# Chemical Composition of *Momordica charantia* L. Fruits

Kuri E. Yuwai,[†] Koyyalamudi Sundar Rao,[*,†] Chalapan Kaluwin,[†] Gwyn P. Jones,[‡] and Donald E. Rivett[§]

Department of Chemistry, University of Papua New Guinea, P.O. Box 320, Papua New Guinea, Division of Human Nutrition, Deakin University, Victoria 3217, Australia, and CSIRO Division of Protein Chemistry, 343 Royal Parade, Victoria 3054, Australia

The chemical composition of bitter gourds (Momordica charantia) was analyzed. The bitter gourds yielded on extraction with chloroform-methanol 0.76% lipids (dry weight), which were separated into nonpolar lipids (38.81%), glycolipids (35.80%), and phospholipids (16.40%) by silicic acid column chromatography. The mineral and amino acid analysis showed that the bitter gourds contained nutritionally useful quantities of most of the essential minerals and amino acids. The predominant fatty acid was $\alpha$-eleostearic acid in nonpolar lipids, linolenic acid in glycolipids, and palmitic acid in phospholipids.

## INTRODUCTION

Momordica charantia Linn. (Cucurbitaceae) is a widely cultivated plant for medicinal and food uses. The fruits (bitter gourds) of the plants are used in culinary preparations all over the world. The cooked fruit is eaten as a remedy for catarrh, flux, and cough. Juice from the green fruit is drunk as a remedy for chronic colitis and bacillary dysentry (Perry, 1980). Information on chemical composition of bitter gourd fruits is not readily available. The present work was undertaken to study the levels of lipids, fatty acids, protein, amino acids, and minerals in bitter gourds.

## MATERIALS AND METHODS

**Materials.** Typical young fresh fruits of this plant normally used in culinary preparations were purchased in local vegetable market. The fruits were cut into small pieces, pooled to form composite samples, and processed immediately.

**Methods.** The recommended methods of the Association of Official Analytical Chemists (AOAC, 1975) were used for the determination of moisture, ash, and protein. The samples were weighed and dipped in hot water to inactivate the lipases (Haverkate and Van Deenen, 1965). The experimental procedures for extraction of total lipids with chloroform-methanol and their purification and separation into nonpolar lipids, glycolipids, and phospholipids by silicic acid column chromatography were described in detail in an earlier paper (Lakshminarayana et al., 1984; Sundar Rao and Lakshminarayana, 1988). The lipid classes were estimated by gravimetry. Acyl lipids were transesterified with methanol containing 1% sodium methoxide (Luddy et al., 1960). The fatty acid methyl esters were qualitatively examined for the presence of novel fatty acids by ultraviolet (UV), infrared (IR), and $^1$H nuclear magnetic resonance spectroscopy. Fatty acid methyl esters were analyzed by using a Hewlett-Packard 5890A gas chromatograph fitted with a flame ionization detector and a data processor. Helium was used as a carrier gas, and the column, injection port, and detector were maintained at 200, 220, and 240 °C, respectively. A polar (BP-20) capillary column (12.0 m × 0.25 mm; SGE Scientific, Melbourne) was used to separate the esters. The peaks were identified by comparison with standard fatty acid methyl esters.

Amino acid analysis was conducted on dried, comminuted fruits. These were heated in sealed glass tubes containing 6 M HCl for 24 h at 110 °C. Amino acid analysis was described in detail elsewhere (Sundar Rao et al., 1989). Samples were ashed and analyzed for component minerals according to AOAC methods (AOAC, 1975) using Varian Model AA-175 atomic absorption spectrophotometer.

[†] University of Papua New Guinea.
[‡] Deakin University.
[§] CSIRO.

**Table I. Proximate Composition of Bitter Gourds (*M. charantia*)**

| | |
|---|---|
| moisture | 93.20 |
| lipids[a] | 0.76 |
| protein[a] | 18.02 |
| ash[a] | 8.12 |
| minerals, mg/100 g[b] | |
| Cu | 3.54 |
| Fe | 5.97 |
| Mg | 119.92 |
| Zn | 3.53 |
| Ca | 137.69 |

[a] On dry basis. [b] Fresh weight basis (average of two determinations).

**Table II. Fatty Acid Composition (Percent Area) of Lipid Classes of Bitter Gourds (*M. charantia*)[a]**

| fatty acid | nonpolar lipids (42.65%) | glycolipids (39.35%) | phospholipids (18.00%) |
|---|---|---|---|
| lauric | 0.25 | 0.58 | 0.27 |
| myristic | 0.09 | 0.36 | 0.32 |
| palmitic | 7.36 | 29.42 | 35.01 |
| palmitoleic | 0.21 | 0.19 | 0.16 |
| stearic | 27.05 | 9.56 | 6.30 |
| oleic | 3.92 | 4.09 | 6.34 |
| linoleic | 6.31 | 14.10 | 19.67 |
| linolenic | 5.87 | 34.92 | 26.26 |
| $\alpha$-eleostearic | 44.92 | 3.63 | 4.48 |
| unknowns | 4.02 | 3.56 | 1.20 |

[a] Overall recovery of total lipids after column chromatography was 91.01%. Duplicate values for methyl esters in standard mixtures by GLC analysis varied within 10% for minor components (<5%) and within 3% for others.

## RESULTS AND DISCUSSION

The moisture, lipid, protein, ash, and mineral contents are given in Table I. The lipid and protein contents were low, compared with those of leafy green vegetables. The levels of trace minerals were low (Cu, 3.54; Fe, 5.97; Zn, 3.53). One of the major factors influencing trace mineral uptake in plants is the composition of soil (Nielson, 1980).

The lipid content of bitter gourd fruits amounted to 0.76% on a dry weight basis. The lipid classes and fatty acid compositions are presented in Table II. The chief

0021-8561/91/1439-1762$02.50/0 

Table III. Amino Acid Composition of Bitter Gourds[a]

| amino acid[b] | bitter gourds | soybean flour |
|---|---|---|
| Asp | 11.42 | |
| Thr | 2.82 | 3.9 |
| Ser | 1.77 | |
| Glu | 18.37 | |
| Pro | 5.39 | |
| Gly | 6.67 | |
| Ala | 6.11 | |
| Val | 6.75 | 5.2 |
| 1/2-Cys | tr | |
| Met | 0.33 | 1.4 |
| Ile | 5.14 | 5.3 |
| Leu | 9.20 | 7.7 |
| Tyr | 2.75 | |
| Phe | 5.49 | 4.9 |
| His | 2.87 | 2.4 |
| Lys | 3.35 | 6.3 |
| Amm | 3.54 | |
| Asn | 2.05 | |
| Arg | 6.17 | 7.3 |

[a] Average of two determinations. [b] Grams of amino acid per 16 g of N.

constituent fatty acid was $\alpha$-eleostearic acid in nonpolar lipids, linolenic acid in glycolipids, and palmitic acid in phospholipids. The $\alpha$-eleostearic acid was confirmed by spectroscopy studies. The UV study showed maxima at 261, 271, and 282 nm, indicating cis,trans,trans configuration. The IR spectra showed bands at 958 and 987 $cm^{-1}$, indicating conjugated trans double bonds (Hopkins, 1972). The $^1H$ NMR spectra showed the following signals ($\tau$): 9.1 (terminal $CH_3$); 8.7 [$(CH_2)_n$]; 7.6 ($CH_2COOCH_3$); and 3.7 (CH=CHCH=CHCH=CH) (Conachar et al., 1970). In all lipid classes, about half the quantity of total fatty acids was accounted for by unsaturated fatty acids. Information on detailed chemical compositions of other vegetable fruits is too scantly for meaningful comparisons. The protein (N × 6.25) content was 18.02% on a dry weight basis. The amino acid composition values are summarized in Table III. The values obtained for cystine and methionine are perhaps lower than the actual content since a small proportion of these acids could have been oxidized during acid hydrolysis and not shown in the chromatographic analysis. The bitter gourds are comparable with soybean flour in their content of all essential amino acids except lysine and methionine (Altschul, 1958). Comparison of the content of amino acids in bitter gourd with WHO recommended protein and amino acid requirements of human subjects (WHO, 1973) indicates the bitter gourd is a good source of most essential amino acids with the exception of lysine, cystine, and methionine. Their moderate availability of essential and other amino acids compared to conventional food crops such as leafy vegetables or legumes indicates their potential for future feed supplements. The nutritional value of the bitter gourd meal can be further improved by adding lysine and methionine.

## LITERATURE CITED

Altschul, A. M. *Processed Plant Protein Foodstuffs*; Academic Press: New York, 1958.

AOAC. *Methods of Analysis*, 12th ed.; Association of Official Analytical Chemists: Washington, DC, 1975.

Conachor, H. B. S.; Gunstone, F. D.; Hornby, G. M.; Padley, F. B. Glyceride Studies: Part IX: Intraglyceride Distribution of Vernolic Acid and of Five Conjugated Octadecatrienoic Acids in Seed Glycerides. *Lipids* **1970**, *5*, 434–436.

Haverkate, F.; Van Deenen, L. L. M. Isolation and Chemical Characterization of Phosphatidylglycerol from Spinach leaves *Biochim. Biophys. Acta* **1965**, *106*, 78–92.

Hopkins, C. Y. *Topics in Lipid Chemistry*; Gunstone, F. D., Ed.; Elek Science: London, 1972; Vol. 111.

Lakshminarayana, G.; Pantulu, A. J.; Sundar Rao, K. Lipid Class and Fatty Acid Compositions of Young Amaranthus gangeticus L. Leaves. *J. Agric. Food Chem.* **1984**, *32*, 1361–1363.

Luddy, F. E.; Barford, R. A.; Riemenschneider, R. W. Direct Conversion of Lipid Components to their Fatty Acid Methyl Esters. *J. Am. Oil Chem. Soc.* **1960**, *37*, 447–451.

Nielson, J. D. *A Nordic Symposium on Soil/Plant/Animal/Man Interelationships and Implications to Human Health, 1980*; Mineral Elements: Helsinki, 1981.

Perry, L. M. *Medicinal Plants of East and South East Asia*; MIT Press: Cambridge, MA, 1980; p 117.

Sundar Rao, K.; Lakshminarayana, G. Lipid Class and Fatty Acid Compositions of Edible Tissues of Peucedanum graveolens, Mentha arvensis, and Colocasia esculenta Plants. *J. Agric. Food Chem.* **1988**, *36*, 475–478.

Sundar Rao, K.; Jones, G. P.; Rivett, D. E.; Tudker, D. J. Amino Acid Compositions of Brachychiton discolour, Brachychiton diversifolius, and Brachychiton acerifolius Seeds. *J. Agric. Food Chem.* **1989**, *37*, 916–917.

WHO. *Energy and Protein Requirements*; WHO Technical Report Series 522; WHO: Geneva, 1973; p 55.

Received for review April 8, 1991. Accepted June 28, 1991.

**Registry No.** Cu, 7440-50-8; Fe, 7439-89-6; Mg, 7439-95-4; Zn, 7440-66-6; Ca, 7440-70-2.