Food Chemistry **26** (1987) 119–124

Chemical and Nutritional Evaluation of Neem Oil

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(Received 12 November 1986; revised version received 19 January 1987; accepted 2 March 1987)

ABSTRACT

In view of the edible oil shortage in India, nutritional and toxicological evaluations of unconventional oils of high potential are needed to assess them for safe edibility. Seed of Azadaracta indica, *popularly known as neem, has 45% oil and is a minor oil seed of considerable potential. Neem oil is usually bitter and non-edible. A new process has been developed recently to produce a colourless, odourless and non-bitter oil. Chemical and nutritional evaluation of this oil is therefore undertaken.*

The oil has 50% oleic and 15% linoleic acid and no unusual fatty acids. The physico-chemical parameters are within the range of other edible oils. Nutritional studies, carried out for 14 weeks in weanling rats, feeding at the 10% level of the oil in 20% protein diet adequate in all nutrients, showed good growth performance and food intake comparable with groundnut oil. Cholesterol and triglycerides in serum and liver were comparable in both the neem oil and groundnut oil groups. Absorption of neem oil is comparable with groundnut oil in rats fed these diets. Retentions of nitrogen, calcium and phosphorus are also comparable in both groups.

Nutritional studies indicate that debitterized neem oil has a chemical and nutritional quality comparable to other edible oils.

INTRODUCTION

Studies on minor oil seeds (Rukmini *et al.*, 1982; Rukmini & Vijayaraghavan, 1984) are in progress as part of an effort to meet the present shortage

Food Chemistry 0308-8146/87/$03·50

of edible oil in India. Recently, studies on the oil from the kernels of *Terminelia bellerica* (Rukmini & Udayasekhara Rao, 1986) have been reported. *Azadaracta indica* (Wealth of India, 1984), popularly known as neem, is widely scattered in India and other tropical countries. The production and availability (Lakshmikantan, 1977) of the oil are given in Table 1.

TABLE 1
1977–1978 Estimates of Neem Oil (in 1 000 Tonnes) (Wealth of India, 1984)

Estimated production of seeds	*Actual seeds collected*	*Oil produced*
418 000	100	30

Neem oil is bitter, has an unpleasant odour and hence is non-edible. The bitter principles comprise about 2% of the oil. Several bitter principles have been isolated, the major being nimbidin (1·4%), which, on hydrolysis, gives nimbidinic acid, which contains sulphur. The unpleasant odour is due to these sulphur-containing components. Besides nimbidin, several other bitter principles have been reported (Vimal & Napaade, 1980; Prasad & Venkoba Rao, 1981) such as nimbinin (0·01%), nimbin (0·12%) and nimbidiol (0·5%). All these compounds are active insecticides. Neem oil is reported to be antidiabetic (Sankaram, 1986). Recently, azaradactin, a potent pesticide which is also bitter, has been isolated from neem seeds (Sankaram, 1986). A simple technology has been developed by scientists of the Regional Research Laboratory at Hyderabad to extract the insecticides from the kernel prior to extraction of the fat, as the bitter principle is soluble in a polar solvent. Subsequent hexane extraction gives a pale yellow clear oil devoid of bitterness and smell.

The chemical nature and nutritional quality of the debitterized neem oil are studied and reported in this paper.

MATERIALS AND METHODS

Chemical analysis

The debitterized neem oil was supplied by the Regional Research Laboratories, Hyderabad, for our experiment. The physico-chemical parameters and the fatty acid composition by GLC (Varian 3700) on a

15% DEGS column on Chromosorb W (45–60 mesh) and FID were determined by conventional methods.

Nutritional evaluation

Weanling albino rats of the Wistar strain were divided into two groups of 12 animals each (6♀ and 6♂) and fed a diet containing 20% protein and 10% neem oil or groundnut oil which was adequate in all nutrients, for 14 weeks. Animals were caged individually and food and water supplied *ad lib.* Weekly food intake and body weights of individual animals were recorded. Towards the end of 14 weeks the animals were transferred to metabolic cages and faeces were collected for 3 days. Diet and faeces were analyzed for nitrogen, calcium and phosphorus (AOAC, 1984). Retention of these nutrients was calculated from the diet intake and faecal excretion. Cholesterol (Abel & Brodie, 1952) and triglycerides (Ulrich, 1974) were estimated in liver and serum of all animals at the end of the study. All the results were analyzed statistically.

RESULTS AND DISCUSSION

Tables 2 and 3 provide data on the physico-chemical parameters and fatty acid profile by GLC of the neem oil. The oil does not contain any unusual Fatty Acids and the physico-chemical parameters are within the normal range. The oil has 33% saturates and 65% unsaturates, of which 50% is oleic and 15% linoleic acid.

Table 4 gives data on growth parameters. The body weights of the two groups at the end of 14 weeks' study did not show significant differences. The

TABLE 2
Analysis of Neem Oil

Parameters	*Obtained (Debitterized oil)*	*Reported (Bitter oil)*
Colour	Yellow	Greenish–brown
Odour	Odourless	Garlic repulsive
RI (40°)	—	1·461 7–1·462 7
Sp. Gr. (30°)	—	0·908 7–0·918 9
Iodine value	69·3	68·0–75·8
Sap. value	196	193–204
Acid value	0·3	—
Unsap. matter	1·4%	0·8–2·3%

TABLE 3
Fatty Acids Composition of Neem Oil/Groundnut Oil

Fatty acids		*Neem oil % weight (GLC)*	*Groundnut oil % weight (GLC)*
Myristic	(14:0)	0·03	—
Palmitic	(16:0)	17·8	14·3
Stearic	(18:0)	14·4	3·1
Oleic	(18:1)	51·3	42·6
Linoleic	(18:2)	14·7	35·9
Arachidic	(20:0)	1·6	2·7

TABLE 4
Growth Chart of Rats Fed Groundnut Oil or Neem Oil for 14 Weeks[a]

Oils studied	*Initial body weight (g)*	*Final body weight at the end of 14 weeks (g)*	*Gain in body weight in 14 weeks (g)*	*Average food intake per animal/per week (g)*
Groundnut oil (12)	46·1 ± 3·59	235·6 ± 55·82	189·4 ± 55·65	68·0 ± 9·33
Neem oil (12)	46·1 ± 1·99	206·0 ± 57·44	159·9 ± 57·79	65·9 ± 9·56

[a] Values are mean ± SD.

TABLE 5
Lipid Profile of Rats Fed Groundnut Oil (GNO) or Neem Oil for 14 Weeks[a]

Parameters	*Serum*		*Liver*	
	GNO (12)[b]	*Neem oil (12)*	*GNO (12)*	*Neem oil (12)*
Total lipids ($g\,100\,g^{-1}$)	—	—	6·6 ± 0·717	6·1 ± 1·09
Cholesterol ($mg\,dl^{-1}$)	68·7 ± 13·27	58·0 ± 8·7	75·5 ± 17·31	56·0 ± 20·62
	$P < 0·05$		NS	
Triglycerides ($mg\,dl^{-1}$)	51·8 ± 18·29	38·0 ± 23·01	134·3 ± 10·2	119·7 ± 10·7
	NS		$P < 0·05$	

[a] Values are mean ± SD.
[b] Numbers in parentheses indicate the numbers of animals.
NS, not significant.

TABLE 6
Fat Absorption, Nitrogen, Calcium and Phosphorus Retention in Rats Fed Groundnut Oil (GNO) or Neem Oil (NO) for 14 Weeks

		Fat absorption (%)	*Retention*		
			Nitrogen (%)	*Calcium* (%)	*Phosphorus* (%)
GNO	(6)[a]	96·8	86·4	95·4	99·1
NO	(6)	95·4	85·1	94·2	96·7

[a] Numbers in parentheses are the numbers of animals.

food intake was also comparable in both groups. Table 5 gives the cholesterol and triglyceride contents of the serum and liver of both groups, which are also comparable. Neem oil is absorbed to the same extent as groundnut oil. Nitrogen, calcium and phosphorus balance studies showed that the retention values for these nutrients were similar in both groups (Table 6).

Neem oil is usually bitter and non-edible. Animals refuse to eat diets containing neem oil. However, after removing the bitter principle, rats were able to consume diets containing debitterized neem oil, as well as control diets containing groundnut oil. Hence, it was possible to conduct nutritional studies on this oil. The results of such studies indicated that debitterized neem oil has a nutritional quality comparable to groundnut oil as indicated by growth, food intake, serum and liver lipid profiles (Tables 4 and 5). The retention of nutrients, such as calcium, phosphorus and nitrogen, and fat absorption, are comparable with groundnut oil-fed rats. No adverse effects were seen in any of the parameters studied. Debitterized neem oil has no mutagenicity (Sankaram, 1986).

Complete nutritional evaluation and chemical analysis indicate that debitterized neem oil may be used for edible purposes and can be blended with other oils. However, multigeneration breeding studies with rats fed a neem oil diet are necessary to assess reproductive toxicology, teratogenicity or any other possible toxic effects.

ACKNOWLEDGEMENTS

The author is grateful to the Director, Dr B. S. Narasinga Rao, for his interest in the work. He is also grateful to Dr A. V. B. Sankaram, Assistant Director, R.R.L. (Hyderabad) for the supply of oil. The technical assistance of Mrs Indra Ravindranath, Shri Hari Shankar and Shri Zahid Nazimuddin is gratefully acknowledged.

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