non-conjugated methyl docosahexanoates (Fukuzumi and Wakita, *Ibid. 66,* 1846). Finally, methyl docosahexanoate hydroperoxides were isolated and characterized (Fukuzumi et al., *Ibid. 66,* 1675).

ANTIOXIDANTS

The antioxidants and their importance in the preservation of dietary fats were discussed (Adamo, *Quaderni Merceol. 1* (1) 15) (Gerchuk, *Sb. Nauchn. Tr. Kooperat. Inst. po Vopr. Tovaroved i Organiz. Tekhn.,* (Moscow) *1963,* 3) (Paoletti et al., *Atti Acad. Med. Lombarda, Suppl. 17,* 700) (O'Neill, *Rept. Progr. Appl. Chem. 47,* 171). The group of phenolic antioxidants received considerable attention. The effect of various concentrations of four of them on the stability of lard was investigated. Maximum stability was attained with 1.5% cyclohexylphenol. All the phenolic antioxidants tested had lower activity than either tocopherol or gallates (Pokorný and Vašáková, *J. Inst. Chem. Tech.* (Prague) *5* (3) 11). In other experiments, catechol derivatives were demonstrated to be equal or better stabilizers than phenolic hydroquinol and pyrogallol derivatives (Pokorný et al., *Ibid. 5* (3) 173). The addition of Cu shortened the induction period in mixtures of phenolic antioxidants and fats (Janíček et al., *Z. Lebensm.-Untersuch.-Forsch 124,* (1) 17).

The synthesis and properties of BHA were described (Daniewski et al., *Tludszcze i Srodki Piorace 7* (6) 338). Dried fish were dipped in emulsions of BHA or BHT, surface active agents, and vegetable oil. BHA was more active than BHT in keeping fish from deterioration (Toyama and Saruya, *Nippon Suisan Gakkaishi 28,* 1020). The reverse was true in salted fish (Toyama and Saruya, *Ibid. 29,* 675). A BHT preparation containing also sorbitol, Span 20 and sucrose monostearate was superior to ordinary solid BHT preparations (*Ibid. 870*). Mixtures of BHA and Na erithorbate were effective in preventing the alteration of salted salmon (Ando et al., *Ibid. 28,* 823).

The preservation by BHA, BHT, and gallates was compared in several substrates. In suet, propyl gallate and BHT were better than BHA. In general, mixtures of antioxidants seemed to preserve better than an antioxidant alone (Tollenaar, *Proc. Pacific Sci. Cong., Pacific Sci. Assoc., 9th,* Bangkok, Thailand, 1957, *5,* 92 (Pub. 1963)). Mixtures of equal parts of propyl gallate and BHA and of propyl gallate and dibutylhydroxytoluene were effective in the preservation of ethyl oleate (Alemany-Verdaguer and del Pozo, *Galenica Acta* (Madrid) *16* (2) 109). Among several antioxidants tested, gallic acid esters were the best in preserving thermally treated fats (Waginaire, *Gattefosse- SFPA Bull. Tech. 1963* (60) 51) and goose fat (Rutkowski et al., *Zeszyty Nauk. Wyzszej Szkoly Rolniczej-Olsztynie 13* (3) 387). Color reversion of tallow could be best prevented by BHA, BHT or hydroquinone (Yamajako and Loury, *Rev. Franç. Corps Gras 10,* 513).

Several other antioxidants were investigated. Polyphosphates were tested in the preservation of frozen cod (Dyer et al., *J. Fisheries Res. Board Canada 21* (1) 101); wild rose hips in lard (Koeppe et al., *Med. Weterynar.* (Poland) *20* (3) 154); ascorbyl palmitate in cold stored butter (Koops, *Neth. Milk Dairy J. 18,* 38); tea leaf extracts or powder in cookies, mayonnaise, French dressing, and lard (Kihara and Inoue, *Kaseigaku Zasshi 15* (2) 67); sorbic acid and sorbates in margarine (Rutkowski and Holczak, *J. Inst. Chem. Tech.* (Prague) *5* (3) 129) (Stepanova et al., *Maslob. Zhir. Prom. 30* (3) 20). Phosphatides had protective action of the vitamin A in cottonseed oil used in cooking practices (Ismailov, *Tr. 2-oi (Vtoroi) Nauchn. Konf. po Vopr. Probl. Zhira v Pitanii, Leningrad 1962,* 366). Antioxidants were formed in lard during rendering at 110–120C (Rutkowski and Korzeniowski, *Roczniki Technol. Chem. Zywnosci 9,* 69). Tempeh powder was effective against oxidative deterioration (Ota et al., *Shokuryo Kenkyusho Kenkyu Hokoku 18,* 67). Other substances whose antioxidant properties were demonstrated were: flavone aglycones from vegetable extracts (György et al., *Nature 203* (4947) 870) and alkylated dihydroxynaphthalenes (Taeufel and Maune, *Fette Seifen Anstrichmittel, 66,* 260). The structure of two antioxidants isolated from oats was determined (Daniels and Martin, *Chem. Ind.* (London) *1964,* 2058).

Vitamin E at 0.05% was shown to retard rancidity in bottled olive oil (Fahmi and El Said, *Agr. Res. Rev.* (Cairo) *40* (3) 154). Mixtures (1:1) of olive oil and soybean oil were stored at 30C for 14 months with or without antioxidants. The oils containing antioxidants showed better keeping quality (Gutierrez, *Grasas y Aceites 15,* 249). The addition of soybean meal to waste and low quality fats improved their keeping quality (Pokorný et al., *J. Inst. Chem. Tech.* (Prague) 7 (1) 103). Alpha-tocopherol and ascorbic acid were ineffective in maintaining the oxidative stability of cereals (Anderson et al., *Food Technol. 17,* 1587).

Several substances usually grouped as antioxidants could act as pro-oxidants if the necessary conditions were provided. Propyl gallate, for example, enhanced the rate of initial oxidation of soybean or rapeseed oils if added to a concentration of 0.6% or higher (Pietrzyk, *Roczniki Technol. Chem. Zywnosci 9,* 29). Other so-called antioxidants showed similar effects (Pietrzyk, *Ibid. 9,* 81). Some pro-oxygenic properties were also detected in tocopherol (Dubois, *Ann. Technol. Agr. 13* (2) 97) (*Ibid.* 105). Carbonyl compounds of the type produced in browning degradation of sugars were also pro-oxidants (Anderson and Huntley, *JAOCS 41* (10) 686). Addition of dried algae reduced the stability of fats when they were stored in daylight (Pokorný et al., *J. Inst. Chem. Tech.* (Prague) *5* (3) 153).

Several chromatographic techniques were used for the qualitative and quantitative determination of a wide variety of antioxidants. Most numerous were quantitative thin-layer chromatography methods (Amano et al., *Shokuhin Eiseigaku Zasshi 5,* 333) (Rutkowski et al., *Roczniki Panstwowego Zakladu Hig. 14* (4) 361) (Sahasrabudhe, *J. Assoc. Off. Agric. Chem. 47* (5) 888) and qualitative (Ishikawa and Katsui, *Bitamin* (Japan) *30* (3) 203) (Jonas, *J. Pharm. Belg. 17* (3–4) 103) (Slonaker and Sievers, *Anal. Chem. 36,* 1130). GLC was also used (Choy et al., *J. Chromatog. 12,* 171) (Schweeke and Nelson, *J. Agr. Food Chem. 12* (1) 86) (Takahashi, *J. Assoc. Offic. Agr. Chemists 47* (2) 367), as well as paper chromatography (Sedlacek, *Fette Seifen Anstrichmittel 65,* 915) or chromatography on alumina followed by a fluorometric assay (Brueggemann and Zentz, *Z. Tierphysiol., Tierernaehr. Futtermittelk 18* (2) 99).

Non-chromatographic procedures were based on colorimetry (Nakamura et al., *Bunseki Kagaku 13* (1) 3) (Khomutov and Kulakovskaya, *Maslob.-Zhir. Prom. 30* (1) 12), fluorometry (Gordon et al., *J. Assoc. Offic. Agr. Chemists 47* (3) 516), measurement of methyl linoleate from oxidation (Quencer et al., *JAOCS 41* (10) 650) and titration with 2,4,6-tri-*tert*-butylphenoxy radicals (Paris et al., *Anal. Chem. 36* (7) 1332).

The Annual Review of Literature will be continued in November

New Shell Chemical Plant

Shell Chemical Co. recently broke ground for a $24.4 million plant at Geismar, La., in the New Orleans industrial complex.

C. W. Humphreys, company president, said that products of the plant, scheduled to go into operation in late 1966, will include: (1) ethylene oxide derivatives for further processing into plastics, textile chemicals, antifreeze and solvents, and (2) primary-range detergent alcohols, produced for manufacturers of household detergents and such industrial products as lubricating additives, cleaning compounds, emulsifiers and wetting agents.

The Geismar plant is the third in a new multi-million dollar complex the company is developing along the Gulf Coast. Other units in the complex are at Norco and Houston, Texas.