholesterol synthesis by dietary cholesterol is mediated through the thyroid gland; and synthesis was inhibited to at least as great an extent in animals which had received radioactive iodine as in normal rats. Data recorded by Raulin (*Arch sci. physiol. 8,* 107) indicate that administration of cholesterol to rats on a lipide deficient diet or diets supplemented with lard increased growth, but with several vegetable oils excess cholesterol hindered growth. Feeding 7-cholestenol to rabbits produces the same effect as feeding cholesterol (Lemmon *et al.*—*Arch Biochem. & Biophys. 51,* 161).

Bloch (*Helv. chim. acta 36,* 1611), Schwenk *et al.* (*Arch. Biochem. & Biophys. 49,* 187), Cornforth & Popjack (*Biochem. J. 58,* 403), and Popjak (*Arch. Biochem. & Biophys. 48,* 102) have elaborated on the mechanism of biosynthesis of squalene and cholesterol from acetate. Conditions desirable for the synthesis of cholesterol from acetate in liver extracts have been worked out by Frantz & Bucher (*J. Biol. Chem. 206,* 471) and Rabinowitz & Gurin (*Ibid. 208,* 307). Coenzyme A is necessary for *in vitro* synthesis of cholesterol by rat-liver extracts but is an inhibitor when present in relatively high concentration (Migicovsky & Greenberg—*Biochim. et Biophys. Acta. 13,* 135). Werthessen *et al.* (*Am. J. Physiol. 178,* 23) have demonstrated that the aorta can synthesize cholesterol within itself. Investigation on the disappearance of previously labeled cholesterol in rats maintained on a diet free of cholesterol shows that cholesterol is synthesized in liver, intestine and skin, and the metabolism of this endogenous cholesterol is far greater in scope than heretofore reported (Landon & Greenberg—*J. Biol. Chem. 209,* 493).

α-Naphthylisothiocyanate, when administered to rats in oil, increases the liver cholesterol (Mazzanti & Lopez—*Boll. soc. ital. biol. sper. 29,* 307). Cholesterol feeding produces a marked hypercholesterolemia in animals intoxicated with carbon tetrachloride (Saka *et al.*—*Bull. fac. med. Istanbul 17,* 24). It has been suggested that the transformation of cholesterol to coprostanal in human subjects involves direct saturation of the 5,6 double bond of cholesterol (Rosenfeld *et al.*—*J. Biol. Chem. 211,* 301).

LIPIDE METABOLISM IN DISEASE. Studies of lipides in diseased conditions most often involved the coronary disease, atherosclerosis, and the lipide, cholesterol. As yet there is still disagreement as to the value of low-cholesterol, low-fat diet in atherosclerosis. This was pointed out by Robinson (*Am. J. Clin. Nutr. 2,* 353) even though she published diets low in cholesterol and fat which still may be prescribed for such patients. In a review on relation of fat and caloric intake to atherosclerosis, Gofman *et al.* (*J. Am. Dietetic Assoc. 30,* 317) have pointed out that low fat diets will result in a lowering of certain classes of high density lipoprotein levels which are high in such patients.

Laboratory experiments on atherosclerosis dealt principally with factors which affect its development and the development of other pathological conditions associated with it. Atherosclerosis development in rabbits by feeding cholesterol was less harsh when the cholesterol was fed in corn oil than when in hydrogenated vegetable oil or alone (Kritchevsky *et al.*—*Am. J. Physiol. 178,* 30). Also different breeds of chickens differ in their susceptibility to cholesterol administered in cottonseed oil, and the atherogenic potential of the cholesterol is influenced by the grade of cottonseed oil used (Opdyke & Ott—*Proc. Soc. Exptl. Biol. & Med. 85,* 414). Pilgeram & Greenberg (*Science 120,* 760) have suggested that susceptibility to atherosclerosis may be due to the need for certain phospholipides which clear cholesterol. Laboratory tests have indicated that administration of inositol phosphatide (Moses—*Geriatrics 9,* 325) or other lipotropic agents (Goldbloom *et al.*—*Am. J. Digestive Disease 21,* 152) is of no value in the treatment or prophylaxis of atherosclerosis. Atherosclerosis, which is induced in rabbits receiving 0.2 g. per kg. of cholesterol, does not appear when a small amount of histidine accompanies the cholesterol (Chimakadze—*Farmokol. i Toksikol. 17,* No. 3, 11). Methionine and cystine supplements in the diet of monkeys inhibit production of atherosclerosis by dietary means (Mann *et al.*—*J. Exptl. Med. 98,* 195). In chickens methionine, magnesium, inositol or potassium iodide depressed atherosclerosis (Balaguer-Vintro—*Rev. espan. fisiol. 10,* 1). Aluminum oxide, boric acid, and cortisone were also tested but were unsuccessful (Baeder *et al.*—*Proc. Soc. Exptl. Biol. & Med. 86,* 326). β-Sistosterol depressed absorption of dietary cholesterol and has been recommended for studying the effects of a sustained lowering of serum cholesterol in atherosclerotic states (Best *et al.*—*Circulation 10,* 201). Heparin administration was used in atherosclerosis studies because it decreases serum cholesterol and other lipides (Bianchi & Tansini—*Arch. studio fisiopatol. e clin. ricambio 17,* 184), but it did not cause regression of the lesions (Horita & Loomis—*J. Exptl. Med. 100,* 381; Horlick & Duff—*Arch. Pathol. 57,* 417, 495). However, one investigator ascribed the lesions to heparin deficiency (Baratta—*Arch. studio fisiopatol. e clin. ricambio 17,* 31) and

another considered heparin involved only in fat transport (Woldow *et al.—Am. Heart J. 47,* 568).

Gertler & Oppenheimer (*Geriatrics 9,* 157) reviewed the evidence which supports the thesis that total cholesterol/lipide phosphorus ratio is a good index to atherosclerogenesis in males. Iannaccone (*Minerva med. 1954, I,* 688) found that the difference of this ratio in diabetic individuals with and without atherosclerosis was insignificant. Data by Goldman & Eiber (*Bull. N. Y. Med. Coll. Hosp. 16,* 32) showed excessive ratios of cholesterol to phospholides in only 26.6% of the patients with atherosclerosis. Kram's & Gertler's (*Bull. N. Y. Acad. Med. 30,* 319) analyses of sera from normal and arteriosclerotic subjects indicate that the ratios of choline to serine and ethanolamine are different for the two groups.

Other work on atherosclerosis pertained to relationship of the serum lipoprotein abnormality to the disease. Measurements of the three high density lipoproteins associated with atherosclerosis in the serum of 566 clinically healthy adults have been made as basic information for studying the diseased state (Delalla *et al.—Am. J. Physiol. 179,* 333). High density serum lipoproteins increased in dogs on feeding cholesterol, but no atherosclerosis developed (Shull *et al.—Am. J. Physiol. 176,* 475). The amount of high density serum lipoproteins did not seem to serve as an index of atherogenosis in diabetics (Collens *et al.—J. Am. Med. Assoc. 155,* 814). The sera of persons with coronary heart diseases become turbid more rapidly than those of normal persons when treated with α-toxin of *Clostridium welchii* (Horlick—*Circulation 10,* 30). This is due to the serum being less stable to lecithinase in the disease. Other investigators have drawn attention to the deviations that occur in the composition of the protein moiety of serum lipoproteins in the disease (Marfori *et al.—Acta Med. Scand. 146,* 148; Leinwand & Moore—*Circulation 10,* 94; Nikkilä—*Scand. J. Clin. & Lab. Invest. 5,* Suppl. 8, 5).

Deviations of plasma phospholipides, and/or cholesterol and/or lipoproteins from the normal were observed in diabetes (Petersen—*Acta Med. Scand. 146,* 375; Renkonen & Koulumies —*Ann. Med. Exptl. et Biol. Fenniae 31,* 248; Fasloi *et al.*—*Proc. Soc. Exptl. Biol. & Med. 85,* 609), in nephrotic hyperlipemia (Heymann *et al.—Metabol., Clin. and Exp. 3,* 27), in multiple sclerosis (Dobin & Switzer—*Arch. Neurol. Psychiat. 71,* 405) in liver diseases without jaundice (Goldbloom *et al.*—*Am. J. Digest. Dis. 20,* 354), in hyperthyroidism (Facchini—*Endocrinol. e sci. costituz. 21,* 88) and in mongolism (Simon *et al.—Am. J. Psychiat. 111,* 139). In total tetanus there is a decline in cerebrosides in the brain but the other lipides are unaffected (Promyslov — *Doklady Akad. Nauk S.S.S.R. 92,* 1003). In experimental alloxan diabetes unsaturated acid in the diet aggravated the condition, whereas saturated acids had a protective action (Rodriquez—*Compt. rend. soc. biol. 147,* 1099). The high level of fat excretion in idiopathic steatorrheas was reduced by treatment with emulsifiers, calcium, and water soluble vitamins in a protein-rich diet containing no cereal products (Cattan & Lumbroso—*Semaine hop., Paris 29,* 3725). It has been recommended that the evaluation of decreased fat absorption caused by celiac disease be based on measurements of lipemia or a vitamin A tolerance curve (Weijers & van de Kamer—*Acta Paediat. 42,* 24, 97; Dicke *et al.—Ibid.* 34, 97). In this work the observation that wheat flour aggravated abnormal fat excretion, whereas wheat starch did not, was interpreted to indicate that there is some unknown substance in wheat responsible for the harmful effect. Fat excretion in the disease was normal if the fat diet contained only unsaturated acids. The effects of several types of gastric operations on the loss of fat in feces were determined by investigations on dogs (Welbourn *et al.—Gastroenterology 23,* 441).

The newly published treatments for obesity make use of calorically unrestricted diets. Pennington (*J. Clin. Nutr. 1,* 343; *Am. J. Digestive Dis. 21,* 65, 69) recommended a diet consisting mainly of protein and fat, which is restricted only in regard to carbohydrates. The principal feature of the reducing diet of Dole *et al.* (*Am. J. Clin. Nutr. 2,* 381) is that proteins are restricted.

LIPIDES IN MICROBIOLOGY AND PLANT BIOCHEMISTRY. Lard oil is oxidized slowly in the early stages of penicillin producing fermentations and very rapidly under conditions present after 48 hours of fermentation (Rolinson & Lumb—*J. Gen. Microbiol. 9,* 385). In tests on oxidation of fatty acids by *Mycobacterium tuberculosis,* even chain acids were oxidized by the constitutive enzymes and odd-numbered chains by adaptive enzymes (Iida—*Tuberculose, Japan 28,* 299).

A procedure for assessing lipase activity of cereal products has been developed for control analysis in milling (Templeton & Carpenter—*Analyst 78,* 726). A new procedure for evaluating the activity of lipase, involved providing very finely-emulsified fats as substrates and maintaining optimum pH for enzyme action (Goldman *et al.—Food Res. 19,* 503). Bozzetti (*Boll. soc. ital. biol. sper. 28,* 1087, 1089) recommended use of polyoxyethylene sorbitan fatty esters as substrates for lipase tests. Methods for extraction and evaluating castor bean lipase were published (Calabrese—*Ricerca sci. 23,* 1963).

Work with *Penicillium roqueforti* has indicated that the lipases of this mold grown under different conditions will exhibit different relative specificity in mixed fatty medium (Morris & Jezeski—*J. Dairy Sci. 36,* 1285). The work is pertinent to cheesemaking.

The enzymes of snake venom and of *Clostridium perfringens* type A toxins hydrolyze lecithins to diglycerides (Hanahan *et al.—J. Biol. Chem. 206,* 431, 443; *J. Am. Chem. Soc.* 76, 1804). Crotoxin, lecithinase A, causes considerable changes in the lipoprotein fractions of egg yolks. These effects involved the lipide moiety since the protein is not split off (Feeney *et al.—Arch. Biochem. & Biophys. 48,* 130).

Spectrophotometric means were used to estimate synthesis of butyl oleate in the evaluation of esterases (Ramakrishnan—*Experienta 10,* 308). The esterase of horse-liver was concentrated and its hydrolytic activity among a homologous series of fatty acids was found to be maximum against the 12 carbon acid members (Hofstee—*J. Biol. Chem. 207,* 211, 219).

In an investigation on the antibiotic activity of fatty acids and their derivatives, the cis-type unsaturated acids were more active than saturated acids, and among saturated acids the C_{12}-C_{14} were most active (Asahura & Yanase—*J. Chem. Soc. Japan Ind. Chem. Sect. 56,* 442). The germicidal action was altered by inclusion of α-bromine; the maximum activity then occurring with a much shorter chain.

Among various saturated, unsaturated, and branched chain acids, those of 7-12 carbon chain length are most trichomonacidal (Frank & Reiner—*J. Immunol. 72,* 191).

Characteristics and Composition

GENERAL AND COMPREHENSIVE. The communications dealing principally with analytical methods and composition of fatty materials are cited in this section. Other information on the subject is found throughout the review; because the other information along with the composition data caused the articles to be more pertinent to the text of other divisions. For convenience of presentation some data are appended to this section in tabular form.

Among the comprehensive reports much collaborated work was published on standardization of various analytical methods. These reports pertain to the analysis of seeds and seed meals (Hopper *et al.—J. Am. Oil Chemists' Soc. 31,* 370), standardization of color evaluation of soybean oil (Stillman *et al.—Ibid.* 347), the German standard methods for special tests for fats (Baltes—*Fette u. Seifen 56,* 490), provisional methods of the American Leather Chemists' Association (anon. —*J. Am. Leather Chemists' Assoc. 49,* 333), British standard methods (*Brit. Standard Inst. B.S. 684*), and German standard methods for the dairy field (anon.—*Z. Lebensm.-Untersuch. u. -Forsch. 98,* 358). The scopes of other papers containing diverse information were: chromatography, countercurrent extraction, spectrography and polarography in analysis of oils (Wolff—*Rev. Francaise corps gras. 1,* 331), rapid methods for determining characteristics of fats (Wolff—*Seifen-öle-Fette-Wachse 80,* 269), review of chemistry and analysis of highly unsaturated fatty acids (Hammond—*Univ. Microfilms Publ.* No. 7229, 114 pp.), recent advances in the analysis of oils and fats (*Oils & Oilseeds J., India, 4,* No. 9/10, 41), and review of methods for evaluation of olive oils (Alcala—*Grasas y aceites, Spain, 4,* 113).

ANALYSIS OF THE FAT SOURCE. The basis for several rapid or simplified procedures for determination of fat pertained to a digestion of the sample to release the fat: A digestion with 25% hydrochloric acid is recommended in a procedure for seeds (Sabiniewicz & Waclaw—*Roczniki Panstwowego Zakladu Hig. 5,* 85). In animal feeds, the fat may be released by boiling with 3.0 *N* hydrochloric acid (Campen & Geerling — *Chem. Weekblad 50,* 385). However, if volatile fatty acids are present, the material is first digested with potassium hydroxide in ethanol, and then the fatty acids are released at cool temperature with 3.0 *N* hydrochloric acid. A new procedure for cacao,

chocolate, and like material includes digestion with 4.0 *N* hydrochloric acid (Fincke—*Deut. Lebensm. Rundschau 47,* 220). A procedure for crude fat in baked dog food using a Mojonnier fat extraction also included an acid digestion step (Hoffman—*J. Assoc. Off. Agr. Chemists' 37,* 98, 250). Complete fat extraction from cereal or potato starches is only obtained after acid treatment (Lindemann—*Starke 3,* 141). Potato starch is capable of taking up fatty acids from methanol solution, which cannot be re-extracted merely with hydrocarbon solvents.

In comparative tests on solvents for extraction of liver a mixed solvent containing acetone, petroleum ether, and ethanol gave results approximating those of more conventional but longer procedures (Bixby *et al.*—*J. Agr. Food Chem. 2,* 375).

Rapidity in analyses was obtained by various means. Details of the method and equations for calculation have been published for refractometric determination of oil in olives (Rousseau—*Olivicoltura 6,* No. 5, 7). A rapid determination of oil in tung products is based on the density at 25° of a petroleum ether extract obtained under specified conditions (McKinney & Holmes—*J. Am. Oil Chemists' Soc. 31,* 172).

High speed stirrer disintegrators, as for example the Waring Blendor, are being used to gain rapidity and precision in fat determinations (Dangoumau—*Rev. Francaise corps gras 1,* 227; Francois & Bleicher—*Ibid.* 69; Andre—*Compt. rend. acad. agr. France 40,* 314). A commercial anionic detergent, Ultra Wet, has been recommended to demulsify extractions made in a Waring Blendor (Dunn & Earle—*Anal. Chem. 26,* 1099). A method which is said to be most rapid involves extraction with *o*-dichlorobenzene in a Waring Blendor and measurement of the high frequency impedence of the extract solution (Furgal—*Food Eng. 26,* No. 2, 58).

Large high speed disintegrators have been recommended for grinding large samples of herring to obtain a representative sample for fat analysis because fat is very unevenly distributed in this material (Brandes & Dietrich—*Veröffentl. Insts. Bremerhaven 1,* 232; *2.* 109; *Fette u. Seifen 56,* 495). This series of work included data on seasonal changes of fat and the relationships between moisture and fat content which are intended to serve for calculating the fat content of the whole fish from a determination on a specific limited sample. In other tests on fat determination in fish flesh, it was shown that haddock flesh exhaustively extracted with acetone and with ethanol-ether mixtures still contained 0.55% lipides of which lecithin constitutes 43%, triglycerides 2.4% and the remainder mostly nonsterol unsaponifiable matter (Olley and Lovern—*Biochem. J. 57,* 610).

New control methods for rapid determination of fat in meat (Kelly *et al.*—*Food Tech. 8,* 273) and for solid and semisolid substances in general (Armandola & Cacciatore—*Boll. lab. chim. provinciali 4,* 40) made use of a technique as applied in the Babcock and Gerber methods in the dairy industry.

Sethi *et al.* (*Current Sci., India, 22,* 266) recommended that the iodine value determination be combined with fat determination by making the extraction with carbon tetrachloride and by using an aliquot for gravimetric determination of oil and another directly for the iodine value. A very rapid method for determining oil content of seeds was based on their behavior in a series of solutions containing different concentrations of salt (Berdyshev & Lededeva—*Zemledelie 2,* No. 1, 89). A table has been developed showing how sunflower seeds within ranges of oil content from 48 to 69% can be separated with these solutions.

The present official procedure of the American Dairy Products Association for the Babcock fat test for milk was published in detail (Cordes *et al.*—*J. Dairy Sci. 37,* 761). A modification of this test to inhibit charring during acid digestion comprises adding a detergent with the acid (Wildasin—*Proc. Ann. Conv. Milk Ind. Foundation Lab. Sect. 46,* 14). Varying conditions were studied in the Babcock test and in the test wherein butter fat is released by using detergents, Schain test, to obtain fundamental data for adjusting procedures to give results agreeing with more precise but tedious methods (Henningson—*Milk Dealer 43,* No. 9, 56). In a comparison of butyrometric methods using detergents and one using sulfuric acid to release fat from milk, the latter technique was found more accurate and less tedious (Adamo—*Boll. lab. chim. provinciali, Bologna, 4,* 95). Comparative data on determinations of fat in dried milk by the Roese-Gottlieb method and a gravimetric procedure which included acid hydrolysis of the casein showed close agreement, except that an English procedure for the latter technique gave results 0.3-0.4% higher (Mohr & Merten—*Milchwissenschaft 9,* 153). Another similar investigation indicated that results of the acid technique are slightly lower than those with the Roese-Gottlieb test (Muldar & Meyers—*Proc. 13th Intern. Dairy Congr. 3,* 1317).

Some fat determination methods were designed specifically for use in biological studies. A new method of isolating the total lipides from blood consists of digestion of the protein with pepsin and papain, followed by extraction with ether (Kaufmann & Schwarz—*Fette u. Seifen 56,* 17). Apparatus and method have been designed for the determination of total lipides in brain tissue by disintegration of the tissue in a closed space followed by extraction with a chloroform-methanol mixture (Sperry—*J. Biol. Chem. 209,* 377). Very small apparatus, using "cold-finger" reflux condensers, were designed for determination or total extraction of microquantities of lipides (Scoggin & Tauber—*Iowa State Coll. J. Sci. 28,* 165; Schaffer *et al.*—*Arch. Biochem. & Biophys. 50,* 188).

A procedure for determining total fat, neutral oil, and free fatty acids in soap stock was based on exposing a sample in 5.0% hydrochloric acid to infrared rays for 2.5 hours under mechanical stirring (Fauve & Lacoste—*Bull. mens. inform. ITERG 7,* 421). The treatment liberates fatty material without hydrolysis or decomposition of the glycerides present. Fatty oil in mixtures with mineral oil, as is used in textile oiling, is analyzed by saponification of the fatty material and calculations from the amount of lye used in the process (Antonacci—*Chim. e. ind., Milan 35,* 561). A procedure for determining fatty oils in citronella oil is based on determination of glycerol and calculation to glyceride oil (Biggs—*Anal. Chem. 26,* 602). Synthetic ester waxes were aminolyzed by boiling with monoethanolamine, the alcohol portion was extracted with organic solvent, and the aqueous portion was used to determine fatty acid and oil constitutents (Thinius & Schroder—*Chem. Tech. Berlin 5,* 611, 671).

EVALUATION TESTS. Moisture determined in some fats and oils on the basis of the volume of acetylene released from calcium carbide was in fair agreement with results of more conventional methods (Segar—*Chem.-Ztg. 78,* 681). A new titration procedure for moisture in animal fats was based on the reaction of acetyl chloride with water in the presence of pyridine (Lapshin & Chervinskaya—*Myasnaya Ind. S.S.S.R. 25,* No. 4, 55). Another new method comprised drying the fat at 70-5° in a desiccator which is being continuously evacuated and flushed with carbon dioxide (Etimova—*Ibid.* No. 5, 54).

Titrations of free acidity of dark cottonseed oils in alcohol-ether solvent with bromothymol blue indicator gave a clearer endpoint and a better reproduction of results than titrations in 15% aqueous salt solutions with phenolphthalein indicator (Omel'chenko—*Masloboino-Zhirovaya Prom. 19,* No. 2, 27). A patented method of determining free fatty acids in fats and oils makes use of a ternary mixture of ethanol, water, and carbon disulfide as the solvent with phenolphthalein or alkali blue 6B as the indicator (Fuentes—*Span. 208,657; Inform. quim. anal., Madrid, No. 6,* 181). Neutral fat in fats of more than 70% free fatty acids are determined by cold neutralization with 0.5 *N* lye in 1:1 mixture of ethanol and ether, washing out soap, and evaporation of solvent layer to recover the neutral fat (Paquot & Querolle—*Bull. mens. inform. ITERG 7,* 495).

A method for measuring turbidity of oils independent of color was based on the Tyndall-effect of light passing through the sample (Schulz-Metke—*Fette u. Seifen 56,* 242). The test can be applied continuously in controlling certain processing operations.

Naudet (*Rev. Francaise corps gras 1,* 318) reviewed the various existing refining tests and pointed out the application of the results to commercial refining.

Oil-foots soap stock is evaluated and a calculation is made for conversion to soap by determination of sodium ion in an ashed sample and determination of neutral oil (Naudet—*Bull. mens. inform. ITERG 7,* 378). The methods are useful for studying losses in processing soap stock.

The laboratory bleaching tests of the American Oil Chemists' Society has been historically reviewed and discussed with regard to justification of present and proposed techniques (Smith—*J. Am. Oil Chemists' Soc. 31,* 127, 128; Freyer—*Ibid.* 130).

Rich (*Ind. Eng. Chem. 46,* 2272), with the aim of developing bleach tests conforming close to plant performance, designed a 150-lb. capacity pilot plant for the purpose. In addition to bleaching, the complete plant can be used for testing neutralization, pressing, hydrogenation, and deodorization properties of oils.

Some fats are evaluated on the basis of their vitamin content. The Boldingh & Drost chromatographic technique utilizing a water-weakened alumina column and an alkaline alumina column, one above the other, was found applicable in the determination of vitamin A in margarine (Morgareidge—*J. Assoc. Off. Agr. Chemists' 37,* 748), and the method was simplified to a single column procedure (Rosner & Kan—*Ibid.* 887). A rapid method for vitamin A in whale-liver oils was based on adsorption by Floridin earth that had been treated with ammonia and elution to eliminate inactive kitol and anhydrovitamin A, followed by spectroscopic analysis (Green & Singleton—*Analyst 79,* 431). When vitamin A is absorbed on Bentonite, it is transformed into anhydrovitamin A; when eluted, a secondary reaction product is formed, which can be determined on the basis of an absorption maximum at about 290 mμ (Laughland & Phillips—*Can. J. Biochem. & Physiol. 32,* 610).

Data have been published on the vitamin D content of commercial samples of Indian butters (Henry & Kon—*J. Dairy Res. 21,* 81; Ranganathan—*Indian J. Med. Res. 42,* 165).

The newly published methods for determining vitamin E in oils were modifications of the Emmerie & Engel test (Deacon & Wamble—*J. Am. Oil Chemists' Soc. 31,* 284; Edisbury *et al.* —*Analyst 79,* 617).

CHEMICAL CHARACTERISTICS. In two new procedures for determining iodine value with bromine vapors the sample is, respectively, spread on a watch glass (Vurden & Grindley—*Analyst 78,* 619) and absorbed on a strip of filter paper (Fritz —*Deut. Farben Z. 8,* 94). Details for a procedure using standard bromine solution as the reagent and titration with iodate solution were published (Kamath—*Oils & Oilseeds J., India, 5,* No. 10/12, 82). An investigation on methods suitable for determination of iodine value of phospholipides has indicated that the results of either the Wijs or Hanus method are nearest to the actual value. (Lea & Rhodes—*Analyst 79,* 304). In a coulometric titration method, chlorine generated electrically from 0.2-1.2 *N* hydrochloric acid in 80-90% acetic acid adds to the double bond, and the end of the addition is indicated by the formation of a current in an indicator circuit with imposed 0.36 volt potential (Guta & Kucera—*Chem. Listy 47,* 1166). Polarographic and an amperometric micro-methods for determining iodine value using the bromine solution of Kaufmann have been dveloped (Baltes & Hiller—*Fette u. Seifen 56,* 371). These procedures can also be used to study the bromine addition to unsaturated fatty acids in relation to time. The use of hypochlorite as the reagent for determination of iodine value has been recommended, because it reacts rapidly and its behavior with conjugated and isolated systems of double bonds is identical (Basu—*Indian Soap J. 18,* 259). Apparatus and methods for micro-determining iodine value by catalytic hydrogenation have also been described (Colson—*Analyst 79,* 298; Kasturi *et al.*—*J. Indian Inst. Sci. 35A,* 339; *Current Sci., India 22,* No. 6, 174). The seasonal variations of the iodine values of butters from Normandy and Alsace have been recorded (Bejambes & Savoie—*Chemie & Industrie 71,* 501). The Woburn iodine value (method B), partial Wijs iodine value, Woburn diene value, Kaufmann-Baltes diene value, and pan-diene value on many conjugated fatty acids and the mixed fatty acids of many drying oils have been recorded (von Mikusch—*Farbe u. Lack 60,* 178). The data indicate that diene-data in the literature are irregular as the result of instability of many trienes, and that the presence of antioxidants insures a correct diene value. Nomographs were prepared for calculating fatty acid composition of oils and fats from iodine values and either extinction coefficients or thiocyanogen values (Narayan—*J. Am. Oil Chemists' Soc. 31,* 137).

Application of potentiometric nonaqueous titration to highly colored mixtures of acid, as wool wax fatty acids, permits the determination of the neutralization equivalents which usually were unattainable or were grossly inaccurate (Radell & Donahue—*Anal. Chem. 26,* 590). Use of a solvent system of ethanol-pyridine in saponification value determination of difficultly saponifiable drying oil products gives excellent results, except with maleic-modified oils of certain types (Shaw & Forno—*J. Am. Oil Chemists' Soc. 31,* 448). A potentiometric saponification value procedure was also designed for handling very small samples of fatty material (Gorriz & Garcia—*Anales real soc. espan. fis. y quim., Madrid 46B,* 385).

In a method for determining unsaponifiable matter by Tsyskovskii (*Masloboino-Zhirovaya Prom. 18,* No. 8, 19), separation from water solution of sodium soaps is made with ether in a continuous extraction apparatus. Tests by Andre & Maille (*Compt. rend. 237,* 1763) show that increasing the sample size from five to 25 g. and the number of ether extractions from three to eight reduced the unsaponifiable results one-fifth in its determination on seed oils of crucifiers.

DETECTION OF ADULTERATION. In a general information communication on detection of adulteration it is suggested that pork fat can be identified on the basis of the melting point of α-palmitodistearin which can easily be isolated, and cocoa butter is identified by its ability to supercool (Wolff—*Mises au point chim. anal. pure et appl. et anal. bromatol. Ser. 1,* 159). Another method for distinction between cocoa butter and its substitutes is based on the difference between solidification and fusion points (Invernizzi—*Boll. lab. chim. provinciali 4,* 44). This characteristic for cocoa butter is 35-30°, whereas for substitute only eight degrees is the highest. Another procedure for characterizing cocoa butter is by a specific method of segregating an unsaturated fraction and determining its iodine value and partial iodine value (Borghi & Casolari—*Rev. intern. chocolat. 9,* 97). Adulteration of cocoa butter with over five percent substitute fat is said to be detectable by means of the two tests.

Recommendations have been made to simplify detection of certain adulterations by use of "tracers." By French law margarine contains 0.2% potato or rice starch so that its use to adulterate butter is easily detected. A new test proposed for detection of adulteration of butter in France includes counting the grains of starch (Pien *et al.*—*Ann. fals. et fraudes 46, 350, Lait 34,* 11). Butter containing one percent labeled margarine contained 125,000 particles of potato starch or 20,000,000 of rice starch per cubic centimeter. Legal compulsion of adding sesame oil or butylated hydroxyanisole to all fats and oils other than butterfat would permit simple detection of adulteration of butter with other commercial fats (Fitelson—*Food Eng. 26,* No. 10, 109). α-Dipiridyl and *o*-phenanthroline have been recommended as denaturants for inedible fats because these also label them for simple detection (Jacini—*Olii minerali, grassi e saponi, colori e vernici 30,* 160).

Means for detection of adulteration of butter were studied. Examination under polarized light, refractive index, melting point of sterols, and Reichert-Meissl value were discussed with regard to the contribution of each in a systemic investigation to detect adulteration (den Herder—*8th Congr. intern. inds. agr. Brussels 4,* 68). A rapid chromatographic determination for butyric acid was developed for detection of substitute fat in ice creams (Harper & Armstrong—*J. Dairy Sci. 37,* 481). When it is important to differentiate between butter and hydrogenated dolphin fat in such tests the butyric acid chromatograph is distinguished from that of the isovaleric acid of the latter fat by color produced by 0.05% bromophenol blue containing nitric acid (Antoniani & Cerutti—*Ann. sper. agrar, Rome, 8,* 801). A general method for detection of foreign fats in dairy products is based on the refractive indexes determined on the alcohol soluble and alcohol insoluble portions of the fat from the sample (Bhalerao & Kummerow—*J. Dairy Sci. 37,* 156). Most foreign fats alter refraction of the alcohol insoluble fraction, whereas the effect of coconut oil is a depression of the refractive index of the alcohol soluble fraction. The tocopherol content of butter is very low, whereas in all other vegetable oils, except coconut oil, it is high and accordingly its determination can serve for detection of adulteration (Mahon & Chapman—*Anal. Chem. 26,* 1195). Butter adulteration with hydrogenated dolphin oil can be detected by dissolving five milliliters of the fat in a mixture of 10 ml. of chloroform and one milliliter of glacial acetic acid and adding 2.5 ml. of 10% bromine in chloroform (Cerutti—*Ann. sper. agrar., Rome 8,* 747). The test remains yellow for 12 hours with pure butter, whereas presence of dolphin fat induces development of a green color. Adulteration of butter fat with hydrogenated dolphin fat cannot easily be detected by other tests. Two tests for adulteration of butter were based on the critical temperature of solubility of the fat in nitrobenzene (Ahmad—*Pakistan J. Sci. Res. 5,* 35; Cadrobbi & de Francesco—*Boll. lab. chim. provinciali, 3,* 7). A combination of one of these tests with the Bellier resorcinol reaction was recommended to increase certainty of the judgment (de Francesco—*Ibid. 4,* 90). The Bellier resorcin method is most certain when the butter adulterant is hydrogenated fish or marine animal oil (de Francesco—*Ibid. 3,* 16).

The Bellier indexes of many individual oils and binary mixtures of oils have been recorded to serve as fundamental data in analytical detection and quantitatively approximating adulteration or admixing (Ibarra—*Rev. assoc. bioquim. argentina*

18, 290; de Mingo & Lucia—*Rev. real acad. cienc. exacts fis. y nat., Madrid, 47*, 249). The critical mixing temperature of fatty oils with ethylenechlorhydrin is suggested as a useful characteristic for identification of some oils (Fischer & Horner —*Microchim. Acta 1953*, 386).

Adulteration of olive oil with lard oil is not detectable by general methods now available (Doro—*Boll. lab. chim. provinciali 4*, 97). Differences in iodine value of the unsaponifiable substances have been suggested as criteria for distinguishing between olive drupe and olive seed oils (Tos—*Gracas y aceites 4*, 58). Phase behavior of olive oils with acetic acid has also been recommended to characterize them (Voyatzakis—*Prakt. Akad. Atheon 26*, 111). The type of olive oil present in olive-peanut oil mixtures is not distinguishable (LaRosa—*Chimica, Milan, 9*, 197).

The Baudouin test can detect adulteration of ghee with as little as five percent hydrogenated peanut oil containing sesame oil as a "tracer" according to Indian law (Iyer & Narayanamurthy—*Oils & Oilseeds J., India, 5*, No. 10/12, 98), but it is not applicable if the oil mixture containing the sesame oil was heated. A review of this test and details of a very sensitive modification were published (Mathur *et al.—J. Proc. Oil Technol. Assoc. India 8*, 41).

A method for detecting fish or train oils that had been deodorized by polymerization is based on insolubility in propanol at between five and 20° (Hugel—*Fette u. Seifen 55*, 544).

In the bromide-bromate test for colorimetric estimation of small quantities of argenone oil in mustard oil, peanut, linseed, nigerseed and mineral oils do not interfere but sesame oil does (Mitra *et al.—Science & Culture, India, 19*, 503). Organically bound sulfur is present in all cruciferae oils (rape, mustard, and wallflower) and a determination for organic sulfur in the unsaponifiable material may serve to detect such oils (Andre *et al.—Compt. rend. 236*, 1819). A characteristic that approximately estimates the amount of mustard oil in a mixture, based on erucic acid content is defined as the number of milliliters of 0.1 *N* solution of iodine necessary for the titration of the erucic lead salts obtained from 500 mg. of oil (Hadorn & Jungkunz—*Mitt. Lebensm. Hyg. 44*, 453). Mustard oils having a viscosity of less than 59.0 at 40° are said to be of doubtful purity (Mitra & Roy—*Current Sci., India 23*, 50).

A spectrometric procedure has been developed to identify long-chain fatty acids containing ketonic groups and is applied to the detection of oils containing licanic acid (Mendelowitz & Riley—*Analyst 78*, 704).

The fat of the buffalo (Indian) contains a lipochrome pigment which permits spectroscopic distinction of the fat from that of beef (Di Girolamo—*Boll. soc. ital. biol. sper. 28*, 443). Alkali isomerization-spectrophotometric technique for determination of polyunsaturated acids is said to provide rapid methods for determination of soybean oil admixture to cottonseed and other oils and detection of adulteration of ground beef, pork, or lamb with horse meat (Firestone—*J. Assoc. Off. Agr. Chemists' 37*, 833). Also, because animal fats contain tetraenoic acids which are not generally present in vegetable fats, the method might be useful for distinguishing animal from vegetable fats. Franzke (*Z. Lebensm.-Untersuch. u. -Forsch. 99*, 27; *Fette u. Seifen 55*, 837) reviewed the literature and contributed much data from his own work on the linoleic and linolenic acid contents of beef, pork, and horse fats as fundamental information for detection of horse meat in beef or pork. His experiments indicate that precipitation of the polybromides of a fat sample from petroleum ether at −4° could serve as a criterion. Under these conditions two samples of each fat gave the following results: horse fat 104.8, 96.6; beef fat 4.0, 3.7; pork fat 5.7, 2.6 mg. of polybromides per gram of fat.

Acker's & Jager's (*Z. Lebensm.-Untersuch. u. -Forsch 99*, 13) results on lecithin-decrease in egg alimentary paste suggest that basing analysis for egg content in foods on lecithin phosphoric acid in the lipide extracts would give erroneous results. During storage the enzymes split-off choline which becomes bound to protein; the residual diglyceride phosphoric acid is further split by phosphatase to release free phosphoric acid which is not extracted with the lipides.

Some esterified oils as such or as adulterants in natural oils are detected by testing for the presence of zinc (catalyst) with dithizone (Canneri & Maconi—*Chimica e ind., Milan, 35*, 560). Fatty acid derivatives of polyoxyethylene as well as octylphenolic esters give insoluble precipitates with Dragendoffs' reagent, thus permitting their determination (Gallo—*Il farmaco, Pavia, Sci. ed. 8*, 706).

A test for mineral oil in vegetable oil, sensitive to one percent admixture is based on the turbidity produced on adding a saponified solution of a five-milliliter sample, prepared under specific conditions, to 20 ml. of water (Prakash *et al.—J. Proc. Oil Technol. Assoc., India 8*, 36). Smoke points of fatty oils are reduced by free fatty acids and mineral oils (Kane & Ranadive—*Ibid.* 17). Accordingly, determination of the smoke point and correcting for the lowering caused by free fatty acids permits determinations, roughly, of mineral oil admixtures up to 20%; with more mineral oil the decrease in smoke point is too small to be quantitatively useful.

PHYSICAL PROPERTIES. The surface tensions, interfacial tensions against water, calculated enthalpy, and enthalpy changes have been recorded for various pure glycerides for a better understanding of the fundamental knowledge and practical application of fat emulsions (Benerito *et al.—J. Phys. Chem. 58*, 831). Synthetic glycerides of known configuration were selected to show the effect of the degree of unsaturation, degree of esterification, and cis-trans isomerism on the surface phenomena.

The viscosities of olive, sesame, cottonseed, sunflower, soybean, and linseed oils with increasing temperatures sloped downward and drew closer together becoming nearly equal at 100° (Kupchinskii—*Masloboino-Zhirovaya Prom. 19*, No. 5, 23). Mathematical equations were proposed for estimating the average molecular weight of polymerized oils, based on viscosity in acetone and diffusion of the sample (Kaneko *et al.—J. Chem. Soc. Japan, Ind. Chem. Sect. 56*, 821, 865). Absorption of ultrasonic waves together with viscosities was recorded for several vegetable oils (Mikhailov—*Doklady Akad. Nauk S.S.S.R. 89*, 991).

Equations have been developed for relationships between structure and molar refraction, molar volume and refractive indexes of fatty acid esters (Hammond & Lundberg—*J. Am. Oil Chemists' Soc. 31*, 427). The refractive index, refractive dispersion and heat test of 74 domestic tung oils were correlated with the total eleostearic acid content (Holmes *et al.—J. Am. Oil Chemists' Soc. 31*, 417). The correlations are 0.69, 0.73, and −0.62, respectively. A method of testing fats by measuring the refractive index of the liquid phase at various temperatures below the melting point, without separating the solids, was developed for studying the influence of thermal esterification, hardening, etc. (Thieme—*Fette u. Seifen 56*, 286).

An apparatus and method for determining densities of microquantities of oils by the "falling drop method" have been described and demonstrated to be very accurate (Sims—*J. Am. Oil Chemists' Soc. 31*, 144). Mean monthly data on the refractive index and density of New Zealand butterfat have been graphically recorded for a period of four years (McDowell—*J. Dairy Res. 21*, 383). In an investigation on development of a densitometric method for estimating fat contents of the whole animal body there have been recorded the average densities and the moduli of thermal expansion for human and eight animal fats (Fidanza—*J. Applied Physiol. 6*, 252).

The literature on rheology of fats was reviewed by Blair (*J. Sci. Food & Agr. 5*, 401) and Greethead (*Food Technol. Australia 5*, 195).

Melting point diagrams obtained with the aid of the microscope on the system of palmitic acid-stearic acids were interpreted to indicate that three different solid solutions appear (Kofler—*Mikrochim. Acta 1954*, 444). X-ray observations on drops of oleic acid on lead indicate perpendicular orientation below 23° and at an angle above 23° (Trillat & Barbezat—*J. recherches centre natl. recherche sci., Labs. Bellevue, Paris No. 16*, 18). X-ray technique was used to study the slip phenomena in the growth of palmitic acid crystals (Verma—*Acta Crystallographia 7*, 270).

In investigations on unimolecular films of fatty substances: the surface pressure curve has been recorded for films of oleic acid, oleyl alcohol, and the oleate monoesters of ethylene glycol, glycerol and mannitan (Maruta—*J. Chem. Soc. Japan, Ind. Chem. Sect. 55*, 674); forced-area relations were determined for several α-aromatic substituted fatty acids (Izawa—*Bull. Chem. Soc. Japan 25*, 314), and the refractive indexes of unimolecular layers of C_{14}, C_{16}, C_{18}, C_{22}, and C_{25} fatty acids spread over water were recorded (Hofmeister—*Z. Physik 136*, 137). A layer of water absorbed on the surface of oleic acid has a surface tension six dynes higher than the normal value (Brin & Merigoux —*Compt. rend. 238*, 1808).

Data on the heats of sorption of benzene by the even numbered fatty acids from caprylic to stearic were explained in terms of liquid solutions, solid solutions, and transition sys-

tems (Arnell—*J. Phys. Chem. 57*, 641). The diffusion coefficients and the molecular frictional coefficients of several alcohols and fatty acids between C_4 and C_{18}, inclusive, were measured and related to the length of the molecules (Marinin—*Zhur. Fiz. Khim. 27*, 1823).

The dielectric constants of several fatty materials were investigated. This value for stearic, oleic, linoleic, and linolenic acids is a linear function of the iodine value (Bogdanov & Stepanenko—*Ibid.* 1481). The dipole moments of cis and trans forms of fatty and hydroxy fatty acids in dioxane are independent of the temperature and indicate unassociated monomeric forms (Phadke—*J. Indian Inst. Sci. 35A*, 123). Lower values recorded for other solvents are presumed to be due to association. The dielectric properties of the even fatty acids and their methyl esters, from C_{10} to the C_{18} members, were determined and discussed with regard to the physical structure of the compounds (Buchanan—*J. Chem. Phys. 22*, 578).

Studies on the structure of oleic acid have shown that elaidic esters are saponified or oxidized slower and hydrogenated faster than oleic esters (Plisov & Maleeva—*Zhur. Obshchei Khim 23*, 72; Maleev—*Ibid.* 1662), and similar relationships were observed between petroselinic and petroselaidic acids (Plisov *et al.*—*Ibid. 613*, 1749). The results were interpreted to confirm that the elaidic structure is the trans form.

COMPOSITION. The application of infrared spectroscopy for the analysis of fat-mixtures and composition of oils and fats was reviewed by Lecomte (*Fette u. Seifen 56*, 23, 100). Another review dealt with the spectrum of liquid stearic acid (Barr—*Phys. Rev. 87*, 170). The absorption spectra of 10 fish oils and 14 vegetable oils of Japan were recorded and the characteristics indicative of known and yet unknown structures were discussed (Tsuchiya *et al.*—*Repts. Govt. Chem. Ind. Res. Inst. Tokyo 49*, 141; *J. Chem. Soc. Japan, Ind. Chem. Sect. 55*, 605; *56*, 295, 350). Similar work was published on six commercial oils of Spain and several pure fatty acids (Matutano & Bellanato—*Anales real soc. espan. fis. y quim., Madrid, 49B*, 557) and on cis and trans isomers of some C_{18} fatty acids (Ahlers *et al.*—*J. Appl. Chem., London, 3*, 433). Methods were designed and the necessary reference data recorded for the spectrophotometric determination of arachidonic, linolenic, and linoleic acids in milk and blood (Pasquali—*Acta Vitaminol. 5*, 193; *8*, 113) and for determination of licanic acid or other fatty acids with ketonic groups in the presence of other saturated and unsaturated acids (Mendelowitz & Riley—*Analyst 78*, 704).

The work on the methods for determining composition of fats and oils by distillation technique were an improvement in the micromolecular distillation apparatus of Booy & Waterman (Paschke *et al.*—*J. Am. Oil Chemists' Soc. 31*, 5) and development of equations and tables to simplify calculation of composition from ester fraction analysis (Jones & MacLean —*Ibid.* 473).

A continuous liquid-liquid extraction apparatus and a procedure were designed for determining total fatty acids, oxidized acids and unsaponified matter (Buerki & Holt—*Ibid.*, 335). A dilatometric method of approximating the amount of solid constituents in plastic fat was designed for control of hydrogenation (Fulton *et al.*—*Ibid.* 98). A measure of the tallow saturated acid in soap fatty acid was based on measurement of the amount of crystallization from chloroethane solution at −20° (Loury & Juillard—*Rev. Francaise corps gras 1*, 137). In this work the crystallization behavior of tallow acids and several pure fatty acids in 17 solvents has been determined. Dolasek & Sadek (*Fette u. Seifen 56*, 604) discussed the limitation of urea-precipitation for the isolation and determination of higher fatty acids in biological extracts.

Much progress was made in analysis of fatty material by the chromatographic technique. The paper chromatographic technique of Kaufmann and coworkers has been extended to the separation and identification of the fatty acids and glycerides of castor, soybean, linseed, china-wood, oiticica, 50% isomerized linseed, and castor oils (Kaufmann *et al.*—*Fette u. Seifen 55*, 85). In this technique acetic acid-water mixtures were used as the mobile phase to avoid mutual interference of fatty acids (Kaufmann & Nitsch—*Ibid. 56*, 154). A new paper chromatographic technique for partition of C_{10} to C_{20} fatty acids was based on impregnating paper with a 12% toluene solution of the sample and detection with silver nitrate (Kobrle & Zahradnik—*Chem. Listy 48*, 1189). In a paper technique using cellulose acetate paper the fatty acids are first converted to hydroxamates, neutralized with tetrahydrofuran-acetic acid, chromatographed, and developed with ferric chloride in an ethanol-butanol mixture (Micheel & Schweppe—*Angew. Chem. 66*, 136).

Several of the investigations on chromatographic technique pertained to the technique using columns of adsorptive material. In the method for determination of neutral oil by adsorption of free fatty acids on alumina, the adsorption with palm oils is hindered by the pigments present, but this disturbing influence is eliminated by superposing a layer of kieselguhr-activated carbon mixture on the alumina column (Naudet *et al.*—*Rev. Francaise corps. gras 1*, 230). Reverse phase partition chromatography was used for the estimation of oleic and linoleic acids in presence of saturated fatty acids Mary *et al.*—*Nature 174*, 181). Acetone-water mixtures varying from 45% acetone (for C_{10}) to 90% acetone (for C_{24}) were used in this method as eluting agents. A column of equal parts of "Celite" and high vacuum silicone grease was applied for the analytical separation of the methyl esters of C_{12} to C_{22} fatty acids by vapor-phase chromatography (Cropper & Heywood—*Nature 172*, 1101). Inverse partition chromatography with siliconated kieselguhr as absorbent, with cyclohexine or paraffin oil as the fixed phase, and aqueous acetone solution as the moving phase permits fractionation of C_{10} to C_{14} saturated or unsaturated fatty acid mixtures (Savary & Desnuelle—*Bull. soc. chim. France 1953*, 939). Another similar technique was demonstrated for resolution of natural fatty acids from C_{16} to C_{24} (Silk & Hahn—*Biochem. J. 56*, 406). A procedure for quantitatively separating C_{10} to C_{20} fatty acids involved use of a long silica gel column tinted with bromothymol blue (pH 6.0-7.6) and saturated with methanol and with isooctane saturated with methanol as the mobile phase (Nijkamp—*Nature 172*, 1102; *Anal. Chim. Acta 10*, 448). In investigations in displacement analysis by Hamilton & Holman (*J. Am. Chem. Soc. 76*, 4107) the adsorbabilities of glycerides from ethanol onto carbon were in the following series: trilaurin > tricaprin > tricaproin > tributyrin; monostearin > monopalmitin > monolein > monolaurin; triglycerides > diglycerides > monoglycerides. Absorbabilities from benzene were in the order: tristearin > palmitodistearin > tripalmitin > laurodipalmitin > trimyristin or triolein > trilinolein > trilaurin. The data were applied for the analysis of beef tallow. The behavior of oxidized acids and unsaturated acids containing up to five double bonds was also ascertained and the information was applied to the analysis of fecal lipides and unsaturated acids of cod-liver oil, respectively (Abu-Nash & Holman—*Ann. Rept. Hormel Inst. 1952-3*, 29; *J. Am. Oil Chemists' Soc. 31*, 41).

In a procedure using silicic acid columns, 1- and 2-monoglyceride can be determined by separation after oxidation with periodate, and these can be separated from tri- or diglycerides by chromatographing with heptane and 80% ethanol (Bergström—*Acta Physiol. Scand. 30*, 231). According to another method, fatty acids are removed with "Amberlite IRA 400" resin; mono-, di-, and triglycerides are absorbed on kieselguhr and selectively eluted with various definite mixtures of cyclohexane, ethanol, and water (Savary & Desnuelle—*Bull. soc. chim. France 1954*, 936). In chromatography with silicic acid columns a method has been devised for adding fatty acids or their sodium salts in the aqueous phase so as to eliminate difficulties from dehydration of the silicic acid (Zbinovsky & Burris—*Anal. Chem. 26*, 208). Organic solvents have also been eliminated in chromatography by working at higher temperatures (Lauer—*Fette u. Seifen 56*, 149).

The separation and identification of a series of compounds derived from (dipalmitoleyl)-L-α-glycerylphosporylcholine, have been accomplished by means of paper chromatography (Huennekens *et al.*—*J. Biol. Chem. 206*, 443).

In a broad discussion on analysis of pilchard oil, lithium soap segregation, molecular distillation, reverse phase partition chromatography, and urea complex precipitation were considered for subdividing the oil into fractions simple enough to permit calculation of composition without isolation of the individual components (Silk & Hahn—*Biochem. J. 57*, 577).

The common periodic acid method of Pohle & Mehlenbacher for determining monoglycerides and glycerol was modified to using 95% methanol as the solvent in place of acetic acid (Kruty *et al.*—*J. Am. Oil Chemists' Soc. 31*, 466). This inhibits reduction of iodate by potassium iodate.

As previously mentioned, analytical data convenient for tabulation are being presented in tables. However, some such data involved factors or was limited to only certain constituents and hence could not be conveniently tabulated. Linolenic acid and oil during development of the soybean increase continuously until the 50th day and then remain constant; whereas

NEWLY RECORDED CHARACTERISTICS OF FATS AND OILS

Oil or Fat Source	% Oil or Fat	Specific Gravity	Refractive Index	Acid No. or (% Free Fatty Acids)	Sapon. No.	Iodine No.	SCN No.	Acetyl No. or [(OH) No.]	R.-M. No.	Polenske No.	% Unsapond.	Soliification Pt. or (Melting Pt.)	Diene No.
Abutilon indicum seed[1]	9.2	0.9237[18]	1.4758[18]	7.6	193.2	100.3		4.2	0.54			−10	
Areca palm nut[4] *Areca catechu*	14.7			0.3		27.0					0.6		
Camel-thorn seed[5]		0.9104[40]	1.4683[40]	3.7	184.8	112.9		[19.5]	0.1	0.5	4.5		
Camel-thorn seed pod[5] *Acacia giraffae*	1.2	0.9373[25]	1.4618[65]	57.3	143.2	69.0		[30.2]	0.4	0.3	26.0		
Capparis rothii kernel[6]	40.9		1.4615[40]		189.9	70.7	52.9				0.7		
Clerodendron trihotomum seed[8]	22.3	0.9236[15]		22.3	187.2	101.0					1.0		
Clitoria ternatea seeds[9]	11.8		1.4589[40]		178.7	72.9	57.5				3.0	(35)	
Coconut milk[10]	16.7	0.9196[23]	1.4548[23]	0.3	261.0	6.2				3.8	4.9	(25)	
Corn (Maize)[11]	2.6-13.8		1.4628-1.4687[40]			88.4-174.4							
Corn (Maize) germ[12]	38-40	0.924-0.926[15]		(1.2)	189-190	125-128				0.38	1.6	−10 to −12	
Cynanchum vincetoxicum seed[15]	12.5	0.9319[15]	1.4749[20]	19.5	185-187	109-112			3.1-33	1.9-2.0		(−19 to −22)	
Datura metel seed[6]	16.4		1.4681[40]	(0.23)	187.8	119.5	76.1				3.5		
Datura stramonium seed[6]	16.8		1.4689[40]	(0.23)	189.5	126.9	76.7				3.8		
Digitalis purpurea seed[16]			64.8[25] (Butyro)	1.4	174.0	109.1	74.5				4.9		
Entada phaseoloides seed[9]	6.2		1.4622[40]		185.1	87.8	63.6				1.3		
Fish:													
Cod (*Lotella phycis*) liver[17]				4.2	180.6	108.4					34.9		
Cuttle fish liver[18]		0.926[15]	1.4844[15]	12.3	177.9	189.6					6.8		
Cuttle fish body[19]				15.0	140.0	167.0					2.5-7.0		
Cuttle fish viscera[21]		0.9230-0.9289[20]	1.4800-1.4838[20]		179-188	179-207							
Mackerel offals[20]		0.9178-0.9246[20]	1.4756-1.4794[20]		187-197	140-166					0.4-3.0		
Xiphias gladius eye-ball[22]		0.9261[20]	1.4812[20]	8.8	189.2	188.3					0.7		
Karanja seed[24] *Pongamia glabra*	28-34	0.947[15]	1.4742[40]	3.8	184.0	86.3					4.0		
Karanja seed[25] *Pongamia glabra*		0.9273[32]	1.4774[33]	7.5	187.5	82.9		14.5			2.6		
Lallemantia iberica seed[27]	30.0	0.9321[20]	1.4831[20]	0.8	193.8	198.8	127.0				1.3		2.2
Leucaena glauca seed[28]	8.8	0.9165[28]	1.4674[28]	(2.97)	185.0	110.1					4.7		
Machilus thunbergii seed[29]		0.9340[25]	1.4619[25]	13.6	242.5	52.6					2.0		
Mahaleb cherry kernel[30] *Prunus mahaleb*	35.0	0.9282[25]	1.4976[25]		188.0	146.7	88.7				0.5		25.3
Maroola kernels[32] *Sclerocaya Caffra*	53.8	0.9051[25]	1.4630[25]	14.8	190.0	74.4		8.4	0.4	0.4	2.4		
Moringa seed[33] *Moringa pterigosperma*	31.5	0.8984[30]	1.4652[30]			64.2							
Nandina domestia seed[8]	3.7	0.9355[15]	1.4742[20]	21.6	181.8	132.1					4.6		
Perilla frutescens seed (of Japan)[8]	29.0	0.9308[20]	1.4820[20]	5.3	190.0	190.0		8.4	0.9				
Sesbania aegyptica tree seed[36]	5.3	0.9241[20]	1.4805[20]	3.0	193.2	112.4	71.6	23.0					
Sesli indicum seed[37]	20.0	0.9011[31]	1.4360[31]		148.6	82.1					18.5		
Sorbus japonica seed[8]	23.2	0.9284[15]	1.4752[20]	0.7	202.1	124.0					1.9		
Spinach fruit[38]	3.7-4.8	0.9242[20]	1.474[24]	4.5	172.0	92.5		[68.0]					
Thespesia populnea seed[40]	20.0	0.9251[28]			203.2	71.5			5.5	0.4	0.7		
Whale head blubber[41] *Ziphius cavirostis*		0.8914[20]	1.4628[20]	0.7	182.7	71.1			2.5		29.4		
Whale (Bottle nose) head and jaw[42]			1.4477[40]	0.14	217.2	34.0					17.8		
Blubber				0.3	132.1	87.4							
Bone				0.3	115.2	75.3							
Whale (Sperm) head cavity[43]		0.8711[23]		0.2	137.8	50.1					47.9		
Bone					151.2	83.2					28.6		
Intestine				13.7	158.2	80.6					19.2		

COMPOSITION OF FATTY ACID MIXTURES FROM NATURAL FATS

Oil and Fat Source	Common Saturated Acids			Common Unsaturated Acids			Other Fat Acids
	C_{14} Myristic	C_{16} Palmitic	C_{18} Stearic	$C_{18}(-2H)$ Oleic	$C_{18}(-4H)$ Linoleic	$C_{18}(-6H)$ Linolenic	
Abutilon indicum seed[1]		5.1	11.2	41.3	26.6	6.8	
Albizzia odoratissima seed[2]	0.8	22.0	14.3	26.6	51.4		C_{20} 6.9
Alga: *Chlorella pyrenoidasa*[3]	——— 17 ———			7.0	17.0	34.0	Less than C_{16} 2, $C_{16}(-2H)$ 4, $C_{16}(-4H)$ 6, $C_{16}(-6H)$ 12, $C_{16}(-8H)$ 3, $C_{18}(-8H)$ 1, above C_{18} <4
Areca palm nut[4] *Areca catechu*	44.9	13.8	2.0	7.4	6.4		C_{10} 0.2, C_{12} 16.6, $C_{12}(-2H)$ 0.3, $C_{14}(-2H)$ 0.6, $C_{16}(-2H)$ 7.8
Camel-thorn seed[5]	Trace	12.8	5.6	23.5	41.5	4.2	C_{20} 1.7, C_{22} 0.9, $C_{16}(-2H)$ 7.3, $C_{20}(-2H)$ 1.4, $C_{16}(-4H)$ 1.1
Camel-thorn seed pod[5] *Acacia giraffae*	0.8	17.0	9.1	29.3	19.0		C_{20} 8.3, C_{22} 0.1, $C_{16}(-2H)$ 10.4, $C_{20}(-2H)$ 4.9, $C_{16}(-4H)$ 1.1
Castor bean[7]	——— 3.5 ———			5.5	3.5		Ricinoleic 85.5, dihydroxystearic 2.0
Fish:							
Shark (*Carcharias melanopterus*) liver[21]	3.1	18.4	9.5	——— 19.7(−3.6H) ———			C_{20} 0.1, $C_{14}(-2H)$ 0.8, $C_{16}(-2.1H)$ 10.8, $C_{20}(-6H)$ 15.2, $C_{22}(-8.8H)$ 17.1, $C_{24}(-11H)$ 5.3
Saw fish (*Pristis cuspidatus*) liver[21]	1.2	22.9	12.7	——— 28.5(−2.2H) ———			C_{20} 0.1, $C_{14}(-2H)$ 0.2, $C_{16}(-2H)$ 8.2, $C_{20}(-5.3H)$ 16.3, $C_{22}(-7.4H)$ 5.2, $C_{24}(-11H)$ 4.6
Crocodile body[14] *Crocodylus porosus*	2.9	26.6	4.8	17.0	2.6	3.8	C_{12} 0.4, C_{20} 0.6, $C_{12}(-2H)$ 1.1, $C_{14}(-2H)$ 6.2, $C_{16}(-2H)$ 0.3, $C_{16}(-4H)$ 33.5, $C_{20}(-3.5H)$ 3.8
Crocodylus niloticus	3.9	24.0	3.4	30.8	6.5	3.1	C_{20} 1.3, $C_{14}(-2H)$ 1.0, $C_{16}(-2H)$ 0.3, $C_{16}(-4H)$ 0.3, C_{20} $(-5.8H)$ 6.8, $C_{22}(-7.9H)$ 4.2
Coconut milk[10]	18.9	11.6	11.6	1.9	8.9		C_8 7.2, C_{10} 7.3, C_{12} 40.7
Corn (Maize)[11]	——— 0.0-21.3 ———			16.5-75.9	15.7-67.6		
Corn (Maize)[12]		8.0	3.5	46.2	42.2		C_{20} 0.3
Cow mammary gland[13]	4.4	32.0	14.3	29.3	3.6	1.9	C_4 2.3, C_6 0.9, C_8 0.5, C_{10} 0.6, C_{12} 2.1, $C_{10}(-2H)$ 0.2, $C_{12}(-2H)$ 0.4, $C_{14}(-2H)$ 0.4, $C_{16}(-2H)$ 5.9, $C_{16}(-4H)$ 0.4, C_{20-22} (Unsatd.) 1.9
Kamala seed[23] *Mallotus philippinensis*	2.5	8.7	0.7	13.3	16.2		C_{12} 0.1, kamlolenic 58.5
Karamja seed[26] *Pongamia glabra*	1.6	7.9	3.7	62.1	11.9	5.0	C_{20} 2.5, C_{22} 4.2, C_{24} 1.1
Leucaena glauca seed[28]		12.7	5.0	23.6	54.3		C_{22} 3.6, C_{24} 0.7
Mandara seed[31] *Jatropha euphorbeacea*	5.2	4.3	1.9	16.7	26.1	8.0	C_{10} 1.5, C_{12} 8.9, $C_{16}(-2H)$ 13.7, ricinoleic 12.9
Maroola kernels[32] *Sclerocaya caffra*		16.1	5.1	66.7	7.3		C_{20-22} 2.0, $C_{16}(-2H)$ 1.0, $C_{20}(-2H)$ 2.7
Ostrich body[34] *Struthio camelus*	0.9	24.8	5.9	39.8	17.1	3.8	C_{20} 0.4, $C_{14}(-2H)$ 0.9, $C_{16}(-2H)$ 5.6, $C_{16}(-4H)$ 0.5, $C_{20}(-2.1H)$ 0.3
Palm (from Bahia)[35]* *Elaeis guineensis*	1.3	29.5	4.0	46.9	7.5		
Sesbania aegyptica tree seed[36]		9.0	17.5	24.4	36.3	10.9	C_{24} 1.9
Seseli indicum seed[37]		6.2		31.0	13.8		Resin acids 3, petroselinic 46.1
Rape seed (of Poland)[39]					17.5	7.0	C_{10-24} 6.5, $C_{22}(-2H)$ 50.5, C_{16-20} $(-2H)$ 18.5
Thespesia populnea seed[40]	1.0	21.4	1.9	32.5	43.2		
Ximenia Caffra fruit[44]		0.4	2.6	32.5			C_{20} 0.6, C_{22} 0.6, C_{24} 2.2, C_{26} 3.8, C_{28} 1.0, $C_{16}(-2H)$ 3.8, Ximenynic 24.3, β-elaestearic 0.4, $C_{20}(-2H)$ 2.5, $C_{22}(-2H)$ 2.3, $C_{24}(-2H)$ 5.7, $C_{26}(-2H)$ 3.5, $C_{28}(-2H)$ 9.6, $C_{30}(-2H)$, 5.4, $C_{32}(-2H)$ 1.0

* Based on whole oil.

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oleic and saturated acids fluctuate (Simmons—*Ibid.* 441, 601). Other results of this investigation are that oleic acid may, to some extent, be converted to other acids, and that there is no evidence for dehydrogenation of saturated acids. A study of linseed oils from various provinces of the Soviet Union during the past eight seasons has indicated that yield of oil and accumulation of unsaturated fatty acids in the oil improved with moisture content of the soil, availability of phosphorus, and low mean temperature during seed formation and ripening (Trepacher—*Masloboino-Zhirovaya Prom. 19,* No. 3, 4). In a report on analyses of 30 samples of linseed oils the range of the various individual acids were given (Buchon & Massoni—*Peintures, pigments, vernis 30,* 386). Similar data on 232 samples of American tung oil taken over three successive seasons were very uniform (Holmes *et al.—J. Am. Oil Chemists' Soc. 31,* 417; *Proc. Am. Tung Oil Assoc. 1953,* 56). In a discussion on cottonseed it was suggested that some attention be given to increasing the oil content during culture experiments on improvement of the fiber (Stansbury *et al.—J. Agr. Food & Chem. 2,* 692). The work on culture of sesame seed in the United States indicates that protein synthesis is favored over oil synthesis as the nitrogen supply to the seed increases (Kinman & Stark—*J. Am. Oil Chemists' Soc. 31,* 104). This report contains the yield per acre and the composition of the seed of 24 varieties from 14 United States locations. The oil content of castor, sesame, and flax seeds from various areas of India have been determined in a program for improving the oilseeds grown (Krishnamurty—*Oils & Oilseeds J., India 4,* No. 7, 8). Also, the yield of oil composition, and bodying behavior of four species of Indian cucurbit seeds were recorded (Chowdury *et al.—Science & Culture, India, 19,* 163). The fat content and composition of the fats as affected by source and season of seaweeds of Japan have been recorded (Katayama & Tamaki—*J. Oil Chemists' Soc. Japan 2,* 155).

Among corn oils from corns having 1.6 to 11.5% oil there were linear relationships between iodine value and fatty acid composition, between oil contents of the grains and iodine value, and between oil content and fatty acid composition (Sniegowski & Baldwin—*J. Am. Oil Chemists' Soc. 31,* 414). Increase in oil content in corn was accompanied by a decrease in iodine value and linoleic acid content. In an investigation on the composition of fats of Indian fresh-water fish there were significant differences in the proportions and degree of unsaturation of their unsaturated acids (Pathak *et al.—Biochem. J. 57,* 449).

The fatty acid content and composition of the fatty acids have been recorded for the American foods: bacon, American cheese, Swiss cheese, frankfurters, ham, luncheon meat, shortening, oleomargarine, corn meal, peanut butter, raw peanuts, roasted peanuts, rolled oats, and walnuts (Willard *et al.—J. Am. Oil Chemists' Soc. 31,* 131). The fat content and its physical and chemical characteristics of various meat cuts from different varieties of sheep of Armenia have been surveyed (Malatyan & Nikogosyan—*Voprosy Petaniya 12,* No. 4, 64). The hydrogenated oil product of India, Vanaspati, contains the following fatty acids: oleic 59-78, isoöleic 15-43, linoleic 0-12, and saturated 20-32% (Bhide—*Bombay Technologist 2,* 81). In a survey of the chemical and physical characteristics of Portuguese butters 222 samples were analyzed (Vidal & Netto—*Rev. quim, pura e apl. 4,* 83).

Kartha (*J. Am. Oil Chemists' Soc. 31,* 85; *J. Sci. Ind. Res. India 12A,* 504; *13A,* 72) who had proposed a modified hypothesis of random distribution of fatty acids in natural glycerides limited by deviations caused by inability of production of solid fats by biochemical processes, has added new data to support his suggestions. Thus he points out that tallow contains 70-75% less fully saturated glycerides than is required for random distribution because these are limited to permit fluidity *in vitro.* With the fat of *Myristica malabarica* the fully saturated glycerides agree with the rule of random distribution so all the fatty acids are distributed among the glycerides at random. Brooker and West (*J. Am. Oil Chemists' Soc. 31,* 115) submitted experimental data contrary to one of Kartha's teachings which suggests that saturated glycerides show on progressive dilutions with unsaturated glycerides an even series of decrements in melting point which were independent of the degree of unsaturation of the unsaturated glycerides. He obtained different decrements when tallow was added to peanut and neatsfoot oil and these did not agree with the standard recorded by Kartha. In tests on Karthas' teachings on distribution of fatty acids in glycerides by Luddy *et al.* (*Ibid.* 266), the composition of chicken fat agreed with the calculations whereas that of lard, cottonseed oil, and palm oil did not. Hilditch (*Ibid.* 433) cited data that did not confirm Karthas' concepts and also showed the reliability of analytical methods that were questioned in the polemical discussion on "even" versus "random" distribution concepts.

Some analyses on natural glycerides were directed at the uncommon constituents. Highly unsaturated acids of 20 and more carbon atoms were isolated from seal viscera fat (Tsuchiya & Okubo—*J. Chem. Soc. Japan, Ind. Chem. Sect. 56,* 187), clam fat (Hori & Hosoda—*J. Chem. Soc. Japan, Chem. Sect. 74,* 515), liver oils of various fish (Tsuchiya—*J. Chem. Soc. Japan, Ind. Chem. Sect. 55,* 375; Tsuchiya & Okudo—*Ibid.* 804; Gupta—*Proc. Natl. Inst. Sci. India 19,* 527; Klenk & Bongard—*Hoppe-Seyler's Z. Physiol. Chem. 292,* 51), sardine oil (Toyama & Yamamoto—*J. Oil Chemists' Soc., Japan 2,* 108, 147, 193, 195; *Mem. Fac. Eng. Nagoya Univ. 5,* 114, 122), and South African pilchard oil (Silk *et al.—Biochem. J. 57,* 574, 577, 582).

Saturated and unsaturated C_6 to C_{20} acids occur in the fusel oil of corn and rye alcohols (Cattaneo *et al.—Anales asoc. quim. argentina 41,* 105). Isovaleric, isobutyric, and methylethylacetic acids were detected in porpoise body oil (Takaoka & Tsujino—*Bull. Japan Soc. Sci. Fisheries 18,* 58). C_2 to C_{10} volatile acids of both even and odd carbons have been reported present in the fat of the beef suet that surrounds the kidney (Hansen & McInnes—*Nature 173,* 1093). Fatty acids with uneven-numbered carbon atoms were isolated from mutton fat (Hansen *et al.—Nature 173,* 39; *Biochem. J. 58,* 513, 516) and from shark liver oil (Shorland—*Nature 174,* 603). Trans acids occur in the rumens of pasture fed sheep (*Nature 174,* 185) and in milk fat (Smith *et al.—J. Dairy Sci. 37,* 399). Conjugated acids are present in pomegranate seed oil (Ahlers & Metaggart—*J. Sci. Food Agr. 5,* 75), kapok seed oil (Tsuchiya & Hashimoto—*J. Chem. Soc. Japan Ind. Chem. Sect. 56,* 352), and milk fat (Lembke & Kaufmann—*Milchwissenschaft 9,* 113; Smith & Jack—*J. Dairy Sci. 37,* 390). The occurrence of conjugated fatty acids in commercial pine-wood and tall oils has been attributed to conjugation taking place during sulfate pulping (Kajanne—*Ann. Acad. Sci. Fennicae Ser. AII, No. 50,* 82 pp.).

Monounsaturated acids of C_{10} to C_{18} were isolated from milk fat (Smith & Jack—*J. Dairy Sci. 37,* 380). Analysis of the fruit oils of several umbelliferous plants has shown that these contain petroselinic and petroselaidic (Kurono *et al.—J. Pharm. Soc. Japan 73,* 1207, 1209, 1211, 1213; Menon & Raman—*Proc. Indian Acad. Sci. 38A,* 128); petroselenic acid also occurs in the seed oils of *Ammi visonaga* (Skellon & Spence—*Chemistry & Industry 1954,* 75). Snake gourd seed and pomegranate seed oils contain an acid spectrally similar to punicic acid (Ahlers & Dennison—*Ibid.* 603). Eicosenoic acid occurs in the oils of cameline seed (von Mikusch & Dylla—*J. Am. Oil Chemists' Soc. 31,* 114), rutabaga seed, frenchweed seed, dogfish liver, and blubber of the white whale (Hopkins & Chisholm—*Can. J. Chem. 32,* 1033). An ω-hydroxy triunsaturated acid that has been found in kamalia oil was variously isolated in amounts of 30 (O'Neill *et al.—Chemistry & Industry 1954,* 756), 36 (Calderwood & Gunstone—*J. Sci. Food & Agr. 5,* 382), and 58.5% (Gupta *et al.—J. Am. Oil Chemists' Soc. 31,* 287) of the total fatty acids. Four samples of Japanese beeswax contained about 15% hydroxypalmitic acid (Toyama & Toyama—*Res. Repts. Nagoya Ind. Sci. No. 6,* 28). The vernolic acid present in *Veroninia anthelmintica* seed oil was shown to be 11-hydroxy-9-octadenenoic acid (Gunstone—*J. Chem. Soc. 1954,* 1611). The ximenynic acid of *Ximenia caffra* has 17 carbon atoms with a double bond at the 10th and -yne group at 8th carbon (Ligthelm — *Chemistry & Industry 1954,* 249). 2-Hydroxy-*n*-C_{10}, -*n*-C_{14}, -*n*-C_{16}, -*n*-C_{18}, and -16-methylheptadecanoic acids are present in wool wax (Horn *et al.—J. Chem. Soc. 1954,* 177, 1460). Branched chain acids have been isolated from tubercle bacilli lipides (Chanley & Polgar—*J. Chem. Soc. 1954,* 1003, 1008), hair grease of the dog (Brouwer & Nijkamp —*Biochem. J. 55,* 444), butterfat (Hansen *et al.—Biochem. J. 57,* 297; *58,* 359), and mutton fat (Hansen *et al.—Chemistry & Industry 1954,* 1229).

A method for determination of total phospholipides in comcercial lecithin is based on the difference between the acetone-insoluble matter and the petroleum ether-insoluble matter (Hutt *et al.—Analyst 78,* 712). The ninhydrin procedure was found to be a rapid and sensitive method for estimating phosphatidylethanolamine in phosphatides without previous hydrolysis (Lea & Rhodes—*Biochem. J. 56,* 613). A new method of determining choline in eggs is based on precipitation as reinechate (Hadorn & Jungkunz—*Mitt. Lebensm. Hyg. 44,* 333).

The structure of the inositol phosphatides of peanuts (Malkin & Poole—*J. Chem. Soc. 1953,* 3470) and of soybean and ox brain (Hawthorne & Chargaff—*J. Biol. Chem. 206,* 27) were investigated by hydrolysis, and chromatographic fractionation and analyses of the fractions. The hydrolytic products of the vegetable inositol phospholipides contained water-soluble phosphates, ethanolamine, arabinose, and some disaccharides. The brain lipide hydrolysate contained inositol diphosphate and a more complex substance, probably a diester. The above work on peanut phosphatides and other work (Long & Maguire—*Biochem. J. 57,* 223) have indicated that the phosphatides have a L-α-configuration. An inositol fraction from soybean phosphatides having a low partition coefficient in the fractionation of inositol between hexane and methanol was found to contain phosphatidyl ethanolamine and a nitrogen-free inositol-containing phosphatide (Scholfield & Dutton—*J. Biol. Chem. 208,* 461). It has been shown that the lecithins of beef, rabbit, dog, guinea pig, and rat livers have only unsaturated fatty acid in the α-ester position and only saturated fatty acids in the β-ester position (Hanahan—*Ibid. 211,* 313).

The effect of variables and modifications of the molybdenum blue colorimetric method for determination of phosphorus content of lipides have been studied and the findings were used to adjust the procedure to attain more reliable results (Harris & Popat—*J. Am. Oil Chemists' Soc. 31,* 124 [1954]). The phosphatide content of vegetable oils was reviewed with regard to the influence of the age of the oil, temperature and pressure of extraction, storage of the seed, and its ripeness (Rao & Murti—*Oils & Oilseeds J., India 5,* No. 10/12, 88). The lipides of *Salmonella typhosa, S. ballerup,* and *S. hirshfeldii* contained, respectively, 8.6, 51.7, and 21.6% phospholipides (Cmelik—*Hoppe-Seylers Z. physiol. Chem. 290,* 146; *293,* 222; *296,* 67).

A new method for determination of sesamin, sesamolin, and sesamol in sesame oil and concentrations is based on separation by chromatography and spectrometric study of the fractions (Beroza—*Anal. Chem. 26,* 1173). Gossypol in cottonseed kernels was found to be negatively correlated with temperature during crop season and positively correlated with the rainfall (Pons *et al.*—*J. Agr. Food Chem. 1,* 1115).

The ether-extracted oils from cuttle fish livers of low oil content contain more unsaponifiable and there is a higher content of sterols in this fraction than in commercially extracted oils (Toyama *et al.*—*Mem. Fac. Eng. Nagoya Univ. 5,* 110). The sterol fraction of *Sargassum ringgoldianum* seaweed oil consists chiefly of a sterol melting at 123°, $C_{29}H_{48}O$; which might be identical to fucosterol (Kaneda—*Bull. Japan Soc. Sci. Fisheries 17,* No. 8/9, 20). Modifications of existing spectrophotometric methods for determination of cholesterol and triterpene alcohols in woolwax were designed (Luddy *et al.*—*Anal. Chem. 25,* 1497; Duewell—*Ibid.,* 1548).

Knol (*J. Am. Oil Chemists' Soc. 31,* 59) reviewed the literature on the aliphatic woolwax alcohols. Highly unsaturated C_{28} to C_{34} hydrocarbons were isolated from the unsaponifiable of rice bran oil (Tsuchiya & Kaneko—*Repts. Govt. Chem. Ind. Res. Tokyo 49,* 57).

The amounts of chlorophyll in oils are calculated from measurements made on a spectrometer at 630, 670, and 710 mμ (Stillman—*J. Am. Oil Chemists' Soc. 31,* 469).

A pink color reaction which develops when one milliliter of sample is added to 1:1 mixture of 10% sodium hydroxide: pyridine mixture is the basis of a test for trichloroethylene in cottonseed oil (Wiese & Jesina—*Drug Standards 22,* 105). Sensitivity is 1:200,000. A method for trace metals in edible oils makes use of magnesium nitrate and a special electrically heated block for the ashing; and identification is spectrographically (Gorbach & Vioque-Pizarro—*Fette u. Seifen 56,* 177). Copper in oils and fats over the range of 0.2 to 2.0 p.p.m. is determined by ashing, taking up with dilute acid, extraction as the dibenzyldithiocarbonate with carbon tetrachloride, and measurement of the optical density at 435 mμ (Abbott & Polhill —*Analyst 79,* 547).

Detergents

MANUFACTURE. Poor quality soap stock was converted into suitable soaps by refining treatments either before conversion to soap or after saponification. Gums were removed from vegetable oil foots soap stock by treatment with strong caustic followed by centrifugally separating a soap phase of 45-60% total fatty acids (Keith *et al.*—*J. Am. Oil Chemists' Soc. 31,* 298). Fatty acids recovered from this soap could be submitted to distillation to obtain a recovery from the original foots greater than that from distillation of untreated stocks, and the necessity of Twitchell- or pressure-splitting was eliminated. Low grade fatty materials were also made into suitable soaps by decolorization with propane, addition of a fat antioxidant, saponification and then addition of another antioxidant suitable for protecting soap (Black & Johnson—*U. S. 2,680,122*). A synergistic effect of the two antioxidants is evident. The bleaching of dark soap stock with concentrated hypochlorites in the presence of sulfuric acid was patented (Honrubia—*Span. 206,712*). A Russian method of refining soap stock made use of the soap lyes obtained from a previous saponification and hydrogen peroxide as the refining agents (Ostrin—*Masloboino-Zhirovaya Prom. 18,* No. 8, 13; Chiskis—*Ibid.* No. 9, 23; Noiseev—*Ibid.* No. 11, 22). The process comprised saponification with recovered soap lye and additional caustic lye, graining, and hydrogen peroxide treatment.

A soapmaking process patented by Takahashi & Suzuki (*Japan 5326* ['53]) involved saponifying most of the stock, separating the curd by salting out, and adding equivalent amounts of lye and coconut oil, the latter being the remainder of the stock in the formula.

Reutenauer (*Bull. mens. inform. ITERG 7,* 477, 542) published new results in a series of reports on glycerol losses in soap making. Purifying soap lyes by precipitation with ferric chloride or aluminum sulfate and the presence of sodium chloride caused slight losses, whereas sodium hydrosulfite, sodium chlorate and hexadecyl alcohol had no effect. The losses from combinations of salt, ferric chloride, and aluminum sulfate were not additive with respect to those found individually. Removal of iron with oxalic acid or the presence of a sequestrant inhibited the destructive effect of iron.

Several reports on soap making pertained only to the final steps. A new centrifugal apparatus for separation of neat soap from nigre differs from models previously applied to this operation in that it has a large bowl and is operated at a relatively low speed (Vosganiantz—*Soap, Perfumery & Cosmetics 26,* 1017). New patented equipment to follow a spray drier comprised a cooling tower and a cyclone separator by which sprayed soap particles are dried and separated into tailings, particles of proper size, and fines (Ledgett *et al.*—*U. S. 2,657,797*). Antibridging devices were designed to prevent spray dried soap from blocking the outlet of the spray chamber (Steiner—*U. S. 2,685,388; U. S. 2,697,486*). A reissue patent on a soap extruder pertained to design to increase capacity (Marshall *et al.*—*U. S. Re. 23,760* of *U. S. 2,620,511*). One patent on working a soap mass pertained to salting out, then kneading, and shearing at 80-125° to induce formation of waxy β-phase soap (Ferguson & Rosevear—*U. S. 2,686,761*).

Highly filled plodded soap bars were made by adding 50% by weight of aluminum silicate gel to hot soap, chilling, and then plodding (James—*U. S. 2,677,665*). A standard laboratory size Schaar hand-homogenizer was modified to serve as a laboratory size soap plodder (Hebenstreit & Glynn—*J. Am. Oil Chemists' Soc. 31,* 232). It is recommended for studying plodding characteristics and changes thereof due to formulative variations. Other inventions involving soap bar making were on a continuous soap bar drier (Mastrangelo—*Ital. 474,496*), and an ink for printing on bars (Grauelande—*Span. 208,806*).

The new patents on liquid soaps pertained to addition of five percent light mineral oil and five percent polyethylene glycol ester of stearic acid to lower viscosity (Fortress & Bowen —*U. S. 2,676,152*) and incorporation of behenic acid in a synthetic detergent-soap type shampoo to induce opaqueness and creaminess (Henkin—*U. S. 2,674,580*). A gel-like soap contained soap or synthetic detergent and glycerol solution (Shiba *et al.*—*Japan 6637* ['53]), *638* ['54]). The making of another gelatinous soap pertained to cooling procedure for soap solutions that give desired gelatinous consistency (Belmonte—*Span. 201,715*). Chloro-fluoro hydrocarbons were used as propellants in patented pressure-tight containers of soap solution for producing shaving lather without resorting to whipping, mechanical, or manual operation (Spitzer *et al.*—*U. S. 2,655,480*).

New information has been presented on material added to soaps for special purposes. Laboratory reports on the effectiveness of germicide additives were written on *N*-trichloromercapto-4-cyclohexane-1,2-dicarboximide, "Vancide 89" (Stoltz & Rogers—*Soap & Chem. Specialties 30,* No. 6, 38), tetramethylthiuram disulfide, "TMTD" (Vinon—*Ibid.* No. 4, 44), chlorinated salicylanilide, "Anolial" (anon.—*Ibid.* No. 4, 95), and ethylmercuric phosphate (Zubareva—*Gigiena i Sanit. 1953,* No. 9, 50). New patents were issued on germicide soap additives selected from pentahalogenated phenols (Shumard—*U. S. 2,698,301*) and from halogenated 2-hydrocarbon substituted-8-hydroxyquinolines (Elliott & Shumard—*U. S. 2,695,881*) and substituted methyl tertiary phenols (Beaver *et al.*—*U. S. 2,678,-*

302). Higher 1,2-alkanediols were added to anionic detergents to stabilize foam (Wijga—*Dutch 73,501*). Reaction products of *p*-methyl phenol plus diethanol amine, or chlorophenols, or sulfated phenols with formaldehyde were used in detergents to form complexes with calcium (Ciba Ltd.—*Swiss 288,380, 292,641-3 Cl. 24a*). Many stilbene derivatives (Wallace & Williams—*U. S. 2,658,064*; Adams & Wilson—*U. S. 2,667,458*; J. R. Giegy A.-G.—*Brit. 692,346-8, 692,407*; *Swiss 287,079-82*; Serra—*Span. 202,271*) and coumarin derivatives (Wheelock & Reynolds—*U. S. 2,673,186*) were patented as laundry soap additives to brighten color or improve whiteness of the washes. A recent communication reports that these materials catalyze corrosion of copper or brass inner cages of laundering machines (Nieuwenhuis—*J. Colloid Sci. 1954*, Suppl. 1, 81). The copper oxide formed absorbs these whitening agents to a larger extent than cellulose fibers and may inactivate their effect on the laundry. The relation between dirt suspension and water hardness in laundering with soap containing cellulose glycolate, "Tylose," as an additive was recorded as fundamental information for use of this additive (Carriere & Burger—*Fette u. Seifen 55*, 845). Magnesium silicate was a suitable additive for soaps containing oxygen type bleaching agents to stabilize liberation of oxygen (Uhl—*Ibid. 56*, 380).

Some reports pertained to soap or detergent substitutes. Previous statements that carboxydextrins can replace fats in soapmaking were challenged by Sergeev (*Zhur. Priklad. Khim. 27*, 352). Potato waste obtained in the manufacture of starch was converted to a washing agent by fermentation until acid, followed by treatment with alkali (Vedder—*Dutch 72,839*). For similar purposes cellulose was oxidized with nitric acid in the presence of an added reducing agent that liberates nitrogen from the acid (Nieuwenhuis—*Dutch 74,351*). A cleaning agent composed of soap and vulcanized natural rubber latex was patented (*Takeuchi—Japan 6636* ['*53*]). Similarly, exchange resin was added to soap (Matsushige—*Japan 1681* ['*53*]). Methods for extracting saponins from soapnuts and shikakai pods with ammonium sulfate and alcohol solutions for use as washing agents were patented (Council Sci. & Ind. Res. —*Indian 46,945-6*). An inorganic detergent in cake form was composed of sodium carbonate, sodium bicarbonate, sodium sulfate, ammonium chloride, and small amount of water (Torruella—*Span. 202,046*). A similar product also contained borax (Reinhard—*U. S. 2,673,841*). A combined detergent and bleaching powder contained sodium hypochlorite and sodium carbonate (Montacchini—*Ital. 469,458*). A cleansing paste for dry removal of grease and dirt from hands was composed of fat solvent, lanolin, glycerol, oil, and water (Serrejanne—*Span. 206,133*). A scouring steel wool product was impregnated with soap and a rust inhibitor (Hauf—*Ger. 821,985 Cl. 22g*). Roasted and ashed rice bran was incorporated into metal polishing compositions (Persano & Fevola—*Ital. 474,164*).

A dishwashing detergent comprised an alkaline detergent salt, an alkaline condensed phosphate salt, and chlorinated trisodium phosphate (Anderson & Wegst—*U. S. 2,689,225*). New additives for dishwashing detergents were potassium fluorsilicate to remove siliceous scale from glass (Miller—*U. S. 2,656,289*), and monophenyl thiourea (Sylvester—*U. S. 2,698,302*), dibutyl thiourea (Sweet & Mead—*U. S. 2,692,236*), and hetrocyclic dithiazine compounds (Krems—*U. S. 2,687,379*) to inhibit tarnishing of metals. Used bottle washing detergent solution was recovered by passing through a vibrating screen which caused the bubbles to coalesce and drain, and solid particles to be removed (Wehmiller & Nekola—*U. S. 2,668,796*).

Burton & Byrne (*J. Soc. Leather Trades Chemists' 38*, 10) published results of comprehensive studies on the effects of variations in manufacture on the composition of sulfated fish oils. When sulfating with 20% of 98.5% sulfuric acid, increasing the temperature from 20 to 40° had little effect on extent of hydrolysis or formation of sulfuric esters, but the product formed at 20° was clear and contained sulfonates whereas that at 40° was translucent and sulfonate free. Increasing the acid from 20 to 60% increases hydrolysis and development of hydroxy acids. Sulfuric acid ester formation was greatest with 60% sulfuric acid and least with 100 parts of 20% oleum plus acetic acid and benzene; the latter favored sulfonation and hydroxy fat formation. An investigation on sulfation of tallow alcohols indicated that several sulfating agents give products having good detergent and surface-active properties (Weil —*J. Am. Oil Chemists' Soc. 31, 444*). Here, quality was related to the extent to which reactions at the double bond are avoided, and sodium oleyl sulfate is a desirable component in the mixtures of sulfated tallow alcohols because of its ready solubility. The rates of sulfation of castor oil, its fatty acids, oleic acid, and oleyl alcohol at 0° and 27-29° were recorded as fundamental data for commercial application (Mehta *et al.*— *J. Indian Chem. Soc. Ind. & News Ed. 16*, 81). Data were presented from pilot plant sulfonation of alkylaryl compounds to demonstrate the feasibility of sulfonation with sulfur trioxides (Gerhart & Popovac—*J. Am. Oil Chemists' Soc. 31*, 200). Such sulfonations would have the advantages of: (a) elimination of handling spent sulfuric acid; (b) no drowning step to eliminate acid is necessary; (c) low salt content of product; (d) smaller equipment; and (e) higher sulfonation temperature may be used. Details of sulfonation of monoglycerides of cocoa oil have been issued to serve as inducement to make a synthetic detergent in Jugoslavia from material available there (Pfundner—*Kemi Zbornik 1951*, 178). Similarly in the Japanese literature there was described the synthesis and properties of alkylbenzene sulfonic acid (Ojika *et al.*—*J. Chem. Soc. Japan Ind. Chem. Sect. 54*, 550 552), sulfonated products from naphthalene and 2,2' binaphthyl, (Fukuzumi & Hirai—*Ibid. 55*, 403), derivatives of polyethylene polyamines (Isoda *et al.*—*Ibid.* 441, 621), and transesterification products of fatty oils and 2,2,6,6,-tetramethylcyclohexanol (Isoda—*Ibid. 54*, 773). Directions were published for making the cationic detergent and germicide 2,4-diguanidinophenyl dodecyl ether dihydrochloride (Pasini—*Il Farmaco, Ed. Sci., Pavia, 8*, 646). Decolorization of polyoxyethylene tallates, a nonionic detergent, with ozone and hydrogen peroxides was demonstrated (Karabinos & Ballun—*J. Am. Oil Chemists' Soc. 31*, 71).

Various means were used to produce synthetic detergents in bar form. The detergent polyoxyethylene ethers were complexed with urea so that they could be molded or cut into detergent bars (Barker—*U. S. 2,665,256*). A method for anionic detergents comprised addition of a paraffin wax of melting point 130°F. and an emollient consisting of ammonium pectates, tannates, humates, or alginates (van Dijck & Geyer— *U. S. 2,653,913*), and by plasticizing a mixture of the detergent and zinc stearate with diethylene glycol monostearate (Turck *et al.*—*U. S. 2,678,921*). Dry solid products were also prepared by felting the detergent into water soluble cellulose material (Brown—*U. S. 2,648,635*; Baixeras & Pages—*Span. 206,030*). Hexadecyl alcohol-urea complexes were added to synthetic toilet detergents to inhibit their tendency to cause skin rash or skin irritation (Woodworth & Sherwood—*U. S. 2,675,356*).

Several miscellaneous cleaners contained synthetic detergents. A milk can detergent and disinfectant composition contained fat solvent quaternary ammonium compounds and other synthetic detergents (Scales—*U. S. 2,677,630*). A solution for cleaning metallic surfaces before painting contained equal parts of sulfonated higher alcohols and soulfonated petroleum compounds in water (Dittfeld—*Ital. 468,080*). A mixture of organic solvents, "Versene," "flaxsoap," "Gamal" and lye was made for the cleaning of small antifriction bearings (Gillette & Burroughs—*U. S. 2,683,343*).

Other literature on synthetic detergent manufacture is in patents on manufacturing techniques and products. For convenience of presentation these are cited below under the name of the assignee or patentee:

Algemeene Kunstzijde Unie N. V.
Solutions of synthetic detergents containing cellulose derivatives (*Dutch 73,088*).

Allied Chem. & Dye Corp.
Olefin sulfonates prepared by sulfiting, followed by oxidizing the sulfite (*U. S. 2,653,970*).

Alrose Chem. Co.
Dry cleaning detergent of cationic lactate salts of substituted imidazoline (*U. S. 2,669,546*).

Altpeter, Julius
Sulfonation of brown coal-tar oils or shale oils (*Ger. 889,000 Cl. 12o*).

Anglo-Iranian Oil Co., Ltd.
Solid mixtures of urea, nonionic detergents, and diluents (*Brit. 697,315*). Manufacture of detergents from paraffinic and naphthenic hydrocarbons (*Ger. 870,848 Cl. 12o*).

Atlantic Refining Co.
Alkoxyalkylamine salts of alkylaryl sulfonic acids (*U. S. 2,673,215, 2,686,201*).

Armour & Co.
A mixture of fatty quaternary ammonium compound and inorganic builders (*U. S. 2,658,873*).

Atlas Powder Co.
Fatty acid esters of a cyclic acetals (detergent intermediates) (*U. S. 2,691,026*).

Badische Anilin & Soda-Fabrik
Alkylsulfonamides (*Ger. 751,132 Cl. 12o*). Organic halogen compounds condensed with aliphatic sulfonamide compounds (*Ger. 767,071 Cl. 12o*). Quaternary ammonium compounds (*Ger. 862,156 Cl. 12q*). Sulfonates of chlorined hydrocarbons (*Ger. 765,650 Cl. 12o*). Substituted carboxylic amides (*Ger. 765,735 Cl. 12o*). Nitrogen-containing sulfonation products (*Ger. 807,686 Cl. 12o*). Sulfonates of amino compounds prepared from paraffin hydrocarbons (*Ger. 884,644 Cl. 12o*). Sulfonation of unsaturated hydrocarbons (*Ger. 913,418 Cl. 12o*).

Bauer, Emile
Nitrogen and oxygen-containing heterocyclic compounds (*Brit. 708,523*).

Böhme Fettchemie G.m.b.H.
Glycerol ether sulfates (*Ger. 757,749 Cl. 12o*). Condensates of tetrahydrofurfurylamine with sulfonic acids or their functional derivatives (*Ger. 875,809 Cl. 12o*). Alkyl or aryl ethers or carboxylic esters of hydrofurylalkanols (*Ger. 887,340, 890,342 Cl. 12o*). Sultones of organic carboxylic acids (*Ger. 894,116 Cl. 12o*). Sultone reaction products with hydrocarbon compounds of metals of group I, II, or III (*Ger. 895,598 Cl. 12o*).

Braunkohle Benzin A.-G.
Sulfochlorides of paraffin hydrocarbons (*Ger. 881,794 Cl.* 12o).

California Research Corp.
Hydroxy amides of alkylphosphonic acid (*U. S. 2,648,706*). Mixture of polypropylene phenyl sulfonate and inorganic builder (*U. S. 2,688,599*). Mixture of alkyl sulfonates, alkyl amines (*U. S. 2,691,636*).

California Spray-Chem. Corp.
Dry mixtures of organic sulfonates and inorganic salts (*U. S. 2,678,906*).

Cassella Farbwerke Mainkur.
Sulfosuccinic esters of olefinic alcohols (*Ger. 868,154 Cl. 12o*).

Chemische Fabrik Grünau A.-G.
Reaction products of high molecular weight carboxylic and sulfonic acids or their halides with organic ammonium derivatives (*Ger. 914,855 Cl. 12o*).

Chemische Verwertungsgesellschaft Oberhausen m.b.H.
Synthetic hydrocarbons sulfonated and neutralized (*Ger. 913,419 Cl. 12o*).

Ciba Ltd.
Polyalkylene glycol ether (*Swiss 291,501 Cl. 36o*).

Colgate-Palmolive-Peet Co.
Alkylaryl sulfonamides preparation and mixtures with other detergents (*U. S. 2,658,916, 2,692,235, 2,692,237*). Neutralizing sulfonated organic esters (*U. S. 2,660,588, 2,673,207, 2,687,420, Brit. 693,779, 703,497*). Alkanol-ether-imides of long-chain aliphatic dicarboxylic compounds (*U. S. 2,662,898*). Continuous removal of organic solvent from aqueous detergent solutions (*U. S. 2,673,208*). Mixtures of sulfate or sulfonate detergents with higher alkane 1,2-diols (*U. S. 2,679,482*). Salt-free organic sulfonate detergents (*U. S. 2,682,509*). Alkylolamides (*U. S. 2,684,969; Brit. 693,086*). Poly-alkyl substituted aromatic hydrocarbons (Intermediates) (*U. S. 2,694,086*). Liquid dialkylamide (*U. S. Reissue 23,840*).

Commercial Solvents Corp.
Amide-glycamine condensation products (*U. S. 2,653,932*). Acid esters of fatty acylated *N*-alkylglucamines (*U. S. 2,677,478*).

Council Scientific & Industrial Research
Quaternary pyridinium salt (*Indian 45,116*).

Joseph Crosfield & Sons
Organic nitrogen-containing silicon compounds (*Brit 709,-634*).

Dehydag Deutsche Hydrierwerke G.m.b.H.
Reaction products of higher molecular nitro alcohols and formaldehyde (*Ger. 881,509 Cl. 12o*).

Deutsche Hydrierwerke A.-G.
Cyclohexanols which are sulfonated (*Ger. 863,053 Cl. 12o*). Manufacture of higher molecular primary alcohols which are sulfonated (*Ger. 865,902 Cl. 12o*). Condensation products of cyclic aldehydes with aliphatic aldehydes or ketones which are then hydrogenated (*Ger. 883,894 Cl. 12o*). Sulfonated polyaryl compounds (*Ger. 903,577 Cl. 12o*).

Directie van de Staatsmijnen, Limburg
Hydroxylamine sulfonates (*U. S. 2,677,599*).

Drew & Co.
Using hydroxyethylsulphonic acid salt as a sulfonating agent (*U. S. Reissue 23,823*).

Eastman Kodak Co.
Ammonium oleyl sulfate (*U. S. 2,649,469*).

Estenfanell, V. F.
Sulfonated alcohols manufacture (*Span. 206,344-5*).
Sulfoöleate (*Span. 206,343, 206,346*).

Farbenfabriken Bayer
Sulfonic acids and sulfonates of higher molecular weight paraffin hydrocarbons (*Ger. 873,239 Cl. 12o*).

General Mills Inc.
Sulfonated polyamines (*U. S. 2,668,851*). Mono-*N*-fatty citramides (*U. S. 2,693,490*).

Gooh Chem. Co.
Clearing turbidity in turkey red oil with sodium alkylbenzene sulfonate (*Japan 260* ['*54*]).

Helberger, J. H. *et al.*
Sultones treated with metal derivatives of compounds containing one alcohol and/or phenolic hydroxyl radical (*Ger. 743,570 Cl. 12o*).

Henkel & Cie G.m.b.H.
Alkyl sulfates from higher molecular alcohols of the oxo synthesis (*Ger. 914,606 Cl. 12o*).

Hercules Powder Co.
Purification of water-soluble reaction products of a rosin and an alkylene oxide (*U. S. 2,662,881*).

A. Holtmann & Co.
Detergents from sulfite waste liquor (*Ger. 896,645 Cl. 12o*).

Imperial Chemical Industries, Ltd.
Substituted 3,4-dihydro-2*H*-1,3-benzoxazines (*Brit. 694,-489*). Quaternary ammonium salts of benzoxazines (*Brit. 695,550*). Quaternary sulfates or sulfonates of pyrimidylaminoquinolines (*Ger. 825,413 Cl. 12p*).

McDonald, L.
Fatty acid ester of an ethylene oxide condensation product of a hexitol mixed with soap and ethyl cellulose (*U. S. 2,697,695*).

Märkische Seifen-Industrie
Sulfonated esters of paraffin oxidation acids and polyhydroxy alcohols (*Ger. 762,967, 766,265 Cl. 12o*).

Monsanto Chemical Co.
Sulfated (hydroxyalkylthio) succinates (*U. S. 2,630,449*). *N*-Carboxyalkyl-α-amino toluic acid and their alkyl esters (*U. S. 2,642,456*). Dialkyl *ar*-carboxyhydrocinnamates (*U. S. 2,642,457*). Alkanolamine sulfates of hydroxy ethers (*U. S. 2,644,833*). 1-[2-(alkylsulfonyl) ethyl] pyridinium halides (*U. S. 2,657,988*). Salts of *N*-tetradecyltaurine (*U. S. 2,658,072*). (Alkylphenoxy) alkane sulfonates (*U. S. 2,667,506*). Alkali metal or ammonium sulfates of the 2-butyloctanol-1-polyglycol ethers mixed with salts of *N*-alkyltaurines (*U. S. 2,673,842*). Sodium m-sulfobenzoic acid esters (*U. S. 2,676,979*). Alkylbenzene sulfonate compositions (*U. S. 2,683,692*). Amine salts of tridecyl esters of sulfobenzoic acid (*U. S. 2,683,736*).

NOPCO Chemical Co.
Condensation of ethylene oxide with amino-substituted amides (*U. S. 2,681,354*).

N. V. de Bataafsche Petroleum Maatschappij
Salting out of alkyl aryl sulfonate detergents (*Dutch 72,669*). Mixture of sulfonated detergents and dextrin (*Dutch 74,210*).

Parra, A. LaB.
Fish oils are sulfonated and polymerized (*Span. 202,086*).

Pickett, C. F. & Rosenfeld, M.
Diethylenetriamine condensates (*U. S. 2,680,137*). Reaction products of alkylolamides with alkylating, acylating, or alkoxylating agents (*U. S. 2,679,504*).

Pulcra Ltda.
Sulfated fatty hydroxyamides and of fatty hydroxyamino esters (*Span. 204,372*).

Purex Corp.
Vacuum neutralization of detergents (*U. S. Reissue 23,774*).

Ripert, J.
Water soluble aldehydes and ketones are condensed with a compound having an epoxy group to give nonionic detergents (*Fr. 982,421*).

Rudolf & Co.
Light-colored alkylaryl sulfonates (*Ger. 762,426 Cl. 12o*).

Ruhrchemie A.-G.
Neutralization of sulfonic acids and sulfuric acid esters (*U. S. 2,671,797; Brit. 707,994*). Sulfonation of alkylated aromatic hydrocarbons (*Brit. 692,061*).

Scharf, A.
Reaction products of sulfonated derivatives and phosphatides (*U. S. 2,678,320*).

Shell Development Co.
Intramolecular esters of hydroxy or amino phosphinic acids (*U. S. 2,648,695*). Sulfur-containing ethers of polyhydric alcohols and their derivatives (*U. S. 2,645,659*). 2-Alkylphenol-3,4,5,6-tetrahydropyrimidines (*U. S. 2,658,895*). Alkylated aryl sulfonates (*U. S. 2,676,185*).

Societe anon. d'innovations chimiques dite: Sinnova ou Sadic.
Sulfonated aromatic ethers and thio ethers (*Fr. 981,449*).

Societe laboratories recherches pour applications industrielles.
Fatty acid amide sulfonates (*Fr. 981,934-9*). Sulfonated fats, oils and natural resins (*Fr. 981,940-1*).

Standard Oil Co.
Disulfoxides (*U. S. 2,658,038*). A *tert*-alkyl mercaptan is condensed with an alkylene oxide in the presence of an alkali metal mercaptide (*Brit. 693,966*).

Sun Oil Co.
Alkyl-substituted benzene sulfonate detergents (*U. S. 2,681,362*).

Takamo, G.
Sulfonated mixture of succinic acid and octyl alcohol (Japan *1975* ['*53*]).

Textilana, Inc.
Dry cleaning detergents of salts of alkyl orthophosphoric acid containing mixtures of diacid and monoacid mixtures (*U. S. 2,656,372*).

U. S. A. as represented by the Secretary of Agr.
Gluconamides (*U. S. 2,662,073*).

Universal Oil Products Co.
Alkyl sulfonates (*U. S. 2,677,702*). Sulfonation apparatus *U. S. 2,697,031*).

Weiss, W.
Alkanesulfonate containing inorganic detergent salts (*Ger. 823,473 Cl. 23e*).

Wyandotte Chemicals Corp.
Polyoxyalkylene compounds (*U. S. 2,674,619; 2,677,700*).

Zschimmer & Schwarz vorm. Chemnitz
Reaction products from sulfochlorides of higher molecular aliphatic hydrocarbons and tertiary alkanol amines (*Ger. 884,364 Cl. 12o*).

Many other communications on soaps and detergents contain general economic, manufacturing, promotional, or descriptive information. For convenience of presentation these are classified and cited under the subject treated.

Reviews:

Recent studies on manufacture, analyses, and properties (Nanaka—*J. Oil Chemists' Soc., Japan 2,* 115). A 40-year history of the soap industry (Terry—*Soap & Sanit. Chemicals 30,* No. 1, 34). Quality of Japanese soap (Ueno—*Fette u. Seifen 56,* 801). Glycerine (Lesser—*Soap & Chem. Specialties 30,* No. 7, 37; Pattison—*Soap & Sanit. Chemicals 30,* No. 3, 48).

Raw Materials:

Soaps from neutral fats or from fatty acids (Weber—*Seifen-öle-Fette-Wachse 80,* 29). Refined tall oil for the soap industry (Stein—*Ibid. 79,* 543). Soap from fatty acids (Rowe—*Perfumery Essent. Oil Record 44,* 244). Synthetic fatty acids in soapmaking (Bogod—*Masloboino-Zhirovaya Prom. 18,* No. 10, 24).

Manufacture of soap:

Soap for sea water (Zaliopo *et al.*—*Masloboino-Zhirovaya Prom. 19,* No. 2, 16). Treatment to induce plasticity (*Tyutyunnikov*—*Ibid. 18,* No. 9, 11). Specialty soaps (Reese *et al.*—*Ind. Eng. Chem. 46,* 1354). Drying problems (Zilske—*Fette u. Seifen 55,* 892). Spray drying of detergents (Stüpel & Segesser—*Seifen-öle-Fette-Wachse 79,* 545; Manneck—*Ibid. 80,* 365. Continuous soap making (Nagourski—*Rev. quim. ind. Rio re Janeiro 23,* No. 264, 14; Naumenko—*Masloboino-Zhirovaya Prom. 18,* No. 10, 20; Day—*Perfumery Essent. Oil Record 44,* 320; Lanteri—*Fette u. Seifen 56,* 250; *Soap & Chem. Specialties 30,* No. 11, 42). Alkaline neutralization of fats (Smit—*Masloboino-Zhirovaya Prom. 19,* No. 5, 8). Refining of glycerol by ion-exchange resins (Shah—*Oils & Oilseeds J., India, 4,* No. 9/10, 29). Cost accounting in soap making (McNeill—*Soap & Chem. Specialties 30,* No. 6, 89). U. S. government specifications (anon.—*Soap Sanit. Chemicals 1954 Blue Book,* 229).

Miscellaneous detergent products:

Bar form detergents (anon.—*Soap & Chem. Specialties 30,* No. 9, 93). Liquid detergents (Terry—*Ibid.* No. 5, 46). Transparent soaps containing glycerol (Bergwein—*Seifen-öle-Fette-Wachse 80,* 293). Powdered hand soaps (Peck—*Soap & Chem. Specialties 30,* No. 10, 41). Antiseptic soaps (Augustin—*Seifen-öle-Fette-Wachse 80,* 114). Detergents for dry cleaning (Fulton *et al.*—*A.S.T.M. Bull. No. 192,* 63). Soaps for chemical cleansing (Schuck—*Seifen-öle-Fette-Wachse 80,* 53). Toilet detergents (Manneck—*Ibid.* 101, 127, 149, 184).

Soap defects:

Cracking of soaps (Vernon—*Rev. Francaise corps gras 1,* 82). Sweating and efflorescence of hard soaps (Zilske—*Seifen-öle-Fette-Wachse 80,* 103, 129, 151). Hardening and agglomerizing of synthetic detergents (Stüpel—*Ibid.* 170, 225, 245).

Soap builders and additives:

Building synthetic detergents (Suter & Kramer—*Ind. Eng. Chem. 46,* 1934). Dehydrated sodium phosphates (Hafford—*Ibid.* 1938). Polyphosphate mixtures in soap and detergents (Jacini & Arpino—*Olii minerali, grassi e saponi, colori e vernici 30,* 149). Condensed phosphates as builder (Stüpel—*Seifen Öle-Fette-Wachse 79,* 537, 570, 592, 620). Alkalies (Clements & Kennedy—*Ind. Chemist 28,* 152,301). Ethylenediamine-tetraacetic acid in soaps (Smith & Womersley—*Perfumery Essential Oil Record 45,* 163). Water-soluble cellulose ethers (Jullander—*Chemie & industrie 71,* 288). Bentonite in soaps (Perez—*Rev. fac. quim., La Plata 25,* 169). Diatomite as a soap abrasive (Weymouth & Martinson—*Soap Sanit. Chemicals 30,* No. 2, 139). Antioxidant-stabilizers in soaps (Bergwein—*Kosmetik-Parfum-Drogen-Rundschou 2,* 49). Germicidal soaps (Korff—*Soap Sanit. Chemicals 30,* No. 2, 44; Beland—*Can. Chem. Processing 38,* No. 10, 78). Colored detergents (McCutcheon—*Soap & Chem. Specialties 30,* No. 6, 107). Soap perfumery (Marton & Foy—*Ibid.* No. 1, 38; Kilmer—*Ibid.* No. 7, 34).

Synthetic detergents:

Reviews (Schonfeldt—*Svensk Kem. Tidskr. 65,* 145; Kunugi—*J. Japan Chem. 6,* 419; Mima—*Ibid. 7,* 689; Mikuma—*J. Oil Chemists' Japan 3,* 145; Ramasqamy *et al.*—*Oils & Oilseeds J., India, 5,* No. 10/12, 102; Meyer—*School Sci. & Math. 54,* 83). Status of soap versus synthetic detergents (Smith—*Soap & Chem. Specialties 30,* No. 7, 41). Sulfonation and sulfation (Gilbert & Jones—*Ind. Eng. Chem. 46,* 1895; Sisley—*Rev. Francaise corps gras 1,* 199). Continuous sulfonation (Ballestra—*Ibid.* 483). Sulfonates of olive-foots oils (Herrera & Garcia—*Anales real soc. espan. fis. y quim. 50B,* 107, 111). Alkyl sulfates from sperm oil alcohols (Rabinovich & Skripchenko—*Masloboino-Zhirovaya Prom. 18,* No. 7, 18). Detergents from petroleum (Sherwood—*Erdöl u. Kohle 6,* 551). Detergent alkylates (Kircher—*Ind. Eng. Chem. 46,* 1925; Martens—*Seifen-öle-Fette-Wachse 79,* 49; Gotte—*Fette u. Seifen 56,* 583). Alkylarylsulfonates (Manneck—*Seifen-öle-Fette-Wachse 80,* 437, 469; Bramston-Cook & Elwell—*Ind. Eng. Chem. 46,* 1922; anon.—*Chem. Eng. 61,* No. 6, 372). Nonionic detergents (Jelinek & Mayhew—*Ind. Eng. Chem. 46,* 1930; *Textile Res. J. 24,* 765; Rainey & Denoon—*Chem. Eng. News 31,* 4521). Quaternary ammonium detergents (Mosqueira & Merino—*Congr. Luso-Espan. farm. Congr. 2,* Sec. 1, 28). Effects of synthetic detergents in sewage (Haney *et al.*—*J. Am. Water Works Assoc. 46,* 751).

Theories on detergency:

Physicochemical principles (Linder—*Seifen-öle-Fette-*

Wachse 80, 73, 99, 125; Pankhurst—*Roy. Inst. Chem. Lectures, Monograph & Reptrs. 1953,* No. 5, 21 pp.). Theory of detergency (Kushner—*Soap & Chem. Specialties 30,* No. 5, 50; Rösch—*Textil Praxis 8,* 879; Rosano & Weill —*Mem. services chim. etat, Paris, 37,* No. 3, 219). Ability of synthetic detergents to suspend dirt (Stüpel—*Fette u. Seifen 55,* 501). Oleophillic properties (Demchenko *et al.*—*Colloid J., U.S.S.R. 14,* 183). Structure of soaps in solution (Vinogradov—*Uspekhi Khim 20,* 533).

Analysis and evaluation:

Scheme for total analysis of soaps (de la Torre—*Farm. nueva, Madrid, 18,* 549). Evaluation of detergency (Götte —*Melliand Textilber. 34,* 754; Rösch—*Ibid.* 226, 351, 453, 567; Wolfrom & Nuessle—*Am. Dyestuff Reptr. 42,* P753; Harris *et al.*—*Ind. Eng. Chem. 46,* 1942; McCabe—*Soap & Chem. Specialties 30,* No. 12, 44; Manneck—*Seifen-Öle-Fette-Wachse 79,* 594; Burgess—*J. Roy. Sanit. Inst. 74,* 157). Relationship of composition of alkylsulfates to detergency (Rabinovich & Skripchenko — *Masloboino-Zhirovaya Prom. 19,* No. 1, 18).

Toxicity and legal aspect:

Toxicity (Barail—*Soap, Sanit. Chemicals 30,* No. 4, 52; No. 6, 51). Legal responsibility in injury or allergy (Conner & Burroughs—*Soap & Chem. Specialties 30,* No. 5, 42; No. 6, 48).

CHEMICAL ANALYSIS. The Morawscki test for rosin was used to determine rosin acids in the fatty acids separated from soap solutions (Sanchez—*Congr. Luso-Espan. farm. 2,* Sec. 1*a,* 281). The quantitative aspects of the test involved the photocolorimetric evaluation of the color produced by the reaction. Titanium can be determined in soap polarographically after it is ashed, fused with potassium bisulfate and dissolved in 1.0 *N* sulfuric acid with sodium oxalate (Hejna — *J. Am. Oil Chemists' Soc. 31,* 350). The cathode wave of the diffusion current is well defined and is in direct proportion to the titanium concentration. A new titrometric method for total phosphoric anhydride is based on conversion of all phosphates present, by acid hydrolysis, to the ortho form and titration between pH 4.3 and 8.8 (Andrews—*Ibid.* 192). The standardized sodium hydroxide used between these two pH's is equivalent to $P_2O_5/2$. Dewald *et al.* (*Fette u. Seifen 56,* 105) pointed out that all current determinations for pyrophosphate and tripolyphosphate in detergents are as yet not entirely satisfactory, and they established some conditions through tests under which certain methods are preferable. Neu & Hagedorn (*Ibid.* 298) studied the reaction of octyl-, dioctyl- and lauryldi-(aminoethyl)-glycinhydrochloride with seven types of polyphosphates, containing 57.8-69.6 P_2O_5 with and without acetic acid, and illustrated how the reaction can be used for analysis of detergents.

Spectrophotometric methods have been devised for the identification and the quantitative determination of the soap germicides: dichlorophene, hexachlorophene, and 2,2'-thiobis-(4,6-dichlorophenol) (Clements & Newburger — *J. Assoc. Off. Agr. Chemists' 37,* 190). Lord *et al.* (*Soap, Perfumery & Cosmetics 26,* 783) also published details for spectrophotometric determination of hexachlorophene in soap. A method for detection and evaluation of optical brightener additives in a soap is based on reflectance from fabrics (Schlachter—*Fette u. Seifen 56,* 9). Graphs of measurements on several agents are given and discussed with regard to the merits of each.

A collaborated report on the American Oil Chemists' Society methods for glycol, ash, alkalinity, carbonate, salt, and residue in crude glycerol shows standard deviations of 0.4-1.32 (Pohle *et al.*—*J. Am. Oil Chemists' Soc. 31,* 74). A simple distillation method for evaluation of crude glycerol was developed to supplement analytical data (Schlachter & Hoffman— *Ibid.* 174). In the determination of glycerol by the potassium periodate method, reaction is completed in three minutes when an excess of solid potassium periodate is used (Hartman— *J Appl. Chem., London 3,* 308).

A method of approximating the soap in soap paste is based on the emptying time of a Duclaux pipet filled with known dilutions of the sample, with simultaneous counting of the drops (Gesteau & Heuchel—*Ann. pharm. franc. 11,* 525). A titration with 0.1 *N* hydrochloric acid with phenolphthalein indicator is recommended for determining adjustments of detergent concentrations in dairy cleaning (Mohr & Wortmann— *Proc. 13th Intern. Dairy Congr. 3,* 863).

Six organic qualitative tests are proposed for the classification of various types of anionic and nonionic detergents (Karabinos *et al.*—*Soap & Chem. Specialties 30,* No. 6, 41). These are (a) the ceric nitrate test for hydroxyl groups, (b) color produced on aluminum chloride in chloroform, (c) bromine water test for alkyl phenol ethers, (d) potassium permanganate test for unsaturation, (e) alcoholic potassium hydroxide test for esters, and (f) a modified Liebermann-Storch test for rosin derivatives. In a polarographic method of classifying detergents, rating is with a modified Thiese & Belon formula, which is utilized to determine a constant of adsorption of the detergent affecting the effect of the maxium oxygen concentration on a mercury drop (Cazaux *et al.*—*Bull. soc. pharm. Bordeaux 91,* 38). The method was demonstrated by ratings on many common detergents. A new chromatographic method of identifying synthetic detergents depends on changes of color produced on strips of filter paper from aqueous solutions of the detergents together with fluorescien, fuchsin, methyl blue, and 6B-blue for silk (Blandin & Desalme —*Bull. mens. ITERG 8,* 69). The succession of shades obtained with 20 different detergents is tabulated.

In investigations on analytical methods for anionic synthetic detergents Espector (*Color AITEA, Argentina, 1,* No. 8, *39*), suggested a modification of existing methods for sulfo group in sulfates and also developed a new method for determining alkylaryl sulfonates. The latter involves salting out the detergent from a 30% sulfuric acid solution and measuring its volume. Similarly, House & Darragh (*Anal. Chem. 26,* 1492) reviewed and investigated several analytical procedures and demonstrated the determination of low molecular weight aromatic sulfonates, by extraction with ether from acid solution and colorimetric analysis. An investigation on current methods for analysis of sulfonamide derivatives has indicated that: (a) common sulfonamides can be titrated with sodium methylate in the presence of dimethylformamide with thymol blue as the indicator, but stearic acid, if present, interferes; (b) a nitrite titration is preferred; (c) the 2-thiobarbituric acid method is satisfactory for sulfadiazine; and (d) sulfamerazine is determined spectrometrically correcting for sulfadiazine (Conroy—*J. Assoc. Off. Agr. Chemists 37,* 697).

The amount of many types of anionic detergents in washing solutions can be determined colorimetrically by means of their action on a protein-bromocresol purple complex (Loomeijer— *Anal. Chim. Acta 10,* 147). Within certain limits, the amount of free dye liberated from the complex is proportional to the amount of detergent present. Two methods for nonionic detergent solutions involve precipitation of detergent by phosphomolybdic acid and a subsequent absorptiometric determination (Stevenson—*Analyst 79,* 504). A two-phase solution of methylene blue in water and an anionic solution of methylene blue in chloroform, adjusted to equal color depth in both phases, show a deepening of color in water if a cationic agent is added and a lightening in water with an anionic agent (Weathburn— *Can. Textile J. 71,* No. 16, 45). The commercial nonionic, Lissapol, gives a clear red color when a trace of it is added to sulfuric acid (Stevenson—*Analyst 79,* 504). The test is sensitive to 10 γ of the detergent in 10 ml. of solution. In application of chromatography to nonionic detergents, the ethylene oxide polymers showed more definite R_f values than other compounds (Gallo—*Boll. chim. farm. 92,* 332). Small variations in the fatty acids of these cause large differences in readings. Chromatographic technique with columns of mixtures of Permutit and animal charcoal is recommended for analysis of detergent solutions and industrial waste water (Harker *et al.* —*Nature 173,* 634). The fatty acids can be eluted with ethanol, lanolin with trichloroethylene, and sodium cetyl sulfate with ethylene glycol.

In new reports on determination of contamination of milk with the quaternary ammonium dairy equipment detergents, determination as Reineckates was recommended (Wilson—*J. Assoc. Off. Agr. Chemists 37,* 374, 379), and it was pointed out that control tests are needed for determining the very small amounts which may be transferred to different food products after being absorbed on equipment during cleaning (Fogh *et al.*—*Anal. Chem. 26,* 392).

PHYSICAL CHARACTERISTICS. Rosevear (*J. Am. Oil Chemists' Soc. 31,* 628) illustrated with 35 photomicrographs how the microscope may be used to identify soap phases and phase mixtures. A study of the melting of sodium soaps by Ravich & Nechitailo (*Izvest. Sektora Fiz.-Khim., Anal. Akad. Nauk S.S.S.R. 23,* 314) was interpreted to indicate that among C_{12}-C_{18}

soaps, all except the laurate had six phases, plus a seventh which is isotropic liquid. The laurate had an additional phase. The potassium soaps differed from the sodium soaps in the number of phases and the transition temperatures.

A patented method for testing the solubility of bar soap involves immersing the sample in a bath of hard, still water in such a way that the precipitate cloud which forms as a result of such contact can be observed and measured (Toof—*U. S. 2,674,889*). Earlier observations that aromatic liquids added to nonionic detergent solutions cause separation of the solutions into two phases was extended to solutions of detergents made by condensing 16-18 molecules of ethylene oxide with one molecule of hexadecanol (Livingston—*J. Colloid Sci. 9*, 365). Neoprene or GR-S latexes stabilized with these detergents coagulate on contact with aqueous solutions of phenols. The solubility of sodium sulfonate of alkylbenzenes decreases with increasing size of the alkyl group; the solubility of a mixture of two of these detergents is less than the arithmetic mean value of the solubility of the individual detergents; and the addition of inorganic substances slightly reduces their solubility (Ogawa—*J. Chem. Soc. Japan, Ind. Chem. Sect. 55*, 527). Combinations of a hydrophilic and a lipophilic detergent in suitable proportions considerably increase the solubilization of water in nonpolar solvents over using only one detergent (Palit & Venkateswarln—*J. Chem. Soc. 1954*, 2129).

The conductivity of solutions of soaps and detergent solutions changes when stirred; the conductance parallel to the direction of flow is higher, and that of the perpendicular to the direction of flow lower than that of stationary liquid (Heckmann—*Naturwissenschaften 40*, 478). The equivalent conductance of soap solutions increases with increasing additions of hexanol and appears to reach a maximum (Heckmann—*Kolloid-Z. 136*, 67, 72). This behavior is related to stabilization of small ionic micelles.

The zinc, calcium, magnesium, potassium, sodium, and ammonium salts of lauryl alcohol sulfate were prepared and the cloud points of 10% solutions, viscosity, contact angles, wetting speed, and surface tension versus concentrations were recorded (Giers & Boido—*Soap & Chem. Specialties 30*, No. 8, 38).

Mica sheets roughened with glass paper were recommended for determining the surface tension of cationic detergent solutions, because the commonly used depolished platinum wires are "dewetted" by these agents (Paparoditis & Gustalla—*Compt. rend. 37*, 977). However, at certain concentrations which have been determined, the mica is imperfectly wetted and equipment with a wire band to measure the traction force must be used in this range. The surface tension lowering of potassium soaps of several unsaturated acids and their geometric isomers has been recorded (Kaufmann & Rackers—*Fette u. Seifen 55*, 497). There was a similarity between the optimum temperatures of surface tension lowering and the melting points of the fat corresponding to the fatty acid moiety of the soaps. Surface tension data was also recorded for sodium sulfonates of phenol alkyl esters and ethers (Goto & Mikumo—*J. Chem. Soc. Japan Ind. Chem. Sect. 55*, 387), for sodium palmitamide-*N*-methyl-sulfonate in combination with lye, soda ash, and hydrochloric acid, respectively (Yoshizaki—*Ibid. 56*, 85), for alkylbenzene sodium sulfonates with different chain lengths in the alkyl group, binary mixtures of these, and each as influenced by salt, acid, base, and *p*-cresol (Ogawa—*Ibid.* 191), for alkyl sulfates and dodecyl-pyridinium chloride as affected by electrolytes (Burcik—*J. Colloid Sci. 8*, 520) and for several detergents in presence of one percent of the various compounds commonly used as builders (Hendrick & Vleeschauwer—*Proc. 13th Intern. Dairy Congr. 3*, 891). The data are discussed with regard to structures which are most active, optimum temperatures for each, influence of builders, and detergency.

A new method for studying ionized surface layers made use of radioactive bismuth as the tracer and was demonstrated for sodium dodecylsulfate surface layers (Steiger & Aniansson—*J. Phys. Chem. 58*, 228). Similar technique was used to demonstrate that multilayers of counterion layers were absorbed on the surfaces of detergent solutions and that the electrolytes that might be present accumulated in the region adjacent to the surface in an amount proportional to the electrolyte concentration (Judson *et al.*—*Ibid. 57*, 916). A surface plasticity of sodium myristate solutions was attributed to hydrolysis products (Burcik *et al.*—*J. Colloid Sci. 9*, 281). When these solutions hydrolyze, the free acid formed associates, at least partially, with unhydrolyzed ions to form acid soap.

Gupta *et al.* (*Central Electrochem. Res. Inst., India, 1*, No. 2, 9; *J. Proc. Oil Technol. Assoc., India, 8*, 27), showed that the surface activities of detergents can be evaluated according to their effect on the capacity of a dropping mercury electrode. This method was demonstrated with sulfonated products of oils produced locally.

Interfacial tensions of aqueous sodium and potassium oleate solutions against low mole weight acetate esters show an increase with concentration followed by a decrease, whereas no maximums occur when the soaps are replaced by saponin (Kazi & Desai—*J. Indian Chem. Soc. 30*, 283). Baruël (*Acta Chem. Scand. 7*, 813) related the thermodynamics of interfaces to detergency in dish washing and discussed the application of Dupré adhesion work and the Young condition for equilibrium to a system of porcelain-oil-detergent or gas to calculate the work of adhesion.

Ooshika (*J. Colloid Sci. 9*, 254) suggested that the logarithm of the critical micelle concentration in detergent solutions is approximately a linear function of the number of carbon atoms of the chain, and that added alcohol molecules form a mixed micelle decreasing the logarithm of the critical micelle concentration in a ratio linearly with respect to the number of carbon atoms in the alcohol chain. He considered the Debye theory regarding micelles incorrect. In work by Granath (*Acta Chem. Scand. 7*, 297), detergent micelle calculations from sedimentation, diffusion and viscosity measurements are correlated with chain lengths and are shown to support Debye's view that the micelles are rod-shaped. A review by Hutchinson (*J. Colloid Sci. 9*, 191) of the published data on molecular weight determinations of detergent micelles by light scattering supported the thesis that the size of the micelle is unchanged by the addition of salt and that light-scattering data obtained in salt-free solutions gave information on micelle charge rather than micelle size. Data on specific volume, viscosity, and solubilization of dye for polyoxyethylene glycol fatty ether solutions indicate that micelle formation occurs at a concentration of 1×10^{-4} moles per liter for each one (Goto *et al. J. Chem. Soc. Japan, Pure Chem. Sect. 75*, 73). Work on the critical micelle concentration of binary mixtures of seven potassium soaps suggests that the results are the same when the difference in the number of carbon atoms between pairs of soaps are equal; but discrepancies observed when large differences occur in the number of carbon atoms in binary mixtures are attributed to incompleteness of the penetration of the longer soap molecules into layers of shorter soap micelles (Shinoda—*J. Phys. Chem. 58*, 541). The ability of alkali metal cations to decrease critical concentration of micelle formation of sodium dodecyl sulfate increases with decreasing size of the hydrated cation, but the decrease in critical concentration of the quaternary salts is greater the larger the cation (Goddard *et al.*—*Trans. Faraday Soc. 49*, 980).

In solutions of potassium laurate, added lauric acid up to concentrations of 25% relative to the soap increases the solubilization of benzene at a rate greater than does equimolecular increases of butanol (Spring & Howard—*J. Colloid Sci. 9*, 371). At higher ratios of lauric acid to soap a sharp reduction of benzene solubilization occurs. This change was interpreted as a change from spherical to a rodlike micellar structure. In similar work where the rheology of solutions of sodium phenyl stearate in benzene as affected by polar additives was studied, it was suggested that three structures are found: (a) long polymeric chains of anhydrous soap held together by ionic forces; (b) a small and relatively compact micelle that exists in the presence of a fraction of a mole of additive per mole of soap and (c) for water and glycol additions an extensive but loosely bonded structure forms through a bridging between small micelles by the excess of the bifunctional additives (Honig & Singleterry—*J. Phys. Chem. 58*, 201). Sol-gel transformation in soap-Nujol system was explained by a mechanism of gradual increase in the number and size of soap micelles, the solvation of the micelles with the dispersion medium which is a saturated solution of soap in solvent, and the fusion of the solvated micelles into fibrils which form a gel structure enclosing the remaining liquid (Deshpande—*J. Indian Chem. Soc. 30*, 545). Pilpel (*J. Colloid Sci. 9*, 285) explained gel formation by assuming that soap molecules are either in small, detached, spherical micelles or long, interlinked, cylindrical micelles. The observation that short chain alcohols add to the micelles decreasing their size and destroying gel elasticity is cited as agreeing with this theory. Sundaram (*J. Univ. Bombay 22*, Pt. 3, *No. 34A*, 15, 21) explained clouding and syneresis of soap gels after standing as due to structural changes,

the concentration of soap in the gel phase increasing as the shrinking proceeds.

Some new work was pertinent to the hypothesis of Booij regarding formation of elastic systems in soap solutions and on the coacervation of soap solutions by salts. Recent publications by Booij *et al.* (*Proc. Koninkl. Ned. Akad. Wetenschap. 56,* 255; *57B,* 215) contain data on the influence of pH and the chain length of aliphatic chains in detergents on the salt demanding action of the coacervates; the effect of *o*-cresol, ethers, thioethers, paraffins, halogenated anisole, and other compounds on an oleate coacervate; and a discussion of some of the observations as related to maximum germicidal action in these systems. A phenomena that occurs on increasing the potassium thiocyanate concentration in a cetyltrimethylammonium bromide solution was said to be the same in principle as those found on addition of salt to oleate solution, and is discussed as supporting Booij's hypothesis (deJong & Recourt —*Ibid. 56,* 442).

PERFORMANCE TESTING. Kaufmann *et al.* (*Fette u. Seifen 56,* 596) demonstrated a new instrument, "Vibrationfoamer" for determining foamability of washing agents, by which specific volume and weight of foam are measured. The instrument is demonstrated for determining the influence of temperature and chemical constitution on foamability. Another instrument designed for dishwashing compositions measures foam "build-up index," foaming capacity, and the stability of the foam to soil (Weeks *et al.*—*J. Am. Oil Chemists' Soc. 31,* 254). Maltepe (*Kimya ve Sanayi, Turkey No. 30,* 472) and Aenlle & Carro (*Congr. Luso-Espan. farm. 2,* 294) recorded the relation between height of foam developed in columns and the time for various soap solutions. Included in the data are the effects of different alkali moiety, and of presence of electrolytes and salts. Similar work with alkali salts of alkyl sulfate show that the ammonium compounds foam more than those of sodium, potassium, magnesium or calcium; and that additions of sodium alginate, agar-agar, polyvinyl alcohol and methylcellulose improve the foaming (Nakashima—*J. Chem. Soc. Japan, Ind. Chem. Sect. 56,* 611, 613). The antifoaming action of several low molecular weight alcohols was measured on solutions of many commercial detergents (*Villar—Bol. fac. ing. Montevideo 4,* 697). Sulfonated olive seed oil was fractionated into lightly and heavily sulfonated components by a technique of forming foam and separating it (Herrera & Garcia—*Grasas y aceites, Spain, 5,* 5). Constituents higher in fatty acids concentrate in the foam.

New suggestions have been made for rating detergency in washing tests. A new laboratory method was based on providing controlled mechanical agitation of chopped fibers in detergent liquors (Straw—*J. Soc. Dyers Colourists 70,* 228). Another method comprised soiling standard cloth with a standard fat, washing with the test detergent, and determining residual fat by the Soxhlet method (Approviggionamenti Ind. Lanieri Soc. azioni—*Ital. 470,344*). A radioactive soil for cloths used in detergency test contained C^{14}-labeled carbon soil (Lambert *et al.*—*Nucleonics 12,* No. 2, 40).

Detergency evaluation was studied in a home clothes washer (Ehrenkranz—*Soap, Sanit. Chemicals 30,* No. 2, 46). The results indicate that soil removal relative to the amount that could be removed is lower from swatches with lower initial reflectance, and it is pointed out that a homemaker is more concerned with getting fabrics with a grayish soil white than she is with getting fabrics with a black soil gray. An investigation in evaluating sea-water laundry detergents by laboratory wash tests (Bernstein & Sesson—*Ibid.* No. 1, 46) and a study of laboratory wash tests (Diehl & Crowe—*J. Am. Oil Chemists' Soc. 31,* 404) resulted in the conclusion that the tests are useful for "screening" purposes, but positive results must be confirmed by practical application.

The mechanism of detergent action was studied by von Stackelberg *et al.* (*Kolloid-Z. 135,* 67) by means of the rate of flow of a solution of the detergent through a plug of textile packed in a glass tube while under a potential difference and then calculating the zeta potential from the results. The effect of various detergents and salts at different concentrations on many commercial fibers is recorded. The effectiveness of the detergents in washing is attributed to electrostatic repulsion of like charges produced on fiber and on soil. In a discussion on physical chemical forces related to the role of whiteness in detergent action by Fond & Ward (*Textile Res. J. 24,* 881), ionic materials were said to influence whiteness retention on cotton through increase of electrostatic repulsion between fabric and soil, whereas nonionic additives act on the surface of carbon soil possibly through reduction in van der Waal's attraction between fabric and soil.

Detergency tests on many compounds have been recorded. A test on the sodium salts of α-sulfonated C_{12} to C_{16} saturated fatty acids indicated that detergency at 60° was best with the C_{14} to C_{18} compounds (Stirton *et al.*—*J. Am. Oil Chemists' Soc 31,* 13. The ammonium and triethanolamine salts of α-sulfopalmitic acid are more soluble and better detergents than the sodium salts. Detergency studies with polyethenoxy sitosterols (Karabinos & Ballum—*J. Am. Oil Chemists' Soc. 31,* 136), the polyethenoxy alkonates (Ballum *et al.*—*Ibid.* 20), and polyethenoxy aliphatic ethers (Karabinos *et al.*—*Ibid.* 419) indicated that optimum detergent value is attained when the ethenoxy units reach approximately two-thirds the number of carbon atoms in the hydrophobic portion. Introduction of the substituent either to the hydrophobic or hydrophilic portion of polyethenoxy tallates reduces their detergent capacities (Kapella *et al.*—*Ibid.* 392). In a study of the structure of detergents in relation to detergent action by Yoshizaki & Terashima (*J. Chem. Soc., Japan, Ind. Chem. Sect. 55,* 350, 352, 445), the relative efficiencies of (*a*) sodium cetyl sulfonate, (*b*) sodium cetyl sulfate, and (*c*) sodium palmitate for cotton soiled with wool grease is $c > a > b$; soiled with fatty acids $a > b > c$; and with kerosene $b > a > c$. Their work with various fatty acid amide *N*-methyl sulfonate indicates that excellent detergent action is found with the C_{17} compound. Ogawa's (*Technol. Repts. Osaka Univ. 3,* 183) similar work with sodium alkyl benzene sulfonates correlates structure of the alkyl group with solubility, surface tension, and detergency. In tests on washing wool with various detergents there was little difference in defatting action between neutral and weakly acid detergent solutions, and both were recommended for removal of mineral oil and triglycerides, but for removal of fatty acids an alkaline bath should be used (Siegmund—*Textil-Praxis 8,* 500).

Many detergent additives were studied. The building effect of calgon B, potassium polyphosphate, sodium tripolyphosphate, and sodium pyrophosphate with six synthetic detergents decreased in the same order as listed (Stüpel—*Fette u. Seifen 56,* 209). Reduction of water hardness by sodium pyrophosphate in detergent solutions is greater than with calcined forms of sodium pyrophosphate (Zilske—*Seifen-Öle-Fette-Wachse 80,* 434). Laundering experiments have shown that the same phosphate will not act the same with every type of surface-active agent (Uhl—*Fette u. Seifen 55,* 109).

Stüpel & Rohrer (*Fette u. Seifen 56,* 588) explain the action of the detergent additive carboxymethylcellulose by a soil-carboxymethylcellulose-absorption mechanism, thus preventing adsorption or resorption of soil on textile cellulose. Nieuwenhuis (*J. Polymer Sci. 12,* 237), however, suggested that it is absorbed on the fibers of the fabrics and in this way prevents redeposition of the soil on the fabric. His suggestions for best actions are that the degree of substitution in carboxymethylcellulose should be about 0.5, the substitution should be uniform as possible, and the cellulose chains should be neither too short nor too long. Carboxymethylcellulose was said to afford some protection against the tendency of inorganic salts inducing redeposition of soil when present in detergent solutions (Vitale —*J. Am. Oil Chemists' Soc. 31,* 341). Tests in detergent solutions show that the effect of carboxymethylcellulose decreases as the pH is increased; most effective amount of the compound is about 160 mg. per 500 ml. of solution; and with increasing amounts of an anionic detergent and 40 mg. per 500 ml. of solution, detergency increased up to 2 ml. of the detergent per 500 ml. of solution and then decreased with higher concentrations (Karabinos & Kapella—*Soap & Chem. Specialties 30,* No. 12, 48).

A performance test for dishwashing compounds involved washing glass plates soiled by lard containing 4.5% peanut oil fatty acids and colored with 0.5% nigrosin (Baumgartner—*Seifen-Öle-Fette-Wachse 79,* 488, 514, 540, 568, 597, 622, 645). The test was demonstrated by evaluating some synthetic detergents and the effect of builders with these. Similar work was recorded using a test based on the cleaning action on glass slides which had been dipped in milk (Mead & Pascoe—*Australian J. Dairy Technol. 7,* 114). A method of evaluation of dairy cleaners was based on cleaning stainless-steel strips coated with synthetic milkstone (McGregor *et al.*— *J. Milk and Food Technol. 17,* 136). The test demonstrated that the addition of hypochlorite to dairy cleaning compounds increases cleaning efficiency. A cleaning test, which was based on removing synthetic greasy compositions containing C^{14} carbon black, demonstrated that diphase compositions cleaned metal

plates more quickly than did emulsion cleaners (Osipow *et al.*—*Ind. Eng. Chem. 45,* 2779).

For some use, the germicidal action of detergents is an important property in evaluation of the product. In tests evaluating the skin sanitizing action of soaps containing bis (3,5,6-trichloro-2-hydroxyphenyl)-methane, bis (3,5-chloro-2-hydroxyphenyl)-methane, sodium pentachlorophenate, zinc dimethyldithiocarbamate, and bis (3,5-dichloro-2-hydroxyphenyl)-sulfide, the latter was most effective, dropping bacterial counts to 6-19% that originally present (Quinn *et al.*—*Appl. Microbiol. 2,* 202). Subjective tests were designed to evaluate the relative effectiveness of test soaps for reducing body odors and were used to compare soap containing hexachlorophene with a bland control (Gee & Seidenberg—*Soap & Chem. Specialties 30,* No. 8, 42). A method for evaluating bactericidal action of dish cleaning compounds dealt principally with artificially contaminating the dishes with *Micrococcus pyogenes* and with *Bacillus subtilis* and recovery of residual organism after washing in the test solution (Guiteras *et al.*—*Ibid. 2,* 100). The bactericidal activity of fatty acids has been explained by a mechanism in which bacteria are considered to be suffocated by a coating of fatty groups; while, with rancid fat bacterial activity was associated with development of pelargonic acid by oxidative degradation of oleates (Karabinos & Ferlin—*J. Am. Oil Chemists' Soc. 31,* 228; *Soap & Chem. Specialties 30,* No. 8, 46). The bacterial agent in polyethenoxy tallate ozonide was also identified as pelargonic acid (Ferlin *et al.*—*J. Am. Oil Chemists' Soc. 31,* 103). The sanitizing action of benzalkonium chloride cleaning agent was not adversely affected by hard water of 450 p.p.m. or less hardness, by iron in concentrations of five p.p.m., or by aluminum in five p.p.m. concentrations (Klimek & Bailey—*Soap & Chem. Specialties 30,* No. 7, 129). The relations of chain length of the alkyl groups and halide substituent to bacteriostatic activity of pyridinum, nicotinium, quinolinin, and isoquinolinin salts were determined (Nishihara—*J. Biochem., Japan 40,* 579). The phenol coefficients, bactericidal and fungicidal activity, and effectiveness for control of algae and slime in fresh water cooling systems were determined for some quaternary ammonium compounds made from dodecylbenzene (Darragh & Stayner—*Ind. Eng. Chem. 46,* 254). (Dodecylbenzyl) trimethylammonium chloride effectively prevented slime and algae in fresh water, and their effectiveness was not lessened by hard water salts in concentrations as high as 1500 p.p.m. but was limited by excessive concentration of sodium chromate, hydrogen sulfide, protein, or anionic organic compounds. Venturi (*Boll. ist. sieroterap., Milan 33,* 203) found such compounds active bacteriostats for tubercle bacteria in some test media but inactive in sputum. Many of these types of compounds made from pyridine and its homologs were found to be very active against gram-negative and gram-positive bacteria, and this activity was increased with the copresence of penicillin or sulfamines (Ito —*J. Japan Tar. Ind. Assoc. 6,* 192). Many quaternary ammonium salts containing sulfur or sulfur and bromine were prepared for use as fungicidal cleaners, and their effectiveness was evaluated against spores of *Gibberalla fujikuroi* (Yomamoto & Udagawa—*J. Agr. Soc. Japan 26,* 589). Similarly the disinfective actions of many *N*-oxides and *N,N'*-dioxides of long-chain tertiary amines were recorded (Jerchel & Jung—*Chem. Ber. 85,* 1130).

In tests with 49 cationic detergents, the growth of *Mycobacterium tuberculosis* has been found to be dependent upon the surface tension of solutions of the compounds (Nishihara—*J. Biochem., Japan 40,* 589). A surface tension of 54-57 dynes per cm. completely inhibited growth. The growth of the same organism is supported by polyoxyethylene fatty acid esters (Millberger *et al.*—*Z. Hyg. Infektionskrankh. 139,* 285). These compounds also hinder the bactericidal activity of quaternary ammonium bases (Schoog—*Die Medizinische 1953,* 1557). Sodium lauryl sulfate greatly increases the fungal-growth inhibition of several chemical fungicides (Shiba—*J. Fermentation, Japan 31,* 365). Detergents were said to improve the antibiotic action of pencillin by increasing the penetrating ability of penicillin into the protoplasm of bacteria (Kastorskaya & Pasynskii—*Doklady Akad. Nauk S.S.S.R. 73,* 393).

Commercial detergents inhibit the activity of many enzymes, but this action can be modified or abolished by adjustment in pH or by the use of many chemicals (Wills—*Biochem. J. 57,* 109). Results from similar investigations on invertase were interpreted to suggest that the detergent forms complexes with the enzyme thus reducing enzyme activity (Saraswat—*Proc. Indian Akad. Sci. 38A,* 220).

The investigations on the hemolytic action of detergents have indicated that the hemolytic and bactericidal effects are parallel (Breusch *et al.*—*Hoppe-Seylers' Z. physiol. Chem. 286,* 148, 159; *291,* 1).

The agglutination reaction of BCG is inhibited by detergents having $-OSO_3H$ groups; this activity increases with the number of carbon atoms of the alkyl radical (Yamamoto—*Kekkaku 28,* 268).

The corrosiveness of many commercial detergents and detergent additives has been determined with regard to formulation of milk can cleaners (de Vleeschauwer *et al.*—*Medel. Landbouwhogeschool Opzoekings stas. Staat Gent. 18,* 544). Silicates and metaphosphates were satisfactory for aluminum, and all except sodium hydroxide for tinned iron. All synthetic organic detergents were lower in corrosibility than a standard limit set for this use. Hypochlorite was more corrosive on aluminum and tinned iron than some quaternary ammonium disinfectants. From similar work on many metals it was found that the synthetic detergents containing sodium sulfate were corrosive, but that this action of the salt is depressed by sodium carbonate or sodium phosphate (Mikumo & Kusano—*Res. Repts. Nagoya Ind. Sci. Res. Inst. No. 6,* 33).

The problem of irritation and dermatitis due to household cleaners was discussed from the standpoint of some detergents being the cause in certain cases, but many other known irritants may be contributing factors, for example, ammonia water, hypochlorite bleaches, phosphates, abrasive powders, and organic solvents in waxes and polishes (Brunner—*J. Am. Med. Assoc. 154,* 894).

The pharmacology of detergents was studied. Oral, intraperitoneal, intravenous, and chronic toxicities have been published for "Hyamine 1622" and "Hyamine 2389" (Finnegan & Dienna—*Soap, Sanit. Chemicals 30,* No. 2, 147). Data on the acute and chronic toxicities of 13 commercial quaternary ammonium detergents have been tabulated (Lehmann — *Assoc. Food, Drug Off. Quarterly Bull. 18,* 43). In a comparison of anticholinergic activity of aliphatic *tris* quaternary ammonium compounds, a nonane derivative was five times as active as gallamine (Kensler *et al.*—*J. Pharm. & Explt. Therapeutics 112,* 210). In this work *tris* onium compounds of 5-10 carbon atoms between the onium groups were investigated. A study of the fate of labeled sulfur 35 of arysulfic acid following administration to the rat show that 4-12% was excreted in the urine and six percent in the feces in 96 hours (Hawkins & Young—*Biochem. J. 56,* 166). Embryonation of washed horse strongyle eggs and larvae in water was prevented by addition of 0.05% of sodium sulfate of 3,9-diethyl-6-tridecanol, 0.6% of sodium sulfate of 7-ethyl-2-methyl-4-undecanol, or 1.5% of the sodium sulfate of 2-ethylhexanol (Levine & Ivens—*J. Parasitol. 40,* 419).

Soap solutions were used in analytical work. Serum proteins can be determined by titration with invert soap solution (Ott & Baecker—*Die Medizinische 1953,* 1614). Methods of using chelating agents as reagents in titrimetric analysis were demonstrated (Martell & Chaberek—*Anal. Chem. 26,* 1692). Maron & Elder (*J. Colloid Sci. 9,* 263) developed a procedure for applying the soap titration for determining particle size and specific area of synthetic latices to handle latex samples whose soap contents exceed the critical micelle concentration.

Physical concepts considered to be involved in coacervates between gelatin and detergents of the alkyl sulfate were used to explain the effects of UO_2^{++}-detergent and Mg^{++}-detergent mixtures on the fermentation of sugar by yeasts (Booij—*Kolloid-Z. 136,* 16).

Novel uses for soap were described. Akune & Koga (*Bull. Fac. Agr. Kagoshima Univ. No. 1,* 72) demonstrated the use of alkylbene sulfonate-type detergents for the degumming of silk. The use of the homologous series of alkylpyridium bromides of alkyl groups from C_5 to C_{16} in very small quantities catalytically accelerates the $S\text{-}SO^{--}$ reaction in the manufacture of sodium thiosulfite (Levenson — *J. Appl. Chem., London 4,* 13). A centrifugal method was designed to evaluate the efficiencies with which aqueous solutions of detergents displace petroleum from sand surfaces. It has been used to evaluate many commercial polyoxyethylated detergents for this purpose (Dunning *et al.*—*Producers Monthly 18,* No. 1, 24; *Oil Gas J. 53,* No. 15, 139, 142, 146, 149). The commercial detergent, Roccal, increases the rate of action of α-amylase on raw corn starch (Gates & Sandstedt—*Science 116,* 482). This observation suggests a possible explanation of the faster growth of chicks, rats and pigs when detergents are added to the ration. A stimulation in growth of chicks by adding detergents to

rations was observed in three investigations (Ney & Newell—*Poultry Sci. 33*, 297; March *et al.*—*Ibid.* 300; Balloun—*Ibid.* 1041), whereas in another investigation six synthetic detergents and one soap failed to give an increased growth response over the control (Branion & Hill—*Ibid.* 62). Detergents do not improve digestibility of feed nutrients by steers (Lassiter *et al.*—*J. Animal Sci. 13*, 991). In superphosphate manufacture, detergents tend to accelerate the primary reaction between phosphate rock and sulfuric acid but had no significant effect on the extent of the over-all reaction in a period of one to 24 hours after mixing (Fox *et al.*—*J. Agr. Food Chem. 2*, 618). In another report the over-all experience of using detergents in factory production of superphosphate mixed fertilizer is related (Fox *et al.*—*Farm Chemicals 117*, No. 9, 43).

An Instrumental Method for Measuring the Degree of Reversion and Rancidity of Edible Oils[1, 2]

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THE EVALUATION of an edible oil or fat by organoleptic means has served as a very useful method for measuring its degree of flavor reversion and rancidity. However the selection, training, and maintenance of an elaborate testing panel is time-consuming and expensive. Further, comparatively small laboratories may lack qualified personnel to serve as panel members, or the qualified personnel may be too close to the research program to render a completely unbiased opinion. Therefore it would seem desirable to have available an instrumental method to collect data which could be correlated with those obtained by organoleptic means.

The phenylhydrazone derivatives of the carbonyl compounds which developed in rancid oils have been used as a means of estimating their degree of rancidity (1). However no satisfactory method of general acceptance based on carbonyl compounds has been developed because of two main difficulties. First, oils and fats often contain components which are not responsible for the odor and flavor of the oil or fat but may either interfere or respond to the test. Second, an accurate method for the quantitative measurement of the micro amounts of hydrazones formed had not been developed until recently.

In the present method these difficulties were overcome by removing the volatile carbonyl compounds from the oil with the aid of a stream of nitrogen and collecting them in a cold trap cooled with solid carbon dioxide. The amount of carbonyl compounds condensed in the cold trap was determined by the procedure of Lappin and Clark (2). Carbonyl compounds could be quantitatively determined to a concentration as low as 5 x 10^{-6} molar. The results obtained by this method were correlated with the scores given to the oil or fat by an experienced testing panel.

Experimental

Analytical Procedure. The specifications for the apparatus are shown in Figure 1. A 38-mm. diameter tube was suspended in an oil bath which was kept at 80 ± 0.2°C. by means of a Fenwal thermoswitch control unit and a knife-type of immersion heater. The cold trap, made of a 20-mm. diameter tube, was suspended in a Dewar flask. A Cenco orifice-type Pyrex glass gas flowmeter, calibrated with the aid of a gas burette, was connected to outlet C. The capillary tip B was made by heating a 7-mm. (inside diameter) tube in a flame and allowing it to shrink evenly to 0.5 mm. (inside diameter) and 4.0 mm. in length.

High purity dry nitrogen was passed through the apparatus from A through B to C at a rate of 84 ml. per minute at room temperature for 15 min. to displace air and to remove any trace of solvent in the apparatus. The rate of nitrogen flow was regulated by means of a Hoke metering valve (No. 2RB285), which was connected to a gas reducing valve set at 5 p.s.i. The Dewar flask was then filled with finely powdered solid carbon dioxide. Next 101 g. of an oil or fat were weighed into a 250-ml. beaker, which contained a clean 8-cm. glass funnel. The tempera-

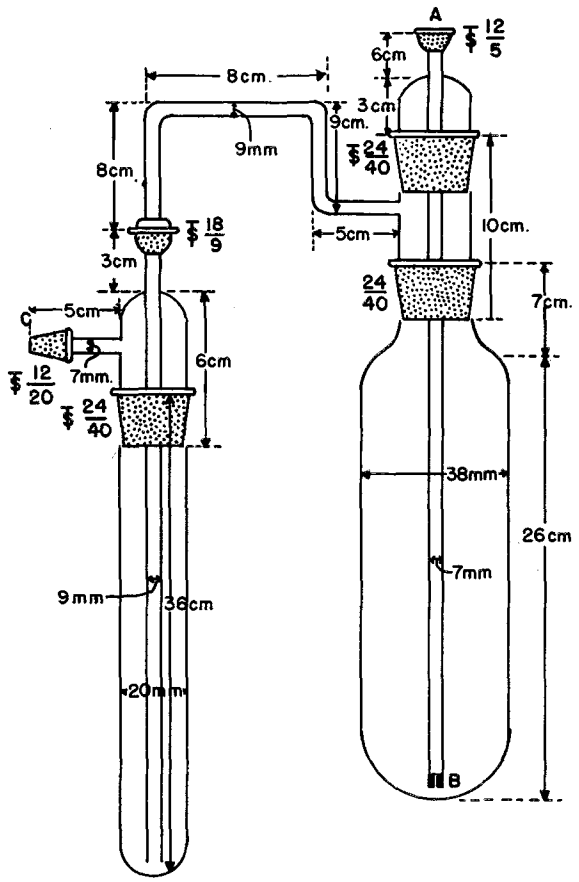

FIG. 1. Apparatus for the determination of carbonyl index.

[1] Funds for this study were furnished by a grant-in-aid from Swift and Company, Chicago, Ill.
[2] Presented at the American Oil Chemists' Society meeting, Minneapolis, Minn., Oct. 11-14, 1954.
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