EFFECT OF ANTIOXIDANTS ON STABILITY OF SUNFOLWER OIL UNDER DIFFERENT STORAGE CONDITIONS

M. A. WARAICH AND AMJAD ALI*

Effect of antioxidants on the stability of sunflower oil under different conditions of storage was investigated. The addition of NDGA and propyl gallate to sunflower oil stored under different storage conditions for 75 days, retarded the development of peroxides to a significant degree. Effect of light and high temperature was quite proxygenic and greatly accelerated the development of peroxides in all cases. Antioxygenic activity of NDGA was comparatively more as that of propyl gallate.

INTRODUCTION

Pakistan, like other developing countries, needs to increase its supply of edible oils. The present consumption of edible oils in Pakistan is less than 1/3rd of the standard recommended for healthy growth (Anon., 1966). In order to meet the ever increasing demand of edible oils, it is not only important to increase the yield of present oilseed crops, but also to introduce some new and more economical crops. For instance, the chances of sunflower as an economic oil bearing crop are very bright, as it offers great promise to reduce the demand and supply gap. It contains 40-50 per cent oil and 30-40 per cent meal comprising, about 40 per cent protein. Because of a well balanced amino acid make-up, the sunflower meal makes an excellent concentrate feed for livestock.

Sunflower oil like other foods is subject to deterioration commonly known as rancidity. Due to serious economic losses of fats and oils or products containing them, it requires the attention of chemists and technologists for improving the storage life of fats towards deterioration.

REVIEW OF LITERATURE

The term rancidity which refers to chief form of fat deterioration is not specific one and is used to denote that stage when the fats and oils develop undesirable flavour and odour as a result of series of chemical reactions chiefly between atmospheric oxygen and triglycerides of neutral fat. The rate of deterioration is not only affected by oxygen available and the chemical nature of fat, but also depends upon moisutre (humidity), temperature, metallic contamination,

*Department of Food Technology, Faculty of Agricultural Engineering and Technology, West Pakistan Agricultural University, Lyallpur.

light and presence or absence of naturally occurring substances that accelerate or retard the development of rancidity.

Lewkowitsch (1940) stated that light, air and moisture influenced separately as well as jointly and varied in marked degree with chemical composition of fat. Kerr (1921) after a series of tests concluded that under no conditions of tests the rancidity occurred in the absence of oxygen. Henry (1915) suggested to keep fat as free as possible from moisture, shield from light with minimum contact with air in order to prevent rancidity. Lundberg (1962) showed that light catalysed the decomposition, and hence fats exposed to oxygen in the presence of light became rancid more quickly than in darkness. Ali and Tremazi (1968) found that light and temperature both catalysed the peroxide formation in vegetable oils.

Most of natural fats (particularly of vegetable origin) contain minor onstituents termed as antioxidants—present naturally or addition permitted by law—that retard the development of rancidity. Common vegetable oils contain appreciable amount of tocopherol to protect it from deterioration. The addition of tocopherols to such oils is not recommended since it loses its effectiveness at higher concentrations. In such cases the use of NDGA and propyl gallate is recommended (Lundberg, 1962). Stuckey (1959) found that propyl gallate and other antioxidants (BHA and BHT) quite effectively stabilized animal fats to a greater extent and vegetable oils to a lesser extent. Contutin *et al.* (1969) studied antioxygenic activity of BHA and gallates with and without citric acid for protection of sunflower oil against rancidity. The results indicated that all the antioxidants gave a superior stable oil as compared to untreated oil and that combination of antioxidants with citric acid was more effective than used alone. Segal (1971) studied the effect of natural and synthetic antioxidants on the degradation of sunflower oil heated to 180°F. He found that the heating affected the antioxygenic qualities of all the antioxidants used. Tappel *et al.* (1953) found NDGA to be the best of several antioxidants for inhibiting the oxidation of sodium linoleate by lipoxidase.

A variety of tests, both qualitative and quantitative, are available to follow the course of autoxidation or ranciditification of fats and oils. Out of the quantitative methods the peroxide value as outlined by Wheeler (1940) is considered to be an excellent indicator of the degree of the reaction. Ali and Termazi (1968) and Naqvi (1967) used the peroxide value as an index of relative stabilities of fats and oils under tests.

MATERIAL AND METHOD

Commercially available sunflower was purchased from the local market and analysed for various physico-chemical constants to establish its quality.

NDGA and Propyl gallate were then added to the characterised oil in the concentration of 0.1, 0.05 and 0.01 per cent. Each lot of the treated oil was then stored in light at room temperature, at 85°C., and in dark at room temperature.

The samples were analysed for peroxide value at two weeks interval. The methods of analysis used were as outlined in AOCS (1950). These tests were carried out during winter 1971.

RESULTS AND DISCUSSION

The sunflower oil purchased from the local market when subjected to quality characterization was found to be normal (Table 1). The oil after establishing its quality was then studied for its stability under different storage conditions with and without added antioxidants.

The stability of raw untreated oil (without added antioxidants) was much affected by storage conditions as is indicated in Fig. 1. High temperature

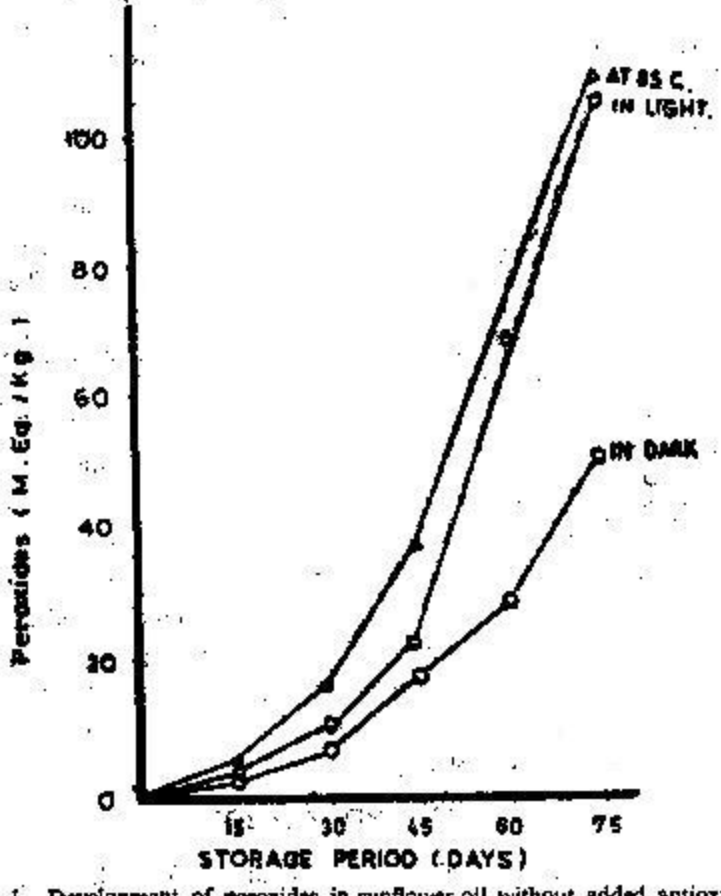

Fig. 1. Development of peroxides in sunflower oil without added antioxidants under different storage conditions.

TABLE 1. *Physico-chemical constants of sunflower oil in its raw condition.*

Specific Gravity	0.919	Refractive Index	1.474
Acid Value	2.300	Saponification Value	188.00
Iodine Value	131.000	Peroxide Value	0.120

TABLE 2. *Development of peroxides (M. Eq./Kg) in sunflower oil with and without antioxidants under different storage conditions*

Treatment	Storage Period (days)					
	0	15	30	45	60	75
			STORED IN LIGHT			
Control	0.12	3.21	10.08	22.57	68.73	105.63
0.10% NDGA	0.12	3.21	6.98	10.81	28.66	56.28
0.05% NDGA	0.12	2.98	6.48	10.48	26.29	50.56
0.01% NDGA	0.12	3.00	6.66	11.43	30.86	59.28
0.10% P. gallate	0.12	2.85	4.80	12.82	32.00	72.56
0.05% P. gallate	0.12	2.85	4.56	10.46	30.35	69.22
0.01% P. gallate	0.12	2.85	4.98	13.65	33.33	75.29
			STORED AT 85 C			
Control	0.12	5.22	16.34	38.52	82.36	112.38
0.10% NDGA	0.12	4.63	12.39	30.76	65.48	88.85
0.05% NDGA	0.12	4.53	11.80	28.42	60.13	80.80
0.01% NDGA	0.12	4.53	12.34	29.68	62.35	83.21
0.10% P. gallate	0.12	4.89	15.37	33.43	70.93	92.62
0.05% P. gallate	0.12	4.44	14.34	32.42	69.47	91.63
0.01% P gallate	0.12	4.76	15.30	34.44	72.17	94.87
			STORED IN DARK			
Control	0.12	2.21	6.48	16.98	28.43	50.83
0.01% NDGA	0.12	2.11	4.69	12.66	19.37	42.53
0.05% NDGA	0.12	2.00	4.36	12.12	18.63	40.53
0.01% NDGA	0.12	2.00	4.11	12.30	17.38	38.23
0.10% P. gallate	0.12	2.33	5.60	15.56	24.22	46.23
0.05% P. gallate	0.12	1.99	5.00	14.82	22.28	45.66
0.01% P. gallate	0.12	2.00	5.37	14.23	21.87	42.28

catalyzed the peroxides (M. Eq./Kg. of oil) development to the maximum, while light did the same but to a lesser degree throughout the storage period of 75 days. The difference is, however, obviously significant. The samples stored in laboratory shelves in dark had the minimum development of peroxides, *i.e.*, 50.83 at the end of test period as compared to those stored in light (105.63) and at high temperature (112.38). This indicates that oil when stored at low temperature and protected from light can keep well for a longer period without any deterioration.

Table 2 shows the peroxides developed in oil samples treated with NDGA and propyl gallate under different storage conditions. Light and temperature likewise affected the antioxygenic activity of antioxidants under test. Such adverse effect of heating on antioxygenic qualities of synthetic antoxidants in sunflower oil has also been reported by Segal (1971). NDGA at all concentrations retarded the development of peroxides to a greater extent than propyl gallate in oil exposed to light. The most effective concentration of NDGA was 0.05 per cent in samples stored in light and at high temperature while for the samples protected from, light 0.01 per cent NDGA was most effective. The differences were obviously significant. Both the antioxidants stabilized the oil at all concentrations and under all storage conditions. Comparatively NDGA was more effective than propyl gallate in retarding the on-set of rancidity. Such effectiveness of NDGA over other antioxidants has also been established by Tappel *et al.* (1953) in lipoxidase catalysed oxidation of sodium linoleate. The propyl gallate is preferred only for its low cost and high solubility. Like NDGA, propyl gallate was more effective at 0.05 per cent concentration level in samples stored in light and at high temperature and at 0.01 per cent in oil stored in dark.

LITERATURE CITED

Ali, A., and S. A. Tremazi. 1968. Stability of fats and oils under different storage conditions as affected by antioxidants. *Pak. Jour. Agr. Sci.* 5 : 74-79.

Annonymous. 1966. Oilseed crops. Basic facts of Pakistan Government of Pak. Dept. of Film and Publications.

A.O.C.S. 1950. Official and tentative methods of Amer. Oil Chemists' Society. 2nd Edn. Chicago, Illinois.

Contutiu, M., Ov. Popescu, Ani. Poboran, Ana Maria, Antoni and Henvieta (Rom). 1969. Antioxidants used for protecting sunflower seed oil. *Luer. Inst. Cereet.* Aliment., 1967, **8** : 79-92. (*Chem. Abst.* 70 : 18973z).

Henry, L. S. 1915. Rancidity of fats. *Pharm. Jour.* **95** : 4-5.

Kerr, H. R. 1921. The causes and preservation of rancidity. *Cotton Oil Press* **5** ; 45-48.

Lewkowitsch, J. 1940. Chemical technology and analysis of oil, fats and waxes. MacMillon Co., London.

Lundberg, W. O. 1962. *Autoxidation and antioxidants.* Vol. 2 : 451, Interscience Pub., New York.

Naqvi, A. T. 1967. The effect of antioxidants and synergists on the development of oxidative rancidity in edible oils and fats. M.Sc. Thesis, WPAU., Lyallpur.

Segal, B. 1971. Effect of some antioxidants on the thermal degradation of sunflower oil. *Igiena* 1970, 19(10) : 595-600. (*Chem. Abst.* 75(5) : 34121d.)

Stuckey, B. N. 1959. Preservation with antioxidants. *Amer. Perfumer Aromat.* 73(2) : 35-36.

Tapple, A. L., W. O. Lundberg, and P. D. Boyer. 1953. Effect of temperature and antioxidants upon the lipoxidase catalysed oxidation of sod. linoleate. *Arch. Biochem, Bio-Phy.* 22 : 293-304. (*Chem. Abst.* 42 : 8790 b).

Wheeler, D. H. 1940. The formation of peroxides in butter fat. *Oil and Soap.* 10(9) : 89.