when a different solvent composition/column type was used [see previous section]. Although this phenomenon has been observed in other types of liquid chromatography, we believe this to be the first time such an occurrence has been observed in the separation of lipids by silver resin chromatography. Thus, care should be exercised in the identification of components when the solvent composition or column types have been changed.

Analyses of the triglyceride fractions by UV and IR indicated the presence of <0.1% conjugation and *trans* isomers. Analysis by TLC and GC did not indicate the presence of diacyl-monoacetyl glycerides or other byproducts or intermediates. The purity of the eluted TG was >99%. Trilinolenin prepared by the *p*-toluenesulfonic acid-catalyzed esterification of linolenic acid by glycerol was found to contain 0.5-1.0% conjugated and/or *trans* isomers. In situations where high-purity triglycerides are required, our procedure can be used to prepare large-scale quantities of these important compounds.

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Chemical Composition and Characteristics of *Moringa peregrina* Seeds and Seeds Oil

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ABSTRACT

The *Moringa peregrina* kernel contains 1.8% moisture, 54.3% oil, 22.1% protein, 3.6% fiber, 15.3% carbohydrate and 2.5% ash. The composition and characteristics of the extracted oil were determined. Gas liquid chromatography of methyl esters of the fatty acids shows the presence of 14.7% saturated fatty acids and 84.7% unsaturated fatty acids. The fatty acid composition is as follows: palmitic 9.3%, palmitoleic 2.4%, stearic 3.5%, oleic 78.0%, linoleic 0.6%, linolenic 1.6%, arachidic 1.8% and behenic 2.6%.

INTRODUCTION

The *Moringa* family consists of ca. 10 Xerophytic species distributed from tropical Africa to the East Indies (1). Four main species exist: *Moringa aptera, Moringa concanensis, Moringa olifera* and *Moringa pterygosperma.* All the species except *M.peregrina* species grow wild and are rapidly growing trees of 25-30 ft high which bear long seed pods, each pod containing ca. 20 seeds. The chemical compositions of the oils of *M.aptera, M.concanensis, M.olifera* and *M.pterygosperma* have been reported.

M.aptera contains 53% oil (2), and in separate studies *M.concanensis* was shown to contain 31.4% oil (1) and 33% oil (3), *M.olifera* contained 21% oil (4) and 27% oil (3) and *M.pterygosperma* contained 34.4% oil (1).

Moringa peregrina, locally called "Yassar", contains seeds which have long been used as a source of oil. The oil is extracted by boiling seeds with water and collecting the oil from the surface of the water. The oil extracted is called "Al-Yassar". At present, the oil is not popular. The purpose of this work was to study the chemical composition of the seed, the physicochemical constants and fatty acid composition of the oil *M.peregrina* which have not been previously reported.

EXPERIMENTAL METHODS

Sampling

The *Moringa peregrina* seeds of wild cultivated trees were collected from the Chewag region of northwest Saudi Arabia. A total of five samples were used.

Methods of Analysis

The specific gravity, water content, nitrogen content, fat and ash of the kernel were estimated by usual standard methods recommended by AOAC (5). The percentage of protein was calculated by multiplying total nitrogen by a factor of 6.25.

Extraction and Analysis of Oil

Moringa oil was extracted (soxhlet) from the seed with petroleum ether (40-60 C) and analyzed immediately for iodine value, saponification number, refractive index, unsaponifiable matter, acid value and peroxide value by AOCS (6).

GLC Analysis

Methyl esters of extracted oil were prepared according to AOCS Method Ce 2-66 using 14% boron trifluoride solu-

TABLE I

Chemical Composition of *Moringa peregrina* Seed (weight of seed, 0.61g)

Assay	Percentage
Kernel	40.0
Moisture	1.8
Fat	54.3
Protein	22.1
Fiber	3.6
Carbohydrate	15.3
Ash	2.5

tion. A Perkin Elmer Model Sigma 2 Gas Chromatograph with flame inoization detecton (FID) was employed for the analysis using nitrogen as the carrier gas. A stainless steel 6-ft long and 1/8-in. od column packed with 15% DEGS on 80-100 mesh Chromosorb W was used under the following conditions: nitrogen flow, 30 mL/min; column temperature, 190 C; temperature of injection port and detector, 200 C.

Identification of each component was made by comparing its retention time with that of the reference sample. Peak areas were calculated using a Perkin Elmer M2 calculating integrator. The gas chromatograph was calibrated with an RM7 standard fatty acid mixture with each peak normalized according to detector response.

RESULTS AND DISCUSSION

The analytical data of *Moringa peregrina* is given in Table I. The percentage of oil was higher than that of other species which have been reported (1-4).

On extraction with petroleum ether, the kernel (40-60 C) gave more yellow-colored oil with characteristic odor. The physicochemical constants of the oil (Table II) were estimated and compared with the oil of other *Moringa* species (1-4). The refractive index of oil agrees with figures previously reported (1-3), but the other physicochemical constants of the oil varied. Fatty acid composition (Table II) is somewhat different from the other species. In *M.-peregrina,* nine fatty acids have been detected; Khan (4) detected only four fatty acids in *M.olifera;* Sengupta (1) detected seven fatty acids in both *M.concanensis* and *M.pterygosperma;* and Verma (3) detected five fatty acids in both *M.olifera* and *M.concanensis.* The difference in the fatty acid composition may be a result of the different species of *Moringa. M.peregrina* has a higher percentage of unsaturated fatty acids consisting mainly of oleic acid, which is the predominant fatty acid of the species.

TABLE II

Physicochemical Characteristics and Fatty Acid Composition of *Moringa peregrina* Oil

Determination	Value
Refractive index	1.4610
Saponification number (mg KOH/g)	182.9
Iodin value	69.5
Specific gravity (at 15 C)	0.9095
Peroxide value (meq/kg)	2.3
Acid value (mg KOH/g)	0.04
Unsaponifiable matter (%)	0.3
Fatty acid composition (% by weight by GLC)	
C14:0	trace
C16:0	9.3
C16:1	2.4
C18:0	3.5
C18:1	78.0
C18:2	0.6
C18:3	1.6
C20:0	1.8
C22:0	2.6
Saturated fatty acids	14.7
Unsaturated fatty acids	84.7

M.peregrina therefore has potential as a new source of fat and protein. It is also a source of antibiotic isothiocyanates (7). Further studies of amino acids, vitamins and minerals are in progress.

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