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The Characteristics of the Kapok *(Ceiba pentadra,* Gaertn.) Seed Oil

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RINGKASAN

Biji kekabu dari Malaysia (Ceiba pentadra) *didapati mengandongi lebih kurang 28 peratus minyak. Minyak daripada biji mentah ini dan juga dari biji yang digoreng menunjukkan uji Halphen yang positif bagi asid lemak siklopropenoid. Nilai asid, juzuk asid lemak secara cerakinan kromotografi gas-cecair, nilai iodin, indeks biasan, nombor uraialkalian, dan mungkinan ketidak uraialkali minyak juga dipastikan. Nilai (keluasan peratus) bagi asid lemak sebagai ester metil ialah : C14 :0 (0.25%), C16 :0 (24.31%), C16 :1 (0.4%), C18 :0 (2.65%), C18 :1 (21.88%), C18 :2 (38.92%), C20 :0 dan C18 :3 (1%), asid molvalik (7.18%), C22 :0 (0.44%) dan asid sterkulik (2.96%). Asid-asid malvalik dan sterkulik ditentukan sebagai terbitan $AgNO_3$-CH_3OH bagi ester metil mefeka.*

Oleh kerana asid lemak siklopropenoid mengakibatkan beberapa kesan buruk ke atas fisiologi haiwan yang digunakan untuk percubaan, maka bijian ini tak patutlah dimakan.

SUMMARY

The Malaysian Kapok (Ceiba pentadra) *seeds were found to contain about 28 per cent oil. The oil from both raw and roasted seeds produced a positive Halphen test for cyclopropenoid fatty acids. Acid value, fatty acid composition by gas-liquid chromatography, iodine value, refractive index, saponification number, and unsaponifiables of the oil were also determined. The values (area percent) for fatty acids as methyl esters were: C14 :0 (0.25%), C16 :0 (24.31%), C16 :1 (0.4%), C18 :0 (2.65%), C18 :1 (21.88%), C18 :2 (38.92%), C20 :0 plus C18 :3 (1%), malvalic acid (7.18%), C22 :0 (0.44%), and sterculic acid (2.96%). Malvalic and sterculic acids were determined as $AgNO_3$-CH_3OH derivatives of their methyl esters.*

Since the cyclopropenoid fatty acids bring about a number of abnormal physiological effects in experimental animals, it would be extremely unwise to consume these seeds.

INTRODUCTION

Malaysian Kapok (*Ceiba pentadra,* Gaertn.) is commonly found in northern parts of peninsular Malaysia. The fruits of this tree are in the form of capsules containing a floss in which a number of dark brown seeds are embedded. The floss has been used for centuries to stuff pillows and cushions (Burkill, 1966). The seeds are normally discarded. In rural areas, however, the seeds are roasted and consumed after removing the husk. Sometimes they are germinated prior to use. Apparently they often upset the stomach and hence they are consumed only in small quantities. Georgi (1922) reported that the oil content of Kapok seeds from different parts of Malaysia is in the range of 20 to 25 per cent. The characteristics of the oil were found to be close enough to that of cotton-seed oil; and consequently can be commercially utilized as an edible oil. The residual cake contains plenty of proteins which can be used as feed for livestock or as fertilizer (Georgi, 1922; Grist, 1922). The composition of the Philippine Kapok seed *(Ceiba pentardra)* and its oil was reported by Cruz and West (1931), and Padilla and Soliven (1933).

The seeds of other kapok species have also been examined for their oil content and fatty acid composition (Hilditch and Williams, 1964; Cornelius *et al.,* 1965; Raju and Reiser, 1966). The oil is reported to be rich in unsaturated fatty acids and contains a variable proportion of cyclopropenoid fatty acids, mainly malvalic and sterculic. The cyclopropenoid fatty acids (CPFA) have been shown to produce numerous physio-

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logical disorders in farm and laboratory animals (Phelps *et al.*, 1965; Shenstone *et al.*, 1965; Allen *et al.*, 1967; Raju and Reiser, 1967; Lee *et al.*, 1968; Sinnhuber *et al.*, 1968; Johnson *et al.*, 1969; Miller *et al.*, 1969; Abou-Ashour and Edwards, 1970a and 1970b; Roehm *et al.*, 1970; Lee *et al.*, 1971; Wells *et al.*, 1974; Pullarkat *et al.*, 1976). In view of this fact it would be extremely unwise to consume these seeds.

The present study was undertaken to determine the fatty acid profile and other characteristics of the oil in Malaysian Kapok seeds with reference to the normal methods of preparation prior to consumption.

MATERIALS AND METHODS

The Kapok seeds were procured from the Universiti Pertanian Malaysia campus. Methyl fatty acid ester standards were obtained through Sigma Chemical Company, U.S.A. Sodium methoxide reagent (0.5N) was purchased from Supelco, Inc., U.S.A. All other reagents used were of analytical grade.

Extraction of Oil:

The decorticated Kapok seeds were pulverized to a fine powder and extracted with petroleum ether (b.p. 40–60°C) in a Soxhlet apparatus for 16 hours. The oil was recovered by evaporating the petroleum ether on a rotary evaporator under reduced pressure. The yield of crude oil was 49.5 per cent.

A sample of kapok seeds from the same lot was roasted in a frying pan until the seeds popped up. The kernels from these seeds were extracted for oil in the same manner.

The moisture content (air oven method) and protein content (Kjeldahl method) of kapok seed kernels, and the acid value, iodine value (Wij's), refractive index, saponification number, and unsaponifiable matter of the oil were determined according to AOAC (1975).

Halphen Test:

This colour reaction was carried out according to the method of Coleman and Firestone (1972); a cherry-red colour developed indicating the presence of cyclopropenoid fatty acids (CPFA). The oil obtained from roasted seeds was also tested under similar conditions.

Preparation of Methyl Esters and $AgNO_3$-CH_3OH Derivatives:

The fatty acid methyl esters were prepared by transmethylation of the oil using sodium methoxide (0.5N) in methanol as described by Timms (1978). The contents of the reaction vessel were centrifuged to effect clarification. The petroleum ether layer containing the methyl esters was removed and treated with $AgNO_3$-CH_3OH according to Schneider *et al.* (1968) to obtain stable CPFA derivatives. The normal fatty acid esters and the CPFA ester derivatives were recovered from the reaction mixture in the usual manner.

Gas-Liquid Chromatography:

A Pye Unicam, series 204, gas chromatograph equipped with hydrogen flame ionization detectors was employed. The analysis was performed on two glass columns (1.5m × 4mm, I.D.). Column 'A', which was packed with 10 per cent w/w polyethylene glycol succinate adsorbed on 100–120 mesh Diatomite C AW, was operated at 180°C with carrier gas nitrogen (OFN) at a flow rate of 30 ml/min. Column 'B', which contained 10% w/w APL supported on 100–120 mesh Diatomite C AW DMCS, was operated at 220°C with carrier gas nitrogen at a flow rate of 50 ml/min. The injection port and detector temperatures were held at 200°C.

Gas chromatograph peaks were identified by comparison with pure methyl esters through retention time relative to methyl heptadecanoate on two columns containing two different phases of opposite polarity. The identity of malvalic and sterculic acids was based on comparison with $AgNO_3$-CH_3OH derivatives of methyl esters of *Sterculia foetida* oil fatty acids through retention time and co-chromatography on column 'A'. The area per cent of each peak was obtained on Hewlett-Packard 3380A Integrator linked directly to the gas chromatograph.

RESULTS AND DISCUSSION

The Kapok seed oil is a clear fluid, pale yellow in colour with a faintly sweet nutty odour The characteristics and fatty acid composition of the oil are presented in Table 1. The composition of the oil is very similar to that of cotton-seed oil (Hilditch and Williams, 1964). The unsaturates comprise mainly oleic and linoleic acids, together forming about 70 per cent of the total fatty acids. The ratio of saturates to unsaturated fatty acids is *ca* 1:3 which is the same as for cotton-seed oil (Hilditch and Williams, 1964).

Cyclopropenoid Fatty Acids (CPFA):

The occurrence of CPFA in the oil was established by the Halphen test which gave a deep cherry-red colour. The presence of malvalic

TABLE 1

Analytical Data on Kapok Seed and Oil

Property	Value
Composition of seed (%):	
Kernel	58.0
Moisture	3.4
Oil	28.7
Protein	23.0
Oil Characteristics:	
Acid value	1.7
Iodine value	94.98
Refractive index, 25°C	1.4656
Saponification number	183.0
Unsaponifiables (%)	0.7
* Fatty acid composition (Area, %)	
C14:0	0.25 (0.16)
C16:0	24.31 (23.26)
C16:1	0.40 (0.29)
C18:0	2.65 (2.54)
C18:1	21.88 (20.92)
C18:2	38.92 (42.0)
C20:0 + C18:3	1.00 (0.36)
Malvalic acid	7.18 (7.11)
C22:0	0.44 (0.42)
Sterculic acid	2.96 (2.94)

*Values in brackets are for roasted seed oil

and sterculic acids was confirmed by comparison with $AgNO_3$-CH_3OH derivatives of methyl esters of *Sterculia foetida* seed oil through retention time and co-chromatography. *Sterculia foetida* seed oil is well known to contain both malvalic and sterculic acids. The Malaysian Kapok seed oil contains about 10 per cent CPFA of which malvalic acid constitutes over 70 per cent. This proportion of CPFA in Malaysian Kapok seed oil is relatively low compared to the reported values in seed oil of other Kapok species (Cornelius *et al.*, 1965; Raju and Reiser, 1966).

Effect of Heat on CPFA content of the Oil:

The oil extracted from the kernels of the roasted seeds gave a strong Halphen test, although the colour developed rather slowly probably because of partial polymerization of CPFA caused by heat during roasting of seeds. The $AgNO_3$-CH_3OH derivatives of methyl esters of this oil fatty acids on gas-liquid chromatography continued to show corresponding peaks for malvalic and sterculic acids in more or less the same amounts (area per cent) as with the oil from the non-roasted seeds. This indicated that the roasting temperature was not sufficiently high enough to destroy CPFA. The effect of heat and hydrogenation on CPFA in oils has been summarized by Phelps *et al.* (1965).

CONCLUSION

Kapok seed oil has a reasonable potential as a commercial edible oil since the CPFA can be deactivated during deodourization and hydrogenation processes. The ingestion of seeds, however, may pose a risk to man. The cause of stomach upset due to excessive consumption of these seeds could probably be linked to CPFA in the seed oil. However, the extent of abnormal physiological effect of CPFA on man could not be ascertained, since there is no experimental data available that relate to humans.

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