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Properties of vegetable oils from some unexplored sources in Malaysia

(Ciri-ciri minyak sayuran dari beberapa sumber di Malaysia)

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Key words: vegetable oils, okra, roselle, 'ciku', avocado, 'undi'

Abstrak

Lima jenis tumbuhan yang mungkin boleh menghasilkan minyak sayuran, iaitu bendi, roselle, ciku, avokado dan undi telah dikaji tentang ciri-ciri fizika-kimia dan komposisi minyaknya.

Minyak biji bendi dan roselle kaya dengan asid linoleik dan menyerupai minyak biji kapas. Minyak biji ciku dan avokado mempunyai kandungan asid oleik yang tinggi. Minyak undi bersifat lebih tepu dan menyerupai lemak illipe dan mowrah.

Abstract

Five possible sources of vegetable oils i.e. okra, roselle, 'ciku', avocado and 'undi' were studied for the physico-chemical properties and composition of their oils.

Okra and roselle seed oils were rich in linoleic acid, resembling cotton seed oil. 'Ciku' seed and avocado oils were also liquid, but high in oleic acid. 'Undi' oil was a more saturated oil and resembled illipe and mowrah butters.

Introduction

Much of the tropical vegetation of Malaysia has not been put to use by man, while some, which have been cultivated for various uses such as food and beverages, are often not fully utilised. Amongst these are oil-bearing plants which may be tapped if only their oils are found to be useful. A few oil-bearing plants such as okra (*Hibiscus esculentus* L.) commonly known as lady's finger or 'bendi', roselle (*Hibiscus sabdariffa* L.), sapodilla (*Achras sapota* L.) known locally as 'ciku', avocado (*Persea americana* Mill.), and 'undi' (*Calophyllum inophyllum* L.) have been selected for the study of their oil-types, as a first step in searching for new oil sources in Malaysia. If these oils should prove to be of interest, further studies on their feasibility in terms of availability and economic viability would have to be considered.

Both the hibiscus species are readily grown in Malaysia and may be cultivated on a large scale if required for their oil. They provide an abundance of small seeds containing 13-17% oil in the case of okra (Sunder, Rao and Lakshminarayana 1985) and 20% in roselle (Sarojini, Chittema Rao, Tupule et al. 1985). Okra produces slender tapering pods which are harvested at the young and tender stage for consumption as a vegetable. These pods may be allowed to ripen and dry out for the oil in their amphitropous seeds. Roselle is valued for its fleshy, flavoured red calyx which is

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extracted to make an acid beverage or a jelly. Its seeds may be extracted for its edible oil which requires refining (Sarojini, Chittema Rao and Geervani 1985).

Sapodilla or 'ciku' is a popular non-seasonal fruit because of its delicious sweet taste, although it has a somewhat granular texture. It contains 2-cm long flat seeds with 20% liquid oil (Nagy and Shaw 1980). Ciku can be made into various products such as candied ciku, jelly and jam (Faridah 1986).

The avocado tree grows well in Malaysia and does not require much care except in the initial stages. Although it only fruits once a year, the yield is very good at 500-600 fruits/tree (Anon. 1986). The fruit is pear-shaped with a dark green to red skin, and has a rich, creamy flesh with a fat content of 11.3% (Woot-Tsuen et al. 1968). The avocado oil is a viscous liquid, dark greenish brown in colour and has mainly been regarded as a cosmetic oil because of its high skin penetration coefficient (Jacobsberg 1988). However, it can also be used in the food industry after the usual refining, bleaching aand deodorisation processes (Werman and Neeman 1986).

'Undi', a wayside tree in Malaysia, is often cultivated as an ornamental for adorning the countryside or garden, as well as for shade and shelter. It produces numerous marble-sized green fruits (botanically classified as drupes). Each fruit has very little mesocarp, but contains a large thick-shelled oil-bearing seed. The oil (known as 'asdomba' oil) is bluish yellow to dark green, and viscous, but can be easily refined for use in soap manufacturing, as an illuminant and for local medication (Vaughan 1970).

Materials and methods

As the aim of this study was mainly to study the oil characteristics, the acquisition of samples was limited to those available in nearby areas only. Ten samples of okra seeds of different varieties were available from the Federal Experimental Station (FES) in Serdang and the MARDI Station in Jalan Kebun. One sample of roselle was obtained from FES and another from the surrounding garden in the Food Technology Division. Two varieties of 'ciku', Jantung and Pasir, were acquired from farms in Malacca. Two types of avocado and one sample of 'undi' were collected from Universiti Pertanian Malaysia.

The composition of fruit or seed was determined by weighing their composite parts such as seed, mesocarp, calyx, shell or kernel respectively. Fat content (by soxhlet extraction with petroleum ether, 40-60 °C) and moisture content (by oven method) were determined on relevant oil-bearing materials such as kernel and mesocarp, according to methods by Pearson (1973).

Extraction of oil

The oil-bearing sample material was comminuted (avocado mesocarp) or ground (seeds and kernels), and dried before extraction with petroleum ether (40-60 °C) on a soxhlet extractor for 16 h. Solvent was evaporated off on a rotary evaporator and the oil obtained was dried over anhydrous sodium sulphate.

Analysis of oil

The empirical tests such as colour, refractive index and specific gravity were carried out on the extracted oils according to methods by AOCS (1980). Viscosity was determined by the falling ball viscometer (Hoppler) at 30 °C (Anon. 1978). Free fatty acids (FFA), Iodine value, saponification value and unsaponifiable matter, as well as composition studies for fatty acids and triglycerides by gas liquid chromatography, were determined as described by Chin and Nushirwan (1984).

Results and discussion

Fruit or seed composition and some proximate analysis

The kernel content of okra, 'ciku' and 'undi' seeds ranged from 9% to 50.8% *(Table 1)*. Undi had the least kernel content of 9%,

Table 1. Fruit or seed composition and some proximate analysis parameters of relevant oil-bearing kernel and mesocarp

Composition	Okra	Roselle	'Ciku'	Avocado	'Undi'
Fruit (%)					
Seed	-	21.1	0.9	14.3	-
Mesocarp	-	55.1 calyx	99.1	85.6	-
Seed (%)					
Shell	64.5	48.9	48.9	-	82.9
Kernel	35.5	50.8	50.8	-	9.0
Kernel (%)					
Fat	15.5	19.9	24.5	1.4	55.1
Moisture	9.6	7.8	30.4	64.0	-
Mesocarp (%)					
Fat	-	-	-	11.3	-
Moisture	-	-	-	79.1	-

Table 2. Physico-chemical characteristics of okra, roselle and 'ciku' seed oils

Characteristic	Okra Mean*	Roselle Mean**	'Ciku' Mean**
Colour R	2.6	1.5	10
Y	29.4	20.2	6.7
(Lovibond units, 2.5 cm cell)			
Refractive index n_D26 °C	1.464	1.463	1.466
Viscosity at 30 °C (cp)	32.2	26.9	59.1
Specific gravity at 26 °C	0.90	0.89	0.90
FFA (% wt. oleic acid)	3.65	1.85	5.19
Saponification value (mg KOH/g fat)	185.1	178.9	190.5
Unsaponifiable matter (% wt)	0.70	0.84	0.95
Iodine value (mg I_2/100 g fat)	89.0	90.5	68.5

* Values are mean of 8 samples
** Values are mean of 2 samples

being predominated by a thick hard shell; but its kernel had the highest oil content of 55.1%. Okra seed kernel contained 15.5% oil, roselle seed 19.9% and 'ciku' seed 24.5%. In the avocado, oil was mainly found in the mesocarp which constituted 85.6% of the fruit and contained 11.3% oil. Due to its high moisture content (79.1%) and the fact that the oil is in a finely dispersed emulsion in the cells (Jacobsberg 1988), extraction of oil from the avocado mesocarp was quite problematic.

Physico-chemical characteristics of oils

Studies on the physico-chemical characteristics of okra, roselle and 'ciku' seeds *(Table 2)* showed that both okra and roselle seed oils were light in colour with Lovibond tintometer readings of 2.6R and 1.5R respectively. 'Ciku' seed oil which was light reddish brown, had a reading of 10R. 'Ciku' seed oil was also rather viscous and had a lower Iodine value than the other two oils. Free fatty acid values were rather variable in okra and 'ciku' seed oils, some being excessively high.

Fatty acid and triglyceride composition of oils

Okra seed oil was found to be high in

Table 3. Fatty acid and triglyceride composition of five vegetable oils

Composition	Okra Mean*	a	Roselle Mean**	b	'Ciku' Mean**	c	Avocado Mean**	d	'Undi' Mean**	e
Fatty acid (%)										
C12	-	-	0.90	-	-	1.6	-	0.2	-	-
C14	0.28	-	0.20	-	-	6.2	-	0.3- 2.2	-	1.2
C16	30.81	23.8	19.50	15	21.47	12.6	27.75	7.2-26.1	25.52	17.8
C16:1	0.90	-	0.58	-	-	-	8.63	6.4- 8.3	1.17	-
C17	0.46	-	0.24	-	-	-	0.22	-	-	-
C18	3.72	7.4	4.07	trace	9.96	12.0	1.10	0.4- 1.3	14.36	17.1
C18:1	19.68	27.1	34.87	29.6	56.0	66.2	49.46	46.9-80.9	35.31	35.4
C18:2	43.13	41.7	38.61	49.0	10.98	1.4	12.20	6.3-16.5	18.74	28.5
C18:3	-	-	0.12	2.0	-	-	0.76	-	-	-
C20	0.43	-	0.70	-	0.84	-	-	0.4	1.36	-
C22	-	-	-	-	-	-	-	-	0.75	-
C22:2	-	-	-	-	-	-	-	-	2.07	-
Unknown	-	-	-	-	-	-	-	-	0.74	-
Saturation	35.70	-	24.80	-	32.27	-	29.07	-	41.99	-
Unsaturation	63.71	-	74.18	-	67.68	-	71.05	-	57.29	-
Triglyceride (%)										
C48	0.61	-	0.24	-	-	-	4.70	-	1.96	-
C50	22.72	-	9.93	-	13.15	-	27.74	-	10.00	-
C52	45.10	-	39.28	-	43.65	-	46.03	-	36.09	-
C54	27.45	-	45.67	-	40.89	-	21.53	-	51.96	-
C56	3.99	-	4.87	-	2.08	-	-	-	-	-

a, d, e Hilditch (1956)
b Sarojini, Chittema Rao, Tupule et al. (1985)
c Nagy and Shaw (1980)
trace = < 0.05%
* Values are mean of 8 samples
** Values are mean of 2 samples

linoleic acid followed by palmitic acid, and was high in C52 followed by C54 and C50 triglycerides. Roselle seed oil, however, had high linoleic acid followed by oleic acid, and C54 triglycerides were more prominent followed by C52 *(Table 3)*. Roselle seed oil was thus the more unsaturated oil. Both oils were quite similar to cotton seed oil in their fatty acid composition (Hilditch 1956; Sarojini, Chittema Rao, Tupule et al. 1955).

Both 'ciku' seed and avocado oils had oleic acid as the main component. 'Ciku' seed oil was also rich in stearic acid and has been classified as such (Hilditch 1956). It was therefore a more saturated fat. Avocado was interesting because of its higher palmitoleic acid content among the 'fruit-coat fats' (Hilditch 1956). 'Ciku' seed oil was high in C52 triglycerides followed by C54 triglycerides, whilst avocado oil was high in C52 triglycerides followed by C50 and C54 triglycerides.

'Undi' oil was also high in oleic acid, however, it was more saturated than 'ciku' seed oil because of its relatively higher stearic and palmitic acids. It has been placed among the 'stearic acid-rich fats' and resembled illipe and mowrah butters (Hilditch 1956). It also contained some long chained C20 and C22 fatty acids. Its major triglycerides were C54, followed by C52 triglycerides.

Conclusion

Okra and roselle seed oils are liquid oils rich in linoleic acid followed by palmitic and oleic acids respectively, and resemble cotton seed oil. The okra and roselle crops which are readily cultivated, can now be grown as sources of vegetable oil besides their normal use as a vegetable or

beverage respectively.

'Ciku' seed oil could be of low priority because of the low proportion of seeds. However, being rich in oleic acid like palm oil or olive oil, it is a valuable oil from the health point of view.

Avocado is similarly a valuable oleic acid-rich oil which has also found good use in the cosmetic industry. The crop is normally cultivated for fresh consumption of its fruit.

'Undi' provides a more saturated fat, relatively rich in stearic and palmitic acids. It is a wayside tree which can be exploited not only for its shade but also for its harvest.

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