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# Fatty Acid Composition of 16 Groundnut *(Arachis hypogaea,* L.) Cultivars grown under Malaysian Conditions

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## RINGKASAN

*Enambelas kultivar kacang tanah* Arachis hypogaea *L. telah didapati mengandungi minyak di dalam julat 43 hingga 50 peratus. Penganalisaan kromatograpi gas-cecair akan ester-ester metil asid lemak telah dijalankan. Analisa ini telah menunjukkan adanya asid-asid major seperti palmitik (12.22 hingga 13.30%), stearik (3.17 hingga 3.67%) oleik (37.94 hingga 41.90%) linoleik (34.59 hingga 37.51%), arachidik (1.63 hingga 1.85%), eicosaenoik (0.99 hingga 1.22%), behenik (3.24 hingga 4.36%) dan lignocerik (1.08 hingga 1.44%). Kultivar-kultivar Tainang 7, Kidang dan Alabama telah didapati mempunyai kandungan minyak yang tinggi dan paras asid behenik yang rendah serta nisbah asid oleik/linoleik yang tinggi di dalam minyak mereka.*

## SUMMARY

*Groundnuts from 16* Arachis hypogaea *L. cultivars were found to contain oil in the range of 43 to 50%. Gas-liquid chromatographic analysis of the oil fatty acid methyl esters revealed the occurrence of palmitic (12.22 to 13.30%), stearic (3.17 to 3.67%), oleic (37.94 to 41.90%) linoleic (34.59 to 37.51%), arachidic (1.63 to 1.85%) eicosaenoic (0.99 to 1.22%), behenic (3.24 to 4.36%), and lignoceric (1.08 to 1.44%) as the major fatty acids. Cultivars Tainang 7, Kidang and Alabama were high in oil content and contained relatively low levels of behenic acid and a high oleic/linoleic acid ratio in their oil.*

## INTRODUCTION

Plant breeders, generally, concentrate their efforts on evolving species/varieties that are high yielding and pest resistant. However, such efforts tend to attach secondary importance to the compositional and nutritional aspects of the final crop. In the case of oil seed crops, it would be desirable to evolve a variety that has not only high oil content but also a nutritionally desirable fatty acid composition.

Much effort has been given to the improvement of groundnut (*Arachis hypogaea* L.) varieties through breeding programmes all over the world. The parameters that have been investigated include climate, irrigation, fertilizer, soil, location, etc. and their influence on the yield, protein and oil content, as well as the fatty acid and amino acid composition (Brown *et al.,* 1975; Young *et al.,* 1974; Downey and McGregor, 1976). The fatty acid composition of the oil in seed crops plays an important role in determining the functional properties, shelf-life, nutritional value and flavour of the food products derived from them (Lea, 1962). The addition to food products of groundnut oil or oil-containing meal could, therefore, alter such characteristics in the final product. Changes in flavour quality may be caused by the development of oxidative rancidity which has been related, at least in part, to high linoleic acid content of the oil (Fore *et al.,* 1953). On the other hand, a reasonable proportion of linoleic acid is essential in nutritional terms.

The evidence that long-chain fatty acids, *e.g.* arachidic and behenic, in groundnut oil may be implicated in heart disease has been noted (Nutrition Foundation, Inc. 1972; Kies *et al.,* 1978; Kritchevsky *et al.,* 1971), but such long-chain fatty acids also have commercial importance since they assist in emulsification and stabilization of products such as peanut butter.

**Key to author's name: S.K. Berry.**

In Malaysia, research is in progress to select and identify groundnut varieties that are high yielding and pest resistant under local conditions (Lim, E.S. Personal Communications, 1980/81). The oil and protein contents of the nuts and the fatty acid composition of the oil need also to be investigated, as these vary with the variety or cultivar. This paper reports the fatty acid composition of the oil from 16 groundnut cultivars grown under the Malaysian conditions.

## MATERIALS AND METHODS

*Materials*

The groundnut samples used in this experiment were obtained through the Department of Horticulture, Faculty of Agriculture, Universiti Pertanian Malaysia. All cultivars were grown at the Experimental Farm under similar conditions and received the same post harvest treatments. The solvents and reagents used in the analysis were of analytical grade. Methyl fatty acid ester reference standards were purchased from Sigma Chemical Company, St. Louis, MO, USA.

*Extraction of Oil*

Samples of groundnut (10-15 g) including the seed coat were randomly divided into two portions and ground to a fine meal. The meal was transferred to a Whatman thimble, the pestle and mortar were rinsed with petroleum ether (b.p. 40-60° C) the washings were poured into the thimble in the Soxhlet apparatus. Extraction with petroleum ether was carried out for 16 hours in a fume chamber. The oil was recovered by evaporating the petroleum ether under vacuum in a rotary evaporator at 45° C.

*Transesterification of the Oil*

The oil fatty acid methyl esters were prepared by transmethylation using 0.5 M sodium methoxide in methanol as described by Timms (1978).

*Gas Liquid Chromatography (GLC)*

The oil fatty acid methyl esters obtained from each replicate sample were analysed using a

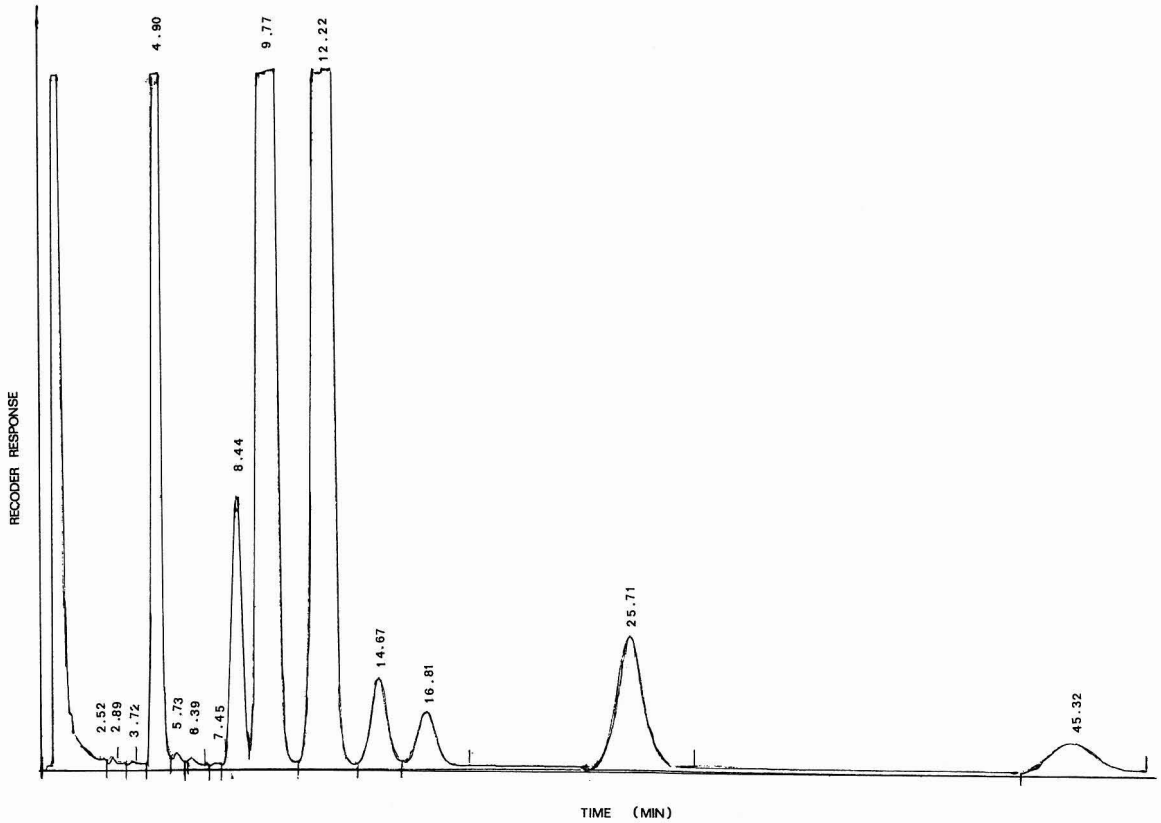


*Fig. 1. A typical gas-liquid chromatogram of groundnut oil fatty acid methyl easters. Column : Diethylene glycol succinate, sample size : 0.8 µl (5% in petroleum ether).*

Pye Unicam, series 204, gas chromatograph. The chromatograph operating parameters have been described previously (Berry, 1980). A typical gas liquid chromatogram of groundnut oil fatty acid methyl esters is depicted in Figure 1. Peak identification and area percentage calculation techniques have been reported earlier (Berry, 1980).

The results were subjected to the analysis of variance and least significant difference test (LSD) to ascertain the variability in oil content and fatty acid composition.

## RESULTS AND DISCUSSION

The groundnut samples employed in this investigation were not graded for size as the amount of samples available for analysis was only 10–15 g. Consequently, some samples contained more of underdeveloped, small-sized and wrinkled kernels than the others. This variability may have contributed to the differences in oil content and fatty acid composition of the oil in different cultivars.

The mean value of the oil content of 16 groundnut cultivars varied between 43 to 50% on a dry weight basis with a coefficient of variation of 2.38 (Table 1). The highest amount of oil occurred in groundnut cultivars Kidang and Tainang 7, both of Spanish type. The LSD test on the oil content data indicated significant differences in oil content for cultivars Kidang, Tainang 7 and Alabama when compared with cultivars Nan Gai 60, 47-5, CES101, Kuala Brang K-2, Banting, CES102, Red Indonesian and Sungai Siput Local.

*Fatty Acid Composition*

Table 1 shows the differences in fatty acid composition of the oil from 16 groundnut cultivars. The differences in methyl fatty acid ester values (%) for palmitic (16:0), stearic (18:0), Oleic (18:1), linoleic (18:2), eicosaenoic (20:1), behenic (22:0) and lignoceric (24:0) in the oil of these cultivars were significant at 5% level. For palmitoleic (16:1) and arachidic (20:0) fatty acids, on the other hand, the values varied insignificantly from one cultivar to another. Oleate and linoleate together constituted 74–76% of the total fatty acids; a desirable nutritional trait. However, higher unsaturation in an oil affects seed stability and lowers the shelf-life of such oil-derived products (Lea, 1962).

The ratio between 18:1 and 18:2 fatty acid values varied amongst the cultivars with a coefficient of variation of 4.44. The ratio of 18:1/18:2 in the oil of cultivars Alabama and Kidang was significantly different (5% level) from that of cultivars CES 101, Kuala Brang K-2, CES 102, Matjam, Gadjah and F-334-33, while the remaining cultivars were relatively insensitive to these differences. The role of the 18:1/18:2 ratio in groundnut oils has been emphasized in controlling the shelf-life of the products (Worthington *et al.*, 1972; Young *et al.*, 1974). The higher this ratio, the higher is the oil stability and the longer is the shelf-life of roasted and other groundnut products. Manufacturers may increase the 18:1/18:2 ratio by blending different varieties of groundnuts to prepare products such as peanut butter with improved texture, flavour and stability (Worthington and Hammons, 1971). For this purpose, locally produced cultivars Alabama and Kidang may prove more suitable.

The results in Table 1 also indicate that the percentage of behenate in the oil of cultivars Tainang 7 and Kidang differed significantly from that of the cultivars Nan Gai 60, 47-5, Red Indonesian, CES 102, SK 28, Sungai Siput Local, V-13, Kuala Brang K-2, CES 101, Gadjah, Banting and F334-33. The percentage of arachidate was relatively insensitive to cultivar differences. The total percentage of arachidate plus behenate was highest in the cultivar Nan Gai 60 and the lowest in cultivar Tainang 7, followed by cultivars Kidang and Alabama. A low level of arachidic and behenic acids in groundnut oil is considered desirable as these fatty acids have been associated with atherogenicity of the groundnut oils (Kritchevsky *et al.*, 1971; Nutrition Foundation, Inc., 1973; Kies *et al.*, 1978). Kritchevsky *et al.*, (1981) have further shown that groundnut oils of different origins exhibit different levels of atherogenicity in rabbits. They attributed these differences to the manner of distribution of these fatty acids on the triglyceride molecules in various groundnut oils. The possibility of occurrence in these oils of other unknown factor(s) with atherogenic properties cannot be ruled out. However, the potential health hazard of these two fatty acids should be considered in the evaluation of different groundnut varieties.

These observations on oil content and fatty acid composition of the various groundnut varieties suggest that cultivars Tainang 7, Kidang and Alabama may prove more promising for further multiplication and for commercial purposes.

TABLE 1

The oil Content and Fatty Acid Composition of 16 Groundnut Cultivars[a]

| Cultivar | Oil % DB | Methyl Fatty Acid Esters (Mean of Area %) | | | | | | | | | 18:1/ 18:2 Ratio | Total 20:0 + 22:0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 16:0[b] | 16:1 | 18:0 | 18:1 | 18:2 | 20:0 | 20:1 | 22:0 | 24:0 | | |
| Nan Gai 60 | 43.43 | 12.98 | 0.12 | 3.65 | 39.09 | 35.35 | 1.85 | 1.10 | 4.36 | 1.41 | 1.11 | 6.21 |
| 47 – 5 | 44.36 | 12.97 | 0.11 | 3.38 | 39.27 | 35.85 | 1.71 | 1.15 | 4.06 | 1.42 | 1.10 | 5.77 |
| CES 101 | 45.56 | 13.30 | 0.11 | 3.56 | 38.60 | 36.72 | 1.69 | 1.04 | 3.62 | 1.26 | 1.05 | 5.31 |
| Kuala Brang K-2 | 45.77 | 13.02 | 0.13 | 3.42 | 38.55 | 36.81 | 1.85 | 1.16 | 3.66 | 1.27 | 1.05 | 5.50 |
| Banting | 45.96 | 12.58 | 0.11 | 3.23 | 40.67 | 35.67 | 1.67 | 1.13 | 3.59 | 1.27 | 1.15 | 5.26 |
| CES 102 | 45.97 | 13.17 | 0.12 | 3.38 | 37.94 | 37.03 | 1.76 | 1.16 | 3.96 | 1.37 | 1.03 | 5.72 |
| Red Indonesian | 46.20 | 12.53 | 0.12 | 3.17 | 39.80 | 35.94 | 1.67 | 1.22 | 4.04 | 1.44 | 1.11 | 5.71 |
| Sungai Siput Local | 46.41 | 13.12 | 0.12 | 3.23 | 38.87 | 35.62 | 1.66 | 1.15 | 3.70 | 1.36 | 1.12 | 5.35 |
| V–13 (Cheek) | 47.08 | 12.88 | 0.11 | 3.56 | 39.76 | 35.91 | 1.73 | 1.04 | 3.68 | 1.19 | 1.11 | 5.41 |
| Matjam | 47.18 | 12.93 | 0.11 | 3.67 | 39.42 | 36.43 | 1.69 | 0.97 | 3.46 | 1.15 | 1.09 | 5.15 |
| Gadjah | 47.97 | 13.13 | 0.11 | 3.56 | 38.65 | 37.00 | 1.70 | 1.06 | 3.61 | 1.11 | 1.05 | 5.31 |
| SK 28 | 48.07 | 13.01 | 0.11 | 3.59 | 39.45 | 35.91 | 1.77 | 1.08 | 3.74 | 1.25 | 1.10 | 5.51 |
| F-334-33 | 48.21 | 13.17 | 0.11 | 3.46 | 38.18 | 37.51 | 1.68 | 1.04 | 3.59 | 1.18 | 1.02 | 5.27 |
| Alabama | 48.98 | 12.22 | 0.12 | 3.31 | 41.90 | 34.59 | 1.63 | 1.13 | 3.51 | 1.41 | 1.22 | 5.14 |
| Tainang 7 | 49.88 | 12.84 | 0.11 | 3.66 | 41.32 | 35.05 | 1.64 | 0.99 | 3.24 | 1.08 | 1.18 | 4.88 |
| Kidang | 50.24 | 12.60 | 0.11 | 3.55 | 41.67 | 34.73 | 1.68 | 1.06 | 3.40 | 1.13 | 1.20 | 5.08 |
| Coefficient of Variation | 2.38 | 1.68 | 10.40 | 4.02 | 2.34 | 1.96 | 4.27 | 5.10 | 3.86 | 4.99 | 4.44 | 2.88 |
| L.S.D., 5% | 2.38 | 0.43 | 0.02 | 0.21 | 1.98 | 1.51 | 0.16 | 0.12 | 0.30 | 0.13 | 0.10 | 0.30 |
| L.S.D., 1% | 3.29 | 0.59 | 0.03 | 0.29 | 2.73 | 2.08 | 0.22 | 0.16 | 0.42 | 0.19 | 0.14 | 0.42 |

[a] All, except Alabama (Virginia type), Spanish type.
[b] No. carbons: No. double bonds
DB = Dry basis

## CONCLUSION

There are numerous variables including climate, location, soil, irrigation, fertilizer, post harvest processing, storage, etc. that may affect the composition of groundnuts. The present investigation did not incorporate any of these variables in the experimental design. Nevertheless, these preliminary studies on the differences in oil content and oil fatty acid composition of 16 groundnut varieties support the need for selection and development of commercial varieties with desired levels of stability and nutritional characteristics.

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