

The level of tocopherol in Ghanaian oils

J. K. B. A. ATA & AGNES COBBINA

Food Research Institute, P.O. Box M.20, Accra, Ghana



SUMMARY

The total tocopherol content of various types of processed oils in Ghana have been studied with a view to identifying those that may have poor shelf lives. The results obtained showed the greatest destruction of total tocopherol in refined coconut and palm kernel oils. The losses due to the traditional process were not as much as that due to the refining process.

Received 6 Apr 72; revised 27 Sep 72.

Introduction

Fats and oils generally contain various levels of natural antioxidants. Schmidt (1968) has compiled the total tocopherol content of some fats and fat products and has shown that the crude oils always have a higher tocopherol content than the refined oils.

The storage life of fats and oils is limited by the presence of air which causes oxidative rancidity. The reaction is very complex and it is catalysed by metallic contaminants especially copper and iron as shown by Pokorny (1971). However, the accepted mechanism described by Glass (1966) for auto-oxidation is as follows:



During storage, oils absorb oxygen and this results in the formation of peroxide. The absorption of oxygen is very slow initially during the induction period. The initial induction period is followed by a chain reaction resulting in the formation of hydroperoxides which may further polymerize and produce many breakdown products

RÉSUMÉ

ATA, J. K. B. A. & COBBINA, AGNES: *La teneur en tocopherol des huiles ghanéennes*. La teneur totale en tocopherol (réducteur) de différentes huiles traitées au Ghana a été déterminée en vue d'identifier celles qui pourraient avoir une mauvaise conservation. Les résultats obtenus ont montré que la plus grande destruction du tocopherol total était produite dans les huiles raffinées de coprah et de palme. Les pertes en tocopherol ont été moindres dans les huiles ayant subi le traitement traditionnel, que dans celles qui ont été raffinées industriellement.

like ketones and aldehydes. These products cause changes in taste and odour of the oils which seriously affect their palatability and market value.

Natural anti-oxidants (tocopherols) are known to prolong the storage life of fat and fat products (Bailey, 1964). These anti-oxidants terminate the oxidative chain reaction by being preferentially oxidized under the conditions of auto-oxidation. In industry, therefore, artificial anti-oxidants such as pyrogallol, butylated hydroxy anisole and butylated hydroxy toluene are added to processed oils whenever the natural anti-oxidant level is reduced.

In Ghana, refining of various edible oils for example, coconut oil and groundnut oil, has become an industrial practice. However, traditional methods of manufacture of edible oils also contribute about 50% of the total edible oil volume. The traditional method of oil extraction involves heating to very high temperatures at various stages of processing. As all such heating is done in open pans, some of which may have iron content, the conditions of oxidation are favourably provided.

The tocopherol content of Ghanaian produced oils has, therefore, been studied with a view to making recommendations concerning their storage-ability.

Materials and methods

Various chromatographic methods for the determination of tocopherol have been developed by Glavind & Holmer (1967), and reviewed by the Analytical Methods Committee (1959) but a modification of the method by Goving Rao, Venkob Rao & Achaya (1965) was used.

Saponification

Approximately 15 g of oil was accurately weighed into a round-bottomed flask. 3.0 g of pyrogallol and 30 cm³ of absolute alcohol were added and heated under reflux. 24 g of potassium hydroxide were added to the boiling mixture. The reflux condenser was replaced and the mixture refluxed for 5 min with occasional shaking of the flask. After refluxing, the flask was removed from the heater and cooled immediately. 30 cm³ of distilled water was added. The unsaponifiable matter was extracted with diethyl ether three times using 25.0 cm³ of diethyl ether for each extract. The combined ethereal extracts were washed with distilled water until the water extracts were neutral to phenolphthalein. The ether solution was transferred to a round-bottomed flask and the ether distilled off into a receiver.

5 cm³ of alcohol and 5 cm³ of benzene were added to the residue and re-evaporated. The dry residue was dissolved in 5 cm³ of benzene and stored in a sample container placed in the dark for the next step.

Thin layer chromatography

Glass plates (20 × 20 cm) were washed thoroughly with water, dried and cleaned with absolute alcohol to remove traces of water. These were then spread with 0.05 cm thickness of Kieselgel G and then dried in an oven at 105°C for 1 hour. 20 microlitres of tocopherol solution were spotted on each plate, which was run in a saturated glass tank containing a solvent system of hexane-ether 1:1 (v/v). When the solvent front had moved to about 14 cm, the plates were removed from the tank, dried by means of air current and

examined under the ultra-violet light of wavelength 254 mμ. The spots, which appeared purple, were scraped off into a test-tube and the tocopherols extracted, with 4 cm³ of absolute alcohol. It was then filtered using Whatman's No. 1 filter paper. 3.5 cm³ of 0.5% "α, α-dipyridyl" in ethanol and 0.5 cm³ of 0.2% freshly prepared ferric chloride in alcohol were added to the alcoholic extract to develop the colour of the tocopherols. The mixture was warmed in a water bath at 70°C for 2 min and the optical density was measured at 520 mμ using a CF4 Optica Milano spectrophotometer. A blank was also prepared using a portion of the plate containing no tocopherol.

Calculation

The amount of total tocopherol in the oil was calculated in microgram per gram of oil using the formula by the Analytical Methods Committee (1959):

$$\text{Tocopherol (in } \mu\text{g/g)} = \frac{D \times F \times V \times 1000}{v \times G}$$

where D = net extinction;

F = spectrophotometric factor for α-tocopherol = 98;

V = volume of benzene in millilitres used to prepare solution for the thin layer chromatography;

v = volume in microlitres spotted on plate;

G = weight of material in grams used for the saponification.

Results and discussion

The experimental results presented in Table 1 showed a large range of tocopherol level in the traditionally processed oils. This is due to the large regional variation in processing methods and also due to the fact that some of the oils had been on sale for a long time during which period some of the tocopherols were used up to protect the oil from oxidation. However, it was shown that the industrially pressed crude oils had the highest tocopherol content. This is because a very short heating time of about 30 min at 120°C is usually required to digest most nuts or seeds before pressing for oil in industry. This period is not enough to cause much oxidation of the tocopherols. In the traditionally manufactured crude oils, the level of tocopherol were found to be

TABLE I
Range of Total Tocopherol in Locally Manufactured Oil Sample

Oil	Calculated level of tocopherol ($\mu\text{g/g oil}$)
Crude palm kernel (traditionally made)	140 - 175
Crude palm kernel (industrial screw press)	300 - 330
Refined palm kernel	88.0- 98.0
Crude coconut oil (traditionally made)	162 - 176
Crude coconut oil (industrial screw press)	350 - 392.0
Refined coconut oil	78.0- 98.0
Crude groundnut oil (traditionally made)	375 - 400
Refined groundnut oil	255 - 263
Crude palm oil (industrial screw press)	371 - 393
Crude shea butter (traditionally made)	780 - 902
Crude shea butter (laboratory screw press)	1720 -1760

about half that of the industrially manufactured crude oils. The traditional process, apart from roasting the nuts or seed prior to extraction, has two other stages: (i) water extraction stage, and (ii) water evaporation stage, during which air is in contact with the oil at high temperatures of about 90–150°C, and sometimes in the presence of metals like iron. The water extraction stage involves boiling for about 3–5 h the finely ground, roasted seeds with a sufficient quantity of water. By this method, the oil which is contained in the tissues of the seed dissolve into the water phase so that on subsequent cooling, after the boiling process, the oil can settle above the water phase.

The water evaporation stage involves 3–6 h of boiling the skimmed oil phase to expel the last traces of water. The cumulative 6–10 h of heating in the open air accounts for the low values of tocopherol found in the traditionally manufactured samples.

All the refined samples, i.e. palm kernel oil, coconut oil and groundnut oil, showed the lowest level of tocopherol. Oils which undergo refining are likely to suffer losses at (a) alkali refining stage; (b) adsorptive decolorization stage; (c) de-odourization stage. The losses at the decolorization and de-odourization stages may not necessarily be due to preferential oxidation since vacuum is applied, but rather due to losses in unsaponifiable constituents resulting in a proportional diminishing of the tocopherol. This loss in refining is, therefore,

inevitable if the process is to be continued by industry. The results showed that values obtained for refined palm kernel oil and refined coconut oil are fairly low. This is an indication that the industry should consider seriously the future possibility of raising the anti-oxidant level of the oils so as to have a comparatively long shelf life.

REFERENCES

- Analytical Methods Committee** (1959) The determination of tocopherols in oils, food, and feeding stuffs. (Report prepared by the Vitamin E Panel.) *Analyst* **84**, 356–371.
- Glass, R. L.** (1956) Food rancidity—its nature and prevention. *Bakers Dig.* **40** (1), 34–35, 38–39.
- Glavind, J. & Holmer, G.** (1967) Thin layer chromatographic determination of anti-oxidants by the stable free radical α , α -disphenyl- β -phenylthio-drazy (DPPH). *J. Am. Oil Chem. Soc.* **44** (9), 539.
- Govind Rao, M. K., Venkob Rao, S. & Achaya, K. T.** (1965) Separation and estimation of tocopherols in vegetable oils by thin layer chromatography. *J. Sci. Fd Agric.* **16** (3), 122–124.
- Pokorny, Jan** (1971) Stabilization of fats by phenolic anti-oxidants. *Can. Inst. Fd. Technol. J.* **4** (2), 68–74.
- Swern, D.** (1964) *Bailey's industrial oil and fat products*; 3rd ed., p. 632. New York: Interscience.
- Schmidt, H. E.** (1968) Determination of tocopherols in oils and fats. Effect of tocopherol content on the oxidation of peanut oil and soya bean oil at high temperatures. II. *Fette Seifen Antr-Mittel* **70** (2), 63–67.