ELSEVIER

Food Chemistry **50** (1994) 379–382

0308-8146/94/$7.00

Nutrient composition of some less-familiar oil seeds

P. Udayasekhara Rao

National Institute of Nutrition, Indian Council of Medical Research, Jamai Osmania PO, Hyderabad 500 007, India

(Received and accepted 28 July 1993)

Seven less familiar oil seeds, namely gokhru, thumba, onion, tobacco, grape, niger seeds and mango seed kernels were analysed for their proximate composition, amino acid and fatty acid composition. Gokhru, niger, tobacco and onion seeds were found to be good sources of protein and fat. Crude fibre contents of thumba and grape seeds were high. The seeds of thumba, niger, onion and mango (seed kernel) contained 4 g lysine per 16 g N. The methionine content of onion-seed protein was very high. Fatty acid profiles of fat from these oil seeds revealed a high proportion of unsaturated fatty acids with the exception of gokhru.

INTRODUCTION

Interest in newer sources of edible oils has grown due to their shortage in India. As a part of our research for newer sources of edible oil seeds, we have so far analysed neem (*Azadirachta indica*) seed kernel cake (Udayasekhara Rao, 1987), goa beans or winged beans (*Psophocarpus tetragonolobus*) (Udayasekhara Rao & Belavady, 1979), okra (*Hibiscus esculentus*) (Udayasekhara Rao, 1985), tomato seeds (*Lycopersicum esculentus*) (Udayasekhara Rao, 1991) and *Terminalia bellireca* kernels (Rukmini & Udayasekhara Rao, 1986). Limited data are available regarding mango seed kernel and grape seed. Comprehensive data with regard to chemical composition, amino acid composition and fatty acid profile of the less familiar oil seeds are not available. Hence, in the present investigation, seven unconventional and/or less-familiar oil seeds, namely, gokhru (*Xanthium strumarium*) kernels, thumba (*Citrullus colocynthis*), onion (*Allium cepa*), tobacco (*Nicotiana tabacum*), grape (*Vitis vinifera*), niger (*Guizotia abysinica*) seeds and mango (*Mangifera indica*) seed kernels were analysed for their proximate composition as well as for amino acid and fatty acid contents.

MATERIALS AND METHODS

Chemical composition

Seeds of gokhru, thumba, onion, tobacco, grape and niger were obtained from the Oil Technology Research Institute, Ananthapur, A.P. while mango kernels were supplied by Foods Fats and Fertilizers, Tadepalligudem, Andhra Pradesh. After cleaning, the seed samples were ground to pass through 40-mesh sieve. The samples were analysed for crude protein (N x 6·25), ether extractives, ash, crude fibre, phosphorus, calcium and iron by AOAC (1970) methods. Trace elements were estimated in an atomic absorption spectrophotometer, Varion Techtron model AAS 1000. Tannin content of the defatted samples was determined by the modified vanillin method of Price *et al.*, (1978). Nicotinic acid and riboflavin were estimated by a microbiological method (Rao & Ramastri, 1969) using *L. arabinoses* and *L. casei*, respectively.

Amino acid composition

Defatted samples (15–20 mg) of oil seeds were hydrolysed in constant boiling hydrochloric acid at 110°C for 20 h in evacuated sealed ampoules. Excess acid was removed by flash evaporation under reduced pressure. Amino acid analyses were carried out in an automatic amino acid analyser (Moore *et al.*, 1958). Tryptophan content of the protein was estimated in an alkaline hydrolysate by a microbiological method using *L. mesenteroides* P-66 as the test organism (Barton-Wright, 1946).

Fatty acid profile

Aliquots of fat were subjected to methanolysis and transesterification. The resulting methyl esters were analysed in a Varion model 3700 gas chromatograph fitted with a flame ionization detector, in a column containing 15% polydiethylene glycol succinate coated

Table 1. Nutrient composition of some less-familiar oil seeds

	Gokhru	Thuma	Grape	Niger	Tobacco	Onion	Mango kernel
Moisture g 100 g^{-1}	5·2	6 0	6·0	2·8	3·0	6·8	7·5
Protein g 100 g^{-1}	48·2	19·4	10·0	30·0	24·7	27·9	5·1
Fat g 100 g^{-1}	29·5	16·1	10·2	34·4	33·7	23·6	11·3
Ash g 100 g^{-1}	10·2	4·3	2·9	9·9	4·4	6·5	2·7
Crude fibre g 100 g^{-1}	2·1	44·5	44·2	9·0	17·6	16·1	0·3
Starch g 100 g^{-1}	5·4	3·9	4·1	6·1	5·6	20·4	—
P mg 100 g^{-1}	911	449	315	801	483	614	172
Ca mg 100 g^{-1}	417	291	290	587	178	279	24
Mg mg 100 g^{-1}	564	198	118	323	345	414	234
Fe mg 100 g^{-1}	8	14	5	30	33	43	5·2
Zn mg 100 g^{-1}	3·9	3·6	1·1	6·6	7·8	5·6	1·1
Mn mg 100 g^{-1}	6·9	3·8	7·8	8·5	3·0	2·3	0·2
Cu mg 100 g^{-1}	4·6	2·4	2·1	5.7	0·5	0·5	0·8
Cr mg 100 g^{-1}	0·2	0·2	0·2	0·4	0·07	0·1	—
Tannins mg 100 g^{-1}	ND	ND	4184	158	—	—	—
Nicotinic acid mg 100 g^{-1}	0·73	0·59	0·66	0·57	3·66	6·0	1.3
Riboflavin mg 100 g^{-1}	0·24	0·10	0·14	0·22	0·56	0·63	0·33

Values given are means of two estimations.

on chromosorb W as the stationary phase (Kishimoto & Hoshi, 1972).

RESULTS AND DISCUSSION

Chemical composition of the oil seeds is presented in Table 1. Protein content of the seeds varied between 5 and 48 g 100 g^{-1}. Gokhru kernels has the highest protein (48·2 g 100 g^{-1}) while mango kernels had the least (5·1 g 100 g^{-1}). Except for mango kernels and grape seeds, the remaining oil seeds contained 20 g 100 g^{-1} or more protein. Out of the seven oil seeds analysed, gokhru, niger and tobacco seeds contained 30 g 100 g^{-1} or more fat, while grape, thumba seeds and mango kernels had between 10 and 20 g 100 g^{-1} fat. Even in the ash content there was a lot of variation (2·7 to 10·2 g 100 g^{-1}). Crude fibre content varied from 0·3 to 44·5 g 100 g^{-1}. This may reflect the varying thickness of the seed coat of these oil seeds. Gokhru and niger were very good sources of phosphorus and calcium. Magnesium content of these oil seeds is high. Grape seeds contained very high amounts of tannin but it was absent in gokhru, thumba and mango kernels. Onion and tobacco seeds contained reasonably high amounts of nicotinic acid and riboflavin.

Lakshminarayana *et al.* (1983) analysed 43 varieties of mango seed kernels and observed that their protein, fat and ash contents varied from 3·7–12·6%, 4·0–8·1% and 1·0–3·7 g 100 g^{-1} respectively. The values for mango kernels reported by Narasimha Char *et al*, (1977) for protein, fat and ash were 5·5 g 100 g^{-1}. 11·0 g 100 g^{-1} and 2·1 g 100 g^{-1} respectively. The values obtained in the present investigation were in agreement with the above values

Castriotta and Canella (1978) observed 10 g 100 g^{-1} protein and 3·6 g 100 g^{-1} ash for the grape seed cake they had analysed. Kamel *et al.* (1985) observed values

Table 2. Amino acid composition of some less-familiar oil seeds

	Gokhru	Thumba	Grape	Niger	Tobacco	Onion	Mango kernel
Lysine	2·3	4·9	2·6	4·0	2·7	5·0	5·2
Histidine	2·2	3·4	2·0	2·1	2·3	1·9	2·5
Arginine	11·4	18·2	5·2	3·3	11·9	9·4	8·4
Aspartic acid	9·8	8·2	16·4	9·6	7·8	6·5	10·0
Threonine	3·2	5·0	3·6	5·3	4·1	2·5	4·2
Serine	5·2	5·1	1·1	5·5	4·1	5·4	5·3
Glutamic acid	26·7	19·2	22·5	27·0	22·9	21·3	22·3
Proline	3·3	—	3·8	—	4·0	1·9	5·0
Glycine	4·7	6·0	7·4	4·8	4·8	3·8	4·7
Alanine	3·8	4·5	4·3	3·7	4·5	4·1	5·1
Valine	4·1	3·7	3·7	4·0	5·1	4·4	4·7
Methionine	1·6	1·2	0·3	1·2	1·6	4·4	1·4
Isoleucine	3·7	3·2	3·3	3·7	7·1	4·8	5·5
Leucine	6·4	6·6	6·3	6·5	8·6	6·1	8·1
Tyrosine	2·8	1·7	1·4	2·7	2·3	2·3	3·2
Phenylalanine	4·3	4·5	3·2	2·8	4·3	3·9	4·4
Tryptophan	1·2	0·9	0·4	1·0	0·7	0·5	0·7
Chemical score	33	36	15	33	39	—	31
First limiting amino acid	Lysine	Methionine	Methionine	Methionine	Lysine	Tryptophan	Methionine

Values given are g per 16 g N.

Table 3. Fatty acid composition of some minor or less-familiar oil seeds

Fatty acid	Gokhru	Thumba	Grape	Niger	Tobacco	Onion	Mango kernel
14:0	23·5	9·2	8·1	8·8	0·7	0·7	—
16:0	12·9	6·9	3·5	6·4	9·4	9·1	8·4
18:0	—	—	—	—	—	4·4	41·6
18:1	34·0	19·6	19·5	14·7	13·7	34·3	41·7
18:2	20·8	62·7	66·7	70·1	70·7	44·6	7·8
18:3	Tr	0·2	0·5	Tr	0·9	0·3	0·3
Others	8·8	1·4	1·7	Tr	—	8·0	—

Values given are means of two estimations.

of 8·2 g 100 g^{-1} protein, 14 g 100 g^{-1} fat, 2·2 g 100 g^{-1} ash and 38·6 g 100 g^{-1} crude fibre. The results of the present study confirm the above results.

The values for onion seed reported by Narasimha Reddy *et al.* (1989) for protein, fat, ash and crude fibre are essentially similar to those observed in the present investigation.

Amino acid composition

Lysine content of thumba, niger, onion seeds and mango kernel proteins is more than 4 g per 16 g N (Table 2). Lysine is the limiting amino acid of the gokhru and tobacco seed proteins. Glutamic and aspartic acid, two non-essential amino acids, constituted 27·4–38·9% of the total amino acid content of these oil-seed proteins. Some of the oil seeds contained high amounts of arginine–thumba 18·2, tobacco 11·9 and gokhru 11·4 g per 16 g N. Tryptophan content of grape and onion seed proteins is very low and tryptophan is the limiting amino acid of the onion-seed proteins.

Methionine content of onion seed protein was high (3·9 g per 16 g N) while its content in grape seed protein is very low 0·3 g per 16 gN. Other oil seeds contained between 0·9 and 1·6 g methionine per 16 g N. Thumba, grape, niger seeds and mango kernel proteins are limiting in sulphur containing amino acids.

Lysine content of grape seed protein was reported in the literature as 2·57 (Kamel *et al.*, 1985), 2·85 (Braddock and Kesterson, 1972) and 3·14 g per 16 g N (Castriotta & Canella, 1978). Total sulphur–containing amino acid content of grape seed protein observed in the present study was lower than that reported in the literature (Kamel *et al.*, 1985; Braddock and Kesterson, 1972). Castriotta and Cannela (1978) observed that sulphur containing amino acids are limiting in grape protein. The glutamic acid content of the grape-seed protein observed in this study agreed well with the literature values (Braddock & Kesterson, 1972; Castriotta & Canella, 1978).

Table 3 gives the fatty acid profiles of fats from different oil seeds analysed. Unsaturated fatty acid content of these oil seeds was 80% or more with the exception of gokhru, where it was found to be 55%. Even the polyunsaturated fatty acid content was more than 60% in the case of thumba, grape, niger and tobacco while gokhru kernel (21%) and onion seed (45%) fat had lower levels of PUFA. Thumba-seed fat resembled that of soya bean; onion-seed fat was similar to that of sunflower, while grape-, niger- and tobacco-seed fat resembled safflower.

Fedele (1983) reported 12–25% linoleic and 60–70% linolenic acid in grape-seed oil. Kamel *et al* (1985) observed 88·6% unsaturate and 72·2% of PUFA in grape-seed fat. The fatty acid composition of grape-seed fat reported in this study agrees well with the values reported earlier.

Lakshminarayana *et al.* (1983) analysed 43 varieties of mango seed kernels and reported the range of the fatty acid composition as palmitic 3–18%, stearic 24–57%, oleic 34–56% and linoleic 1–18%. The results obtained in the present study are very close to those reported by Narasimha Char *et al* (1977) and Rukmini and Vijayaraghavan (1984) as well as Ali *et al* (1985).

Narasimha Reddy *et al.* (1989) observed the fatty acid composition of onion seed fat as palmitic 7·2%, stearic 1·2%, oleic 33·5% and linoleic 58·1% and the results of the present study are in agreement with the above.

The results of the present investigation indicate that gokhru kernels, niger, tobacco and onion seeds are good sources of protein and fat. The crude fibre content of thumba and grape seed is very high. The lysine content of thumba, niger and onion seeds as well as mango seed kernel proteins is above 4 g per 16 g N. Onion seeds contained very high amounts of methionine. All the seeds contained a high proportion of unsaturated fatty acids, with the exception of gokhru.

However, the edibility of the seed fat has to be ascertained. The digestibility and bioavailability of these nutrients from the seeds need to be determined.

ACKNOWLEDGEMENTS

Thanks are due to Dr Vinodini Reddy, Director, National Institute of Nutrition, for her interest in the work and Mr P. Ramulu for his technical assistance.

REFERENCES

Ali, M. A., Gafur, M. A., Rahman, M. S. & Ahmed, G. M. (1985). Variation in fat content and lipid class composition in ten different mango varieties. *JAOCS*, **62**, 520-3.

AOAC (1970). Official methods of analysis 11th edn. Associa-

tion of Official Analytical Chemists, Washington, DC, USA.

Barton-Wright, E.C. (1946). The microbiological assay of amino acids. The assay of tryptophan, leucine, isoleucine, valine, cystine, methionine, lysine, phenylalanine, histidine, arginine and threonine. *Analyst*, **11**, 267.

Braddock, R. J. & Kesterson, J. W. (1972). Amino acids of citrus seed meal. *JAOCS*, **49**, 671.

Castriotta, G. & Canella, M. (1978). Protein classification and nitrogen extractability of grape seed meal. *J. Agric. Food Chem.* **26**, 763.

Fedele, E. (1983). Miscellaneous exotic oils. *JAOCS*, **60**, 404–6.

Kamel, B. S., Dawson, H. & Kakuda, Y. (1985). Characteristics and composition of melon and grape seed oils and cakes. *JAOCS*, **62**, 881–3.

Lakshminarayana, G., Chandrasekhara Rao, T. & Ramalingaswamy, P.A. (1983). Varietal variation in content, characteristics and composition of mango seeds and fat. *JAOCS*, **60**, 88–9.

Moore, S., Spackman, D. H. & Stein, W. H. (1958). Chromato-graphy of amino acids on sulphonated polystyrine resins. An improved system. *Anal. Chem.*, **30**, 1185–90.

Narasimha Char, B. L., Reddy, B. R. & Thirumala Rao, S. D. (1977). Processing of mango stones for fat. *JAOCS*, **54**, 494-5.

Narasimha Reddy, P., Azeemoddin, G. & Thirumala Rao, S. D. (1989). Processing an analysis of onion seed (*Allium cepa*) and its fixed oil. *JAOCS*, **66**, 365.

Price, M. L., Scoyoc, S. V. & Butler, L. G. (1978). A critical evaluation of the vanillin reaction as an assay for tannin in sorghum grain. *J. Agric. Food Chem.*, **26**, 1214–8.

Rao, P.S. & Ramasastri, B. V. (1969). The nutritive value of some *Indica japonica* and hybrid varieties of rice. *J. Nutr. Dietet.*, **6**, 204–8.

Rukmini, C. & Udayasekhara Rao, P. (1986). Chemical and nutritional studies on *Terminalia bellirica* Rob kernel and its oils. *JAOCS* **63**, 360-3.

Rukmini, C. & Vijayaraghavan, M. (1984). Nutritional and toxicological evaluation of mango kernel oil. *JAOCS*, **61**, 789–92.

Udayasekhara Rao, P. (1985). Chemical composition and biological evaluation of okra (*Hibiscus esculentus*) seeds and their kernels. *Qual. Plant. Plant. Foods Hum. Nutr.*, **35**, 389–96.

Udayasekhara Rao, P. (1987). Chemical composition and biological evaluation of debitterised and defatted neem (*Azadirachta indica*) seed kernel cake. *JAOCS*, **64**, 1348–52.

Udayasekhara Rao, P. (1991). Nutrient composition and biological evaluation of defatted tomato (*Lycopersicum esculentus*) seed cake. *Plant Foods Hum. Nutr.* **41**, 101–6.

Udayasekhara Rao, P. & Belavady, B. (1979). Chemical composition and biological evaluation of Goa beans (*Psophocarpus tetragonolobous*) and their tubers. *J. Plant Foods*, **3**, 169-74.

Kishimoto, Y. & Hoshi, M. (1972). Isolation purification and assay of fatty acids and steroids from the nervous system. In *Methods of Neurochemistry*, Vol. 3, ed. R. Fried. Marcel Dekker, New York, USA, 75–154 pp.