2013 2nd International Conference on Nutrition and Food Sciences
IPCBEE vol.53 (2013) © (2013) IACSIT Press, Singapore
DOI: 10.7763/IPCBEE. 2013. V53. 9

Evaluation of Physicochemical Properties of Iranian Mango Seed Kernel Oil

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Abstract. Mango (*Mangifera indica* Linn.) is one of the most important tropical fruits in the world. During processing of mango, by-products such as peel and kernel are generated. The oil of mango seed kernel was extracted using Soxhlet apparatus and fatty acid composition shows that mango seed kernel oil consist of about 44–48% saturated fatty acids and 52–56% unsaturated. Stearic acid (37.73%) was the main saturated fatty acid,while oleic acid(46.22%) was the major unsaturated fatty acid in mango seed kernel oil. The specific gravity(0.9 at 40°C), refractive index(1.443 at 40°C), peroxide value(1.2 meq/kg), unsaponifitable matter (2.9%),free fatty acid(1.5%),saponification number(195) ,iodine number(55),melting point(30°C), and total lavibond colour(25) for mango seed kernel oil was determined. Result shows that mango seed kernel oil is more stable than many other vegetable oils rich in unsaturated fatty acids. Such oils seem to be suitable for blending with vegetable oils, stearin manufacturing, confectionery industry or/and in the soap industry.

Keywords: Mango seed kernel oil, Fatty acid composition, Peroxide value, Unsaponifiable matter

1. Introduction

Mango (Magnifera indica L.) is one of the most important fruits worldwide and is cultivated in more than 100 countries at both tropical and subtropical latitudes, especially in Asia. Mangoes belong to the genus *Angifera*, consisting of numerous species of tropical fruiting trees in the flowering plant family Anacardiaceae. It is cultivated and grown vastly in many tropical regions and widely distributed in the world. The mango is indigenous to the Indian subcontinent and Southeast Asia (Fowomola, 2010). Recognized for its attractive color, delicious taste and exotic flavor, mango is a rich source of carotenoids and provides high contents of ascorbic acid and phenolic compounds, and has been recognized as 'king of the fruit' in the Orient(Pott *et al*.,2003). As with many fruits, the edible fleshly portion or pulp of mango fruit is relished to the extent of commercialization. A wide variety of processed products derived there from include canned whole or sliced mango pulp in brine or in syrup, mango juice, nectar, jam, sauce, chutney and pickle(Singh,1960). In 2008 India is the biggest mango producer, with a 13.6 millions of tons. China (4.2 millions of tons) and Thailand (2.5 million of tons) are the second –and third – largest producer in the world (Kittiphoom,2012).

After consumption or industrial processing of the fruits, considerable amounts of mango seeds are discarded as waste. According to mango varieties, the seed represents from 10% to 25 % of the whole fruit weight (Ahmad *et al*.,2007). The kernel inside the seed represents from 45% to75% of the seed and about 20% of the whole fruit. However, more than one million tons of mango seeds are being annually produced as wastes so that if such seeds could be utilized in some way, hazards could be eliminated and probably valuable products could be produced.

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Compositional studies of the seed kernel of two varieties (Dhingra *et al*., 1985), three varieties (Augustin *et al*., 1987), eight varieties (Hemavathy *et al*., 1987) and 43 varieties (Lakshminarayana *et al*., 1983) have been conducted by Asian scholars. In a similar manner, the lipid composition of various mango kernel varieties has drawn immense research interest because of their potential application in the confectionery industry as a source of a cocoa-butter substitute (Lakshminarayana *et al*., 1983). Zein reported that depending on their variety, mango seed kernels contain on a dry weight average 6.0% protein, 11% fat, 77% carbohydrate, 2.0% crude fiber and 2.0% ash (Zein *et al*.,2005). Although mango seed kernels have a low content of protein, the quality of protein is good. Kittiphoom(2012) shows that mango seed kernel was high in potassium, magnesium, phosphorus, calcium and sodium. The lipid composition of mango seed kernels has attracted the attention of scientists in recent years because of their unique physical and chemical characteristics. Rashwan (1990) extracted and fractionated total lipids from three different mango seed kernel varieties namely Goleck, Pairi and Hindi. The neutral lipids varied from 95.2% to 96.2%, phospholipids from 2.7% to3.3% and glycolipids from 1.1% to 1.4%. Triglycerides constituted the major fraction of the neutral lipids, for all varieties and accounted from 93.7% to 96.4%. The lipids of mango seed kernel consist of about 44–48% saturated fatty acids (majority stearic) and 52–56% unsaturated (majority oleic).

On the nutritional and toxicological studies of the mango seed kernel ,Rakmini *et al*.(1989), indicated that mango seed kernel fat is promising and a safe source of edible oil and was found to be nutritious and non-toxic so that it could be substituted for any solid fat without adverse effects. Rashwan (1990) also showed that the lipids extracted from different mango varieties were free from toxic material such as hydrocyanic acid.

Therefore, the present study attempted to estimate the fatty acid composition and some physicochemical characteristics of the oil extracted from industrial mango seed kernel wastes and evaluate its potential for human consumption.

2. Materials and Methods

2.1. Materials

During the summer season of 2010, about 50 kg of mango seeds as by-products (waste) were collected from manufacture of mango juice in Tehran. All solvent and materials were obtained from Merck company , Germany.

2.2. Methods

2.2.1. Preparation of Mango Seed Kernels

The seeds were washed and air dried and the kernels were removed from their tenacious leathery coat, dried at 50°C and finely ground into powdery form .Then kept in a closed dark glass bottle and stored at 4°C until utilization.

2.2.2. Extraction of Oil from Mango Seed Kernel Powder

The kernel powder (50g) was placed in the thimble and about 300ml of *n*-hexane was poured into the round bottom flask. The apparatus was heated at 70 ℃ and allowed to stay for 8hrs under continuous extraction using Soxhlet apparatus. At the end of the extraction, the resulting mixture *(miscella*) containing the oil was distilled off to recover solvent from the oil. The total yield obtained is expressed in percentage.

2.2.3. Fatty acid Composition

Fatty acid composition of mango seed kernel oil was determined using gas chromatography (GC Hewlett Packard 5890 series II, SP2340 column) with a FID detector. Helium was the carrier gas. The sample(mango seed kernel oil, 0.5 μl) was injected into the system at 220 ◦C injector temperature. The oven temperature was kept at 175 ◦C for 30 min and then it was gradually increased at 3.0 ◦C/min up to 220 ◦C.

For identification peaks The methyl esters for fatty acids were used(Christie *et al*.,1973).To preparation of fatty acid methyl esters, the samples containing fatty acids were esterified to the more volatile methyl esters by methanol BF3 method. 100 mg tomato seed oil or 5mL hexane solution obtained from the extraction of complexes were treated with 5mL methanol -BF3 solution and refluxed for 2 min on a water bath, and then 5mL hexane was added; after another one minute of reflux, the solution was treated with 15mL saturated NaCl solution under vigorous stirring. The organic layer was separated and dried over anhydrous CaCl2.

2.2.4. Physical and Chemical Properties

Physical properties included specific gravity, moisture of kernel, refractive index, melting point and colour were determined according to AOCS (1989).

Determinations for peroxide, iodine, and saponification values, unsaponifiable matter and free fatty acid contents were carried out using Pena *et al*., (1992) standard analytical methods.

2.2.5. Statistical Analysis

All analytical determinations were performed in triplicate and the mean values were reported. Results presented are means ± standard deviations of triplicate values. The percentages of fatty acid were compared by analysis of variance (ANOVA) taking $p < 0.05$ as the minimum criterion for statistical significance. Comparisons between means were performed with Tukey's test.

3. Results and Discussion

3.1. Physical Properties

Physical properties including specific gravity, moisture ,total oil yield, refractive index, melting point and colour of mango seed kernel oil were determined (Table I). From these results, it can be noticed that the values of specific gravity, refractive index and melting point in mango seed kernel oil are in agreement with those reported by other scholars (El.Soukkay,2000& Bahaa El-Din,1979&Mohamed *et al*.,2005). Mango seed kernel oil is pale yellow in color and had a total lovibond colour value of 25 (30Y+10R). The light percentage of oil(12.5%) makes this seed kernel a not distinct potential for the oil industry(Dhingra *et al*.,1989). Variation in oil yield with other reports may be due to the differences in variety of plant, cultivation climate, ripening stage, the harvesting time of the seeds kernels and the extraction method used(Mohamed *et al*.,2005& Shahinaz,2001& Arogba,1997).

Table I: Some physical properties of mango seed kernel oil

Physical properties	Values
Amount of oil(%)	12.5±0.2
Moisture of kernel content (%)	8.5 ±0.1
Specific gravity at 40 °C	0.900 ±0.03
Refractive index at 40 °C	1.443 ± 0.10
Melting point (°C)	30.0 ±1.20
Total Lovibond colour (30Y+10R)	25.00 ±1.50

3.2. Chemical Properties

Chemical characteristics including free fatty acid, peroxide value, iodine number, saponification number and unsaponifiable matter of mango seed kernel oil were shown in Table II. The chemical properties of oil are amongst the most important properties that determines the present condition of the oil. Free fatty acid and peroxide values are valuable measures of oil quality. The low acidity of this oil indicated that the mango seed was almost free from hydrolytic rancidity brought almost by lipases and enables the direct use of such an oil in industries without further neutralization(Arogba,1997). The iodine value (IV) is the amount of iodine (in grams) necessary to saturate 100 g of oil sample and is a measure of the amount of unsaturation in fats and oils. The saponification value is the milligrams of KOH necessary to saponify 1 g of oil sample and shows the capacity of forming soaps of oil and was in agreement with other authors(Kittiphoom,2012&Bahaa El-Din,1979&El-Soukkary *et al*.,2000). The saponification value is high and this suggests the use of the oil in production of liquid soap, shampoos and lather shaving creams. The peroxide value (PV) is a measure of the extent of oxidation of a fat or oil ,mango seed oil had a high quality due to the low level of peroxide value. Unsaponifiable matter is component of an oily mixture which fails to form soap when blended with NaOH. The composition of unsaponifiable matter of vegetable oils including tocopherols, sterols and squalene is of great importance for oil characteristics and stability (Sim *et al*., 1972).

Table II: Some chemical properties of mango seed kernel oil

Chemical properties	Values
FFA (as oleic acid%)	1.50 ±0.20
Peroxide value (milliequivalent O2 per kilogram oil)	1.26 ±0.25
Iodine number	55.15 ±2.20
Saponification number (mgKOH/g)	196.0 ±6.50
Unsaponifiable matter (% of total lipid)	2.98 ±0.15

3.3. Fatty Acid Composition of Mango Seed Kernel Oil

The comparison of the composition in fatty acids of mango seed kernel oil with other common vegetable oil are presented in Table III(Shahidi,2005).

The major saturated fatty acids in mango seed kernel oil were stearic (37.73%) and palmitic (6.43%) acids and the main unsaturated fatty acids are oleic (46.22%), linoleic (7.33%) and linolenic(2.30%) acids. The proportion of unsaturated fatty acids was greater than the saturated fatty acids. The comparison of the composition in fatty acids of mango seed kernel oil with that of vegetable oils indicates that this plant is rich in acids stearic and oleic. Therefore, mango seed kernel oil is more stable than many other vegetable oils rich in unsaturated fatty acids.

Table III: Comparison of the profile in fatty vegetable oil acids

oils	C 14:0	C 16:0	C 16:1	C 18:0	C 18:1	C 18:2	C 18:3	C 20:0
Palm	1.0	39.80	0.2	4.6	42.7	2.11	0.4	0.4
Corn	0.0	10.5	0.0	2.5	28	58.50	1.0	0.5
Cotton seed	0.9	24.7	0.7	2.2	17.7	55.8	0.3	0.1
Soybean	0.04	11	0.02	4.09	22.98	54.51	7.23	0.33
Mango seed kernel	0.6	6.43	0.40	37.73	46.22	7.33	2.30	<4

4. Conclusion

Stearic (37.73%) and oleic acids(46.22%) were the principal fatty acids and the proportion of unsaturated fatty acids was greater than the saturated fatty acids(1.3%). Result shows that mango seed kernel oil is more stable than many other vegetable oils rich in unsaturated fatty acids. Such oils seem to be suitable for blending with vegetable oils, stearin manufacturing, confectionery industry or/and in the soap industry.

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