Evaluation of Physicochemical Properties of Iranian Mango Seed Kernel Oil

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Abstract: Mango seed kernel oil was extracted using Sooksele with hexane. The physicochemical properties (Acid value, peroxide value, unsaponifiable matters, stability against oxidation, Index of refraction, Color, Total Cholesterol, Fe, Cu, Tocopherol, Phospholipid and the fatty acid composition of mango seed kernel oil were examined. Mango seed kernel contains 3.8% oil with 9.42 (mg/g oil) peroxide value, 2.15 (mg KOH/g oil) Acid value, 3.17 (mg KOH/g oil) unsaponifiable matters and Index of refraction 1.46. In Mango seed kernel oil, the maximum amount of unsaturated fatty acid is belongs to Oleic acid (34.8%) and the maximum amount of saturated fatty acid is belongs to Lauric acid (28.7%). The results suggested that mango seed kernel oil is a good source of the unsaturated fatty acid, phenolic compounds and has the potential to be used as nutrient rich food oil or as ingredients for functional or enriched foods. The purpose of this study is evaluation and identification of the physicochemical properties and ingredients of kernel oil of mango that were harvested from Sistan and Baluchestan, Iran, as a new source of this oil.

Keywords: Mango seed kernel oil, Saturated Fatty Acids, Fatty Acids, Acid Value, Peroxide Value, unsaponifiable matters, Sooksele, Hexane.
Introduction

Mangoeconomically is the most valuable fruit of southern Iran. According to the Ministry of Agriculture, Mangoproduction in 1380 was 12928 Tons and in 1384 was 21143 Tons. Mango Seed and shell as waste are about 35 to 55 percent of the total weight of the fruit. Mango Seed which is the waste of this fruit after processing, contains Oil with unique features. The seed content of different varieties of mangoes ranges from 9% to 23% of the fruit weight and the kernel content of the seed ranges from 45.7% to 72.8%.

Mango seed kernel oil is made up 94.7% of neutral fat such as Monoglyceride, sterols, free fatty acids, triglycerides, di-glycerides, hydrocarbons and made up 3.6% Phospholipids such as phosphatidylethanolamine, inositolphosphatidylinositol, phosphatidylethanolamine, phosphatidylcholine and also made up 1.7% Glycolipid.

According to the researches, stearic acid is the main saturated fatty acid and Oleic acid is the main unsaturated fatty acid. Reported amount of stearic acid and oleic acid of mango kernel oil in various sources, are very different.

The amount of stearic acid 3/38% and oleic acid 1/46% are reported (Abdallah et al., 2007). Stearic acid and oleic acid are reported 39.07% and 40.81% respectively (Solís et al., 2004). The amount of stearic acid 40% up to 42% and oleic acid 40% up to 42% are reported (Ismail, 2012)

Mango kernel oil due to high quality and its high amount of natural antioxidants and essential fatty acids has commercial value. Mango kernel, a healthy and safety source can substitute for solid fat withoutharmful effects reported (Van et al., 1981). Percentage free fatty acids were determined according to AOCS Ca 5a-40, 2000 Method. Fat extracted from various species of mango kernels free of toxic materials such as Hydrocyanic acid (Abdallah et al., 2007).

Physicochemical properties Similarities of cocoa butter and mango seed kernel oil and Unique Thermal behavior because of existence of fatty acids, such as Palmitic, oleic and stearic acids caused mango seed kernel oil to be considered (Solís et al., 2004). In mango seed kernel oil three main ingredients are Squalenes (38.2% of total unsaponifiable matters), Sterols (consist of Stigmasterol, Campesterol, beta-Sitosterol and delta-5-avenasterol) and Tocopherol (consist of 80%-alpha-Tocopherol and 20% gamma-Tocopherol). These three mentioned ingredients are 75% of unsaponifiable matters of Mango kernel oil.

Materials and Methods

1. Preparation of Mango kernel oil

In order to extract the mango kernel oil, mango seed was removed manually from flesh and then was washed with water. First of all the seed were exposed to hot air till wooden crust of seed was dried, then wooden dried seed shells were broken and they were withdrawn from the seed kernels, after that seed kernels cut into small pieces and were heated to 60° C for 48 hours to reduce the moisture content to 5%. The kernels were then ground in a food grinder to reduce the particle size. Solvent was extracted from obtained kernel oil by rotary vacuumed evaporator under at 50 °C and the remaining solvent in kernel oil was removed with nitrogen gas. Kernel oil was held in clean glass jar at 4 °C in refrigerator (Izadyar et al., 2015).

2. The physicochemical analysis of mango seed kernel oil:

Determination of the oil content of the Mango seed kernel according to the standard method (AOCS Bc3-49, 2000) carried out in 4 hours, using petroleum ether and sooksele method. For determining the amount and composition of fatty acids according to method (AOAC 969/33),
Six drops of each sample were methylated by a half-normal sodium methoxide. Refer to standard method (AOAC, 2012). Related Fatty acids of Methylesters of all samples were identified by Gas Chromatography (AOCS, 1981).

Mentioned chromatography is manufactured by Agilent Co-model 7890a Acme and Equipped with a flame detector (FID) 100 m capillary column filled with diethylene glycol succinate (DEGS) No. ce-91.

Temperature of sample injection place was 250°C. At the beginning column temperature was 70°C for one minute and it increased to 150°C with a rate of 20°C per minute. Samples were kept 3 min at 150°C and then temperature increased to 220°C with 15°C per minute rate and kept in 220°C also for 3 min.

Detector temperature was 290°C and flow rate of the nitrogengas as a carrier was 20 ml per minute, Injection amount was 0.1 microliter, Column type was HP.88 and injection system was split 1:50.

The acid value was determined by titration of oil with NaOH 0.1 N and 0.01 N with presence of phenolphthalein indicator (Firestone et al., 1992). Peroxide value was determined by titration and was expressed by Meq per 100 gram of oil. The stability against oxidation, according to ISIRI 3734, was performed for 3g sample at 110°C by Ransimeter (Model Metrohm 743).

The color of Oil sample was identified according to ISIRI 5110, by Lovibond Tintometer (Model F), with the cell with 1.5 inch. Determination of unsaponifiable matters was performed according to AOAC933/08. At first, 5g of alcoholic KOH was saponified and unsaponifiable matters was extracted by diethyl ether and then by Thin Layer Chromatography with spraying of 0.01% rhodamine G6 in ethanol, various ingredients were identified.

Unsaponifiable matters of Soybean oil were used as a marker. All analyses were carried out at least in triplicate. Determination of phosphorus Phospholipid based on the method proposed by Cocks & Van Red was performed (Cocks, 1966). Based on AOAC based on 990/05 and AOCS 15-75 at first sample was burned then mixtures of nitric acid and hydrochloric acid are added and after the preparation were used. Based on AOCS2001, Iron and copper concentrations were determined by atomic absorption. Based on AOCS 970/51 and AOCS1999, Sterols and tocopherols were measured using thin layer chromatography.

**Results and Discussion**

Elliptical with yellow color mango was used in this study. Fruit and seed weight is listed in Table No 1. The moisture content of the review mango seed kernel was 11% and the oil content 3.8%. Mangokernel oil content is depending to factors such as variety, region, culture, climate, irrigation depends on the soil type (Yousef, 1999). Fatty acid composition of mangoseed kernel oil samples. Fatty acid composition of Mangoseed kernel oil is shown in Table 2. Table 3 shows the acid value of mangokernel oil, which represents the quality of the oil fat. The Acid value is a factor of quality of fatty acids which is released by the hydrolysis. So Acid value is a function of purity, freshness, degree of hydrolysis and oxidation of fat. Peroxide value and resistant to oxidation in table 3 relatively are shown. Table 4 shows the color analysis results of raw Mango seed kernel oil which are achieved from Lovibond Tintometer. The color of oil which is extracted from dried mangokernel is pale yellow. This oil contains 22.12 Lovibond unit of yellow color, 2.35 Lovibond unit of red color and 1.02 Lovibond unit of blue color. Table 3 shows the composition of unsaponifiable matters in grams per 100 grams of sample oil. Unsaponifiable matters are the composition which completely soluble in fat solvents but they aren’t saponifiable in presence of...
alkaline. Sterols, tocopherols, diolterpenes and hydrocarbons are some samples of unsaponifiable matters. In tested Mango seed kernel oil the fatty acid profile is a main determinant of the oil quality. The extracted oil contained major fatty acid compounds were oleic acid (34.88%) and Lauric acid (28.72%). These two fatty acids are more than 63% of the total fatty acids. Caprylic acid, Decanoic acid, arachidic acid and alpha-linoleic are remained composition of fatty acids. Which are the lowest fatty acids in the mentioned Mango seed kernel oil. Presence of large amount of oleic acid prevents heart disease and the biologically synthesis of prostaglandins, which play a role in increasing HDL in the body and prevents the buildup of fat deposits in the arteries. Linoleic acid is essential for embryonic development and plays an important role in human pregnancy and lactation, and the strength of the capillary vessels.

Linoleic acid (0.01%) is an essential unsaturated fatty acid which belongs to the omega-3 long-chain carbon compound important to learn ability of brain and for retina also.

However, low acid profile of fatty acids in composition of Mango seed kernel oil makes higher oxidative stability for it. Mango kernel oil fatty acid compositions are similar to the fatty acid composition of cocoa butter and Talo also. The fatty acid composition, Cocoa butter has a high palmitic acid in comparison with mango seed kernel oil. There are many similarities between palm oil, cocoa butter, and mango seed kernel oil. Linoleic acid (0.01%) is important to learn ability of brain and for retina also. However, low acid profile of fatty acids in composition of Mango seed kernel oil makes higher oxidative stability for it. Mango kernel oil fatty acid compositions are similar to the fatty acid composition of cocoa butter and Talo also. The fatty acid composition, Cocoa butter has a high palmitic acid in comparison with mango seed kernel oil. There are many similarities between palm oil, cocoa butter, and mango seed kernel oil.

In this study, it was found that less amount composition of unsaponifiable matters will cause less resistant to oxidation. In the other hand, according to the percentage of saturation and non-saturation, maybe there was any possibility to performing some reform processes such as the fractionising on Mango seed kernel oil. In countries which are producing Mango products, Mango seed is one of the byproducts of this process. However, the use of mango seed kernel oil is more economical in comparison with cocoa butter. Storage conditions, Storage duration, humidity, temperature and interval of oil extraction to the test effect on increasing of hydrolysis. In the other hand, acid value is a qualitative indicator which high amount of that is depends on mentioned factors. It’s possible to reduce acid value by filtration process. In general, the resistance oxidation in mango kernel oilismuch higher than other edible oils. That is due to the high content of phenoxylic compounds. In this study, it was found that less amounts composition of unsaponifiable matters will cause less resistant to oxidation.

### Table 1. Weight of mango seed and fruit

<table>
<thead>
<tr>
<th></th>
<th>Average of seeds weight</th>
<th>Average of fruits weight (gr)</th>
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<tr>
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<td>350</td>
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### Table 2. Fatty acids content of mango seed kernel oil

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<tr>
<th>Fatty acids</th>
<th>C8</th>
<th>C10</th>
<th>C12</th>
<th>C14</th>
<th>C16</th>
<th>C18:0</th>
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<tr>
<td>Content</td>
<td>0.45</td>
<td>0.58</td>
<td>28.72</td>
<td>14.48</td>
<td>11.1</td>
<td>3.09</td>
<td>34.88</td>
<td>6.6</td>
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### Table 3. Physiochemical parameter of mango kernel seed oil

<table>
<thead>
<tr>
<th>Peroxide value (meq)</th>
<th>Refractometer index</th>
<th>Reanimation (h)</th>
<th>Acid value (%)</th>
<th>Non-saponification matter (%)</th>
<th>Sterols (mg)</th>
<th>Phospholipids (mg)</th>
<th>Cu (mg)</th>
<th>Fe (mg)</th>
<th>Tocopherols (mg)</th>
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<tr>
<td>9.43</td>
<td>1.46</td>
<td>2.38</td>
<td>2.15</td>
<td>3.17</td>
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<td>0.5</td>
<td>24.50</td>
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</table>
Table 4. Parameters of colorimetry of mango kernel seed color of mango seed oil

| color of mango seed oil | 22.09 | 2.23 | 1.04 |

Conclusions
Mango seed kernel oil contained high amounts of total phenolic, enabling their application as ingredients of functional or enriched foods. The results of present study provide useful information for essential oil and food industry. Due to its special composition, rich in polyunsaturated fatty acids, including linoleic and oleic acids, and in antioxidant compounds.

Considering this item that in Mango processing factories, Mango seed is one of the byproducts of this process, while there is potential to extract edible oil from Mango seed kernel. Planting mango trees in addition to increasing the income of farmers, production of these fruits also significantly increases. According to the analysis of physicochemical properties, fatty acid profile and total phenols, the results showed that these oils are rich in oleic acid and stearic acid, indicating that they are stable and tolerant to rancidity.

Acknowledgement
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Reference
3. AOAC Official Method 2012.13 Determination of labeled fatty acids content in milk products and infant formula


Figure 1. rancimetr
Figure 2. Analysis Report

<table>
<thead>
<tr>
<th>Index</th>
<th>RT[min]</th>
<th>Area[mV*s]</th>
<th>Area%</th>
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