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Studies on Physico-Chemical Characteristics and Lipid Profile of Bittergourd (*Momordica charantia*) Oil

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Momordica charantia (bittergourd) seed oil was evaluated for oil content, physico-chemical characteristics and fatty acid composition. High iodine value (144), R. I_nD^{40} (1.4960) and acetyl value (59%) of this dark-brown coloured oil indicated high degree of unsaturation. The acid and peroxide values were within normal limits. R.M. and P. values showed that the lower volatile fatty acids were present to a small extent. Low unsaponifiable matter (1%) and sap. value (208) were comparable to conventional oils like groundnut and sesame. Bittergourd oil like other cucurbit seed oils has palmitic-stearic-oleic-linoleic type fatty acid composition. In addition, it possessed high level of conjugated α-eleostearic acid (50%) as revealed by GLC and UV spectrum studies..

INTRODUCTION

To alleviate acute shortage of oils, it is imperative to utilize unconventional oil-rich sources. Cucurbit seeds can be classified as oilseeds because their decorticated kernels contain about 40–50% oil and 30–35% protein. The cucurbit seed oils from different cultivated species are mostly unsaturated and generally edible. However, appreciable contents of conjugated trienoic fatty acids (*e.g.* α-eleostearic acid, punicic acid) in the oils of certain species preclude their edibility but increase their industrial value as drying oil, *e.g.* for the manufacture of paints, varnishes and allied industries requiring drying oil as a base.

To screen the seed oils from non-traditional oil resources like cucurbit species, with the expectation that some of these oils might have commercial potential, *Momordica charantia* oil was investigated in detail for its physico-chemical characteristics and lipid profile.

EXPERIMENTAL

The oil content of the kernels of *Momordica charantia* was determined by the cold percolation method[1], using carbon tetrachloride as solvent. Refractive index was determined by using Abbe's refractometer by keeping the prism at 40°C. Other physico-chemical characteristics of bittergourd oil were determined by the procedures described by Association of Official Analytical Chemists[2].

UV spectrum of bittergourd oil

A suitable amount of freshly extracted bittergourd oil was dissolved in known volume of ethyl alcohol. An aliquot of this solution was taken in cuvette and scanned from 190 to 300 nm on UV spectrophotometer. Necessary dilution was made before taking the spectrum.

Fatty acid composition

Total lipids were extracted according to procedure of Folch *et al.*[3] Fatty acid methyl esters were prepared by the method of Luddy *et al*[4]. and analysed by using M/S. Nucon Engineers AIMIL Gas Chromatograph (5700 series) equipped with a flame ionization detector using 6′ × 1/8″ glass column packed with 10% diethylene glycol succinate (DEGS) on 80–100 mesh Chromosorb–W, AW–DMCS. The conditions for the separation were: column temperature 190 ± 2°C; nitrogen flow 60 mL/min; hydrogen flow 40 mL/min; attenuation 128. 0.5–1.0 μL of the sample was injected for analysis.

The peaks were identified by their relative retention time as compared to standard fatty acid esters. The peak areas were calculated using Shimadzu data processor Chromatopac EIA and converted to relative percentage directly.

RESULTS AND DISCUSSION

The oil content in kernels of bittergound seeds was very high (47.1%) and it compared well with some of the conventional oilseeds, *viz.*, mustard (25–40%); sesamum (48–50%) and groundnut (43–48%). Lakshmi Narayana *et al.*[6] have, however, reported 30% oil extracted from bittergourd whole seed. Azeemuddin and Rao[5] found that oil formed 25.3% of the whole seed and 40% of kernels of *Momordica tuberosa*.

The oil obtained from bittergourd seeds was dark brown in colour. The colour arose from the liposoluble pigments present in the perisperm and endosperm layers of the seed. Thus some refining is desirable in this case. The $R.I_nD^{40}$ of the oil was 1.4960 and iodine value 144 which are indicative of high degree of its unsaturation and presence of conjugated trienoic fatty acids. Hence, this oil can be characterised as drying type as per classification used by Jaimason. Fatty acid composition and UV studies carried out in our laboratory have shown that a conjugated trienoic fatty acid: α-eleostearic acid: $C_{18:3}$ $\Delta_{9,11,13\,(cis,\,trans,\,trans)}$ was present in the oil from matured bittergourd seed kernels to the extent of 50 per cent. Lakshmi Narayana *et al.*[6] had indicated presence of α-eleostearic acid in developing seeds of bittergourd. The experience with bittergourd oil has been that after extraction, it formed a dry film within 72 h which was due to polymerization of the α-eleostearic acid. The bittergourd oil with a high I.V., R.I. and presence of α-eleostearic acid might not be considered suitable for edible puposes but could be profitably utilized for industrial purposes, especially in the maufacture of paints and varnishes, where a drying oil is required as a base. Bolley *et al.*[7] have suggested *C. digitata* and *C. palmata* oils (having high iodine value and containing conjugated α-eleostearic acid) could be used similarly as linseed oil, in the manufacture of paints and varnishes, where drying, heat body properties, set to touch time, film hardiness, resistance to water and alkali were of great value. Bittegourd oil gave a sap. value of 208.0, quite comparable to conventional oils, i.e., groundnut and sesame oils. The acid and peroxide values within the normal limits. R.M., P. and K. values showed that lower volatile fatty acids were present to a small extent. The unsaponifiable matter in bittergourd oil was quite low (1%) and compared well with most of the commonly used oils.

The hydroxyl and acetyl values indicate the content of oxygenated functional groups present in the oil. The bittergourd oil showed very high content (59%) of oxygenated functional groups. This was in agreement with the observation of Gurveen[8] that snakegourd drying oil also gave high acetyl value of 85.1.

UV spectrum of bittergourd oil

Since α-eleostearic acid constituted a major fatty acid in bittergourd oil (50%), its U.V. spectrum was studied. No absorption peak was obtained in the region of 233 nm which indicated absence of conjugated diene acids. The oil showed characteristic absorption at 261, 270 and 280.5 nm (Fig. 1). The maximum absorbance was 1.44×10^2 at 270 nm, equivalent to about 43% of conjugated trienoic, α-eleostearic acid. In other cucurbit oils[9] (muskmelon, watermelon and pumpkin), this unusual fatty acid was completely absent although its presence has been reported up to 20% in some other cucurbit species such as *C. palmata*, *C. digitata* and *C. cordata* by Bemis *et al.*[10]

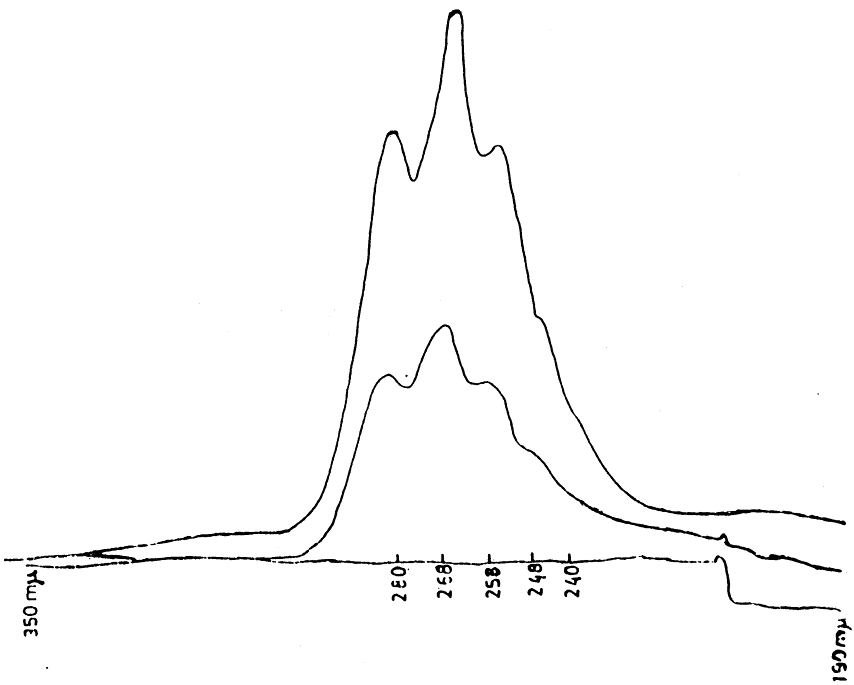

Fig. 1. UV spectrum of oil extracted from Momordica charantia [Solvent-Ethyl Alcohol].

TABLE-1
PHYSICO-CHEMICAL ANALYSIS OF BITTERGOURD KERNEL OIL

Material	Oil (%)	Colour	Refractive index ($_nD^{40}$)	Iodine value	Sap. value.	Hydroxyl value	Acetyl value	Hehner value
Bittergourd (*Momordica charantia*) oil	47.07	dark	1.4960	144.0	208.0	59.5	59.0	94.1

Material	Soluble acids	Acid value (% of oleic acid)	Peroxide value	R.M. value	P. value	K. value	Unsaponi-fiable matter %
Bittergourd (*Momordica charantia*) oil	1.5	0.8	1.73	1.9	1.3	3.3	1.0

Fatty acid compositon

The methyl esters of *Momordica charantia* seed oil were analysed on GLC for its fatty acid composition (Table 2). The studies showed that $C_{18:0}$; $C_{18:1}$; $C_{18:2}$ and $C_{18:3}$ $\Delta_{9,\,11,\,13}$ *(cis, trans, trans)* constituted the major proportion of total fatty acids present in the bittergourd oil. The levels of stearic acid (29.2%) and α-eleostearic acid (50%) were highest while the concentrations of other unsaturated acids such as oleic and linoleic were 9.2 and 8.2%, respectively. Palmitic acid (2.1%), myristic acid (0.8%) and linoleic acid (0.1%) were found to be present in measurable amounts. Palmitoleic acid and lower fatty acids below $C_{14:0}$ were, however, present in traces.

TABLE-2
FATTY ACID COMPOSITION OF BITTERGOURD SEED KERNEL OIL AND ITS NON-POLAR FRACTION (AS PER CENT FATTY ACIDS)

	Material	
	Bittergourd (*Momordica charantia*) oil	Bittergourd (*Momordica charantia*) (Non-polar oil fraction)
$C_{14:0}$	0.8	0.4
$C_{16:0}$	2.1	1.9
$C_{18:0}$	29.2	30.5
$C_{18:1}$	9.2	9.1
$C_{18:2}$	8.2	7.7
$C_{18:3}$	0.1	—
$C_{18:3}\Delta_{9,\,11,\,13}$ *(cis, trans, trans)*	50.0	50.1
$C_{20:0}$	0.3	0.2
$C_{22:0}$	0.1	0.1
Saturated (total)	32.5	33.1
Unsaturated (total)	67.5	66.9
Ratio unsaturated/saturated	2.1	2.0

Note: $C_{16:1}$, $C_{14:1}$ and fatty acids lower than $C_{14:0}$ were present in traces.

In bittergourd oil the proportion of $C_{18:1}$ and $C_{18:2}$ was much lower than those present in the other cucurbit seed oils[11]. The low proportion of these acids in bittergourd oil might be due to the fact that $C_{18:1}$ and $C_{18:2}$ acids formed the precursors for $C_{18:3}$ conjugated trienoic acid (α-eleostearic acid) during seed ripening. Lakshmi Narayana *et al.*[6] showed that in developing seeds of *Momordica charantia* there was a fall in the levels of $C_{18:1}$, $C_{18:2}$ and $C_{18:3}$ acids with a concomitant rise in the levels of α-eleostearic acid with maturity.

It is interesting to note that total unsaturated fatty acids in bittergourd oil were high (68%) while the total saturated fatty acids content was rather low (32%). The high levels of unsaturated fatty acid (including α-eleostearic acid) in bittergourd oil adequately explained the high R.I., I.V., hydroxyl and acetyl values observed for this oil. It could also be observed that bittergourd oil had the palmitic-oleic-steric-linoleic acid type composition in addition to high levels of conjugated α-eleostearic acid which bestows it drying properties.

Conclusion

The different physico-chemical properties and fatty acid composition of the bittergourd oil suggests that this oil is not suitable for edible purposes but it can be used, profitably, as drying oil in the manufacture of paints, varnishes and other industrial products which require quick drying properties.

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