Stabilization of Flaxseed Oil with Capsicum Antioxidant

Sir:

Flaxseed (*Linum usitatissimum* L.) oil has been used as a food (1) from ancient times. The oil from the seeds is a rich source of linolenic acid, but the seed oil is unstable owing to oxidation. The high rate of oxidation of the oil used in human food must be checked by incorporating antioxidants. The utilization of capsicum (*Capsicum annuum* L.) as an antioxidant in food has been shown to be safe for human use (2,3). Other experiments (4) have shown that levels as low as 70–80 μg capsicum (chili) powder/kg of food/d consumed as part of a high-fat diet significantly lowers liver serum triglycerides and serum lipoprotein triglycerides. Its regular use has been related to reduce thromboembolism. Decrease in plasma glucose levels in response to oral administration of glucose containing 14 mg% capsicum also has been reported (5). Hence, in the present work, capsicum powder is used as an antioxidant for the stability of flaxseed oil.

The flaxseed used for the extraction of oil had the following percentage composition: moisture, 8.3; protein, 26.9; and total dietary fiber, 42.8. Since the gum coating on the exterior of the seed hinders removal of husk, the gum was removed by extraction in water for 12 h. The seed after extraction with water was dried in an oven at 70°C for 2 h and then extracted with petroleum ether (bp 40–60°C) using a Soxhlet apparatus. The oil concentration in the seed was about 25% by weight of dry kernel.

Analysis of the fatty acids in the oil was performed in the following way: About 100–200 mg of oil was placed in a 100-mL round-bottomed flask fitted with condenser, and about 10 mL of 0.7% methanolic HCl was added to it. The mixture was refluxed in a water bath for about 2 h. The content was cooled, 0.5 mL of water was added, and the ester was separated by using a petroleum ether wash to remove excess acid, followed by drying with anhydrous sodium sulfate. The analysis of methyl esters was done by measuring the peak areas by gas–liquid chromatography [model AIMIL-UNCON 5700 gas chromatograph (Hewlett-Packard, Mississauga, Ontario, Canada); equipped with a flame-ionization detector at 240°C; injector temperature, 250°C; fused silica capillary column (0.025 mm × 60 m); flow rate, 40 mL/min; carrier gas, nitrogen]. Properties of flaxseed oil are as follows: refractive index, 1.2; saponification value (6), 220.0 mg KOH/g oil; iodine value (6), 82.0; palmitic acid, C16:0, 6.0 mg fatty acid/g of oil; stearic acid, C18:0, 7.1; oleic acid, C18:1, 22.2; linoleic acid, C18:2, 14.2; and linolenic acid, C18:3, 50.4.

Oxidation of flaxseed oil was done in the following way: A standard taper, 250 cc round-bottomed flask containing 100 g of oil was placed in a thermostated bath (30°C). Then air from the air cylinder (pressure: 1.7 kg/cm^2) was passed through the oil (2 mL/min). At different time intervals, oil samples were taken for determination of peroxide value (PV) and thiobarbituric acid (TBA) reactive substances (6). The peroxide formed was estimated iodometrically, where the sample was reacted with a saturated aqueous solution of potassium iodide. The iodine liberated by the peroxide was titrated with a standard solution of sodium thiosulfate. The TBA test was based on the color reaction of TBA with malondialdehyde (mg/kg) in the sample. The experiment was repeated twice, and the percentage error was ±0.05. The oil was kept in the thermostated bath at a particular temperature for 10 min, and then the oil was withdrawn to determine peroxide value at different temperatures and TBA values.

Antioxidant from capsicum powder was extracted with ethanol (volume ratio 1:15). Antioxidant was obtained after ethanol evaporation. One gram of antioxidant was gradually added to a small amount of flaxseed oil of known weight. The minimum weight of flaxseed oil in which the antioxidant was completely soluble was determined (as there would be no residue of antioxidant). The weight of antioxidant soluble in a unit weight of flaxseed oil was 0.025 g/g of oil. The experiment was repeated three times, and the percentage error was ±0.1.

Flaxseed oil contains a high amount of unsaturated fatty acids (more than 86%; see above). These are liable to epoxide formation by reaction with oxygen in air.

The sharp increase in PV of flaxseed oil (Fig. 1) over time indicates that flaxseed oil is readily oxidized. But the PV of flaxseed oil containing antioxidant (antioxidant/oil ratio = 1:40 w/w) remained nearly constant during the experimental period. Similarly, TBA values of oil samples remained constant in the presence of the same antioxidant (data not shown). There was a sharp rise of PV with increasing temperature (Fig. 1). With the addition of an antioxidant (1:40), the PV with increasing temperature remained nearly constant (Fig. 1). Thus, incorporation of oil-soluble capsicum extract checks the rate of oxidation to such a degree that almost no rise in PV and TBA values occurs.

Capsicum is known to contain two homologs of *N*(4-hydroxy-3-methoxy-benzyl)-alkylamide (Scheme 1). The active components of capsicum contain phenolic groups that effectively prevent (i.e., neither initiate nor propagate) further oxidation of glycerides. Thus, antioxidants from capsicum powder are equal to or better than synthetic antioxidants that have been used to retard oil oxidation. Flaxseed oil containing capsicum was bright red, and this color did not deteriorate during 1 yr of storage. The taste of the product was found to be acceptable for use as a salad oil (tasted by 20 persons).

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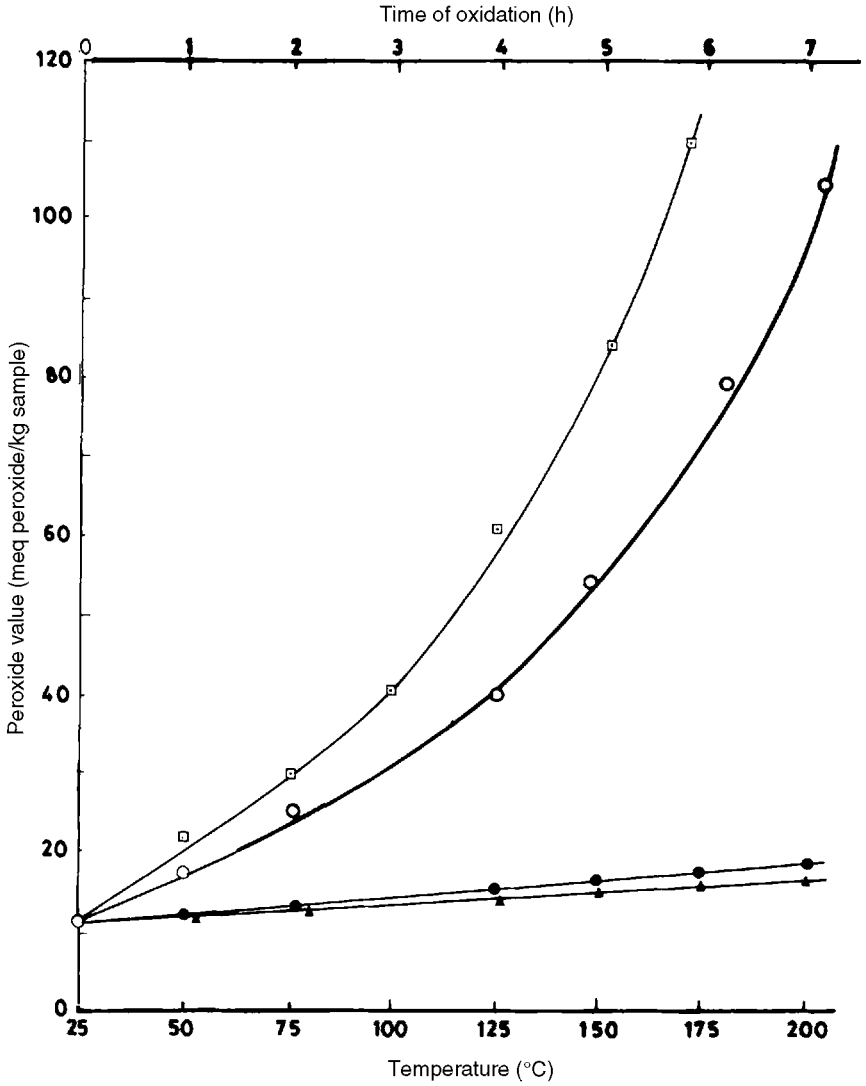
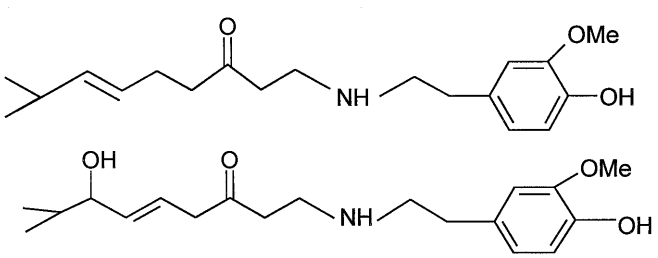


FIG. 1. Peroxide value of flaxseed oil at different temperatures, ○—without antioxidant, ▲—with antioxidant. Peroxide value of flaxseed oil at different times, □—without antioxidant, ●—with antioxidant, at 30°C.

REFERENCES

1. Hettiarachchy, N.S., G.A. Hareland, A. Ostension, and G. Baldner-Shank, Chemical Composition of Eleven Flax Seed Varieties Grown in North Dakota, U.S.A., *Proceedings of the 53rd Flax Institute,* edited by G. Baldner-Shank, North Dakota, June 6, 1990, pp. 36–44.
2. Govindarajan, V.S., and M.N. Sathyanarayana, Capsicum Production, Technology, Chemistry and Quality, *Food Sci. Nutr. 6*: 437–441 (1991).
3. Chopra, R.N., S.L. Nayer, and I.C. Chopra, *Glossary of Indian Medicinal Plants,* 4th edn., Council of Scientific Industrial Research, New Delhi, 1986, p. 321.
4. Srinivasan, M.R., and M.N. Sathyanarayana, Influence of *Capsicum curcumin* and Ferulic Acid in Rats Fed High Fat Diets, *J. Biol. Sci. 12*:143–147 (1987).
5. Monosereenusarn, Y., Effect of Capsicum on Intestinal Glucose Metabolism *in vitro, Toxicol. Lett. 3*:279–284 (1979).
6. David, P., *The Chemical Analysis of Foods,* 9th edn., J&A Churchill, London, 1990, p. 234.



SCHEME 1

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