

Comparison of *Moringa Oleifera* seeds oil characterization produced chemically and mechanically

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Abstract. It is established that virtually every part of the *Moringa oleifera* tree (leaves, stem, bark, root, flowers, seeds, and seeds oil) are beneficial in some way with great benefits to human being. The tree is rich in proteins, vitamins, minerals. All *Moringa oleifera* food products have a very high nutritional value. They are eaten directly as food, as supplements, and as seasonings as well as fodder for animals. The purpose of this research is to investigate the effect of seeds particle size on oil extraction using chemical method (solvent extraction). Also, to compare *Moringa oleifera* seeds oil properties which are produced chemically (solvent extraction) and mechanically (mechanical press). The *Moringa oleifera* seeds were grinded, sieved, and the oil was extracted using soxhlet extraction technique with n-Hexane using three different size of sample (2mm, 1mm, and 500 μ m). The average oil yield was 36.1%, 40.80%, and 41.5% for 2mm, 1mm, and 500 μ m particle size, respectively. The properties of *Moringa oleifera* seeds oil were: density of 873 kg/m³, and 880 kg/m³, kinematic viscosity of 42.2mm²/s and 9.12mm²/s for the mechanical and chemical method, respectively. pH, cloud point and pour point were same for oil produced with both methods which is 6, 18°C and 12°C, respectively. For the fatty acids, the oleic acid is present with high percentage of 75.39%, and 73.60% from chemical and mechanical method, respectively. Other fatty acids are present as well in both samples which are (Gadoleic acid, Behenic acid, Palmitic acid) which are with lower percentage of 2.54%, 5.83%, and 5.73%, respectively in chemical method oil, while they present as 2.40% , 6.73%, and 6.04%, respectively in mechanical method oil. In conclusion, the results showed that both methods can produce oil with high quality. *Moringa oleifera* seeds oil appear to be an acceptable good source for oil rich in oleic acid which is equal to olive oil quality, that can be consumed in Malaysia where the olive oil is imported with high prices. In the same time cultivation of *Moringa oleifera* tree is considered to be a new source of income for the country and give more job opportunities.

1. Introduction

Moringa oleifera commonly called drumstick, horseradish or miracle tree is native to southern foothills of the Himalayas and possibly Africa and Middle East and many other places including central and southern America, Mexico and Malaya [1-3]. It belongs to *Moringaceae* family. It is a

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multi-purpose tree crop with great potentials. The seeds contain 35 - 47% oil. The plant is grown for food and it is an exceptionally nutritious vegetable tree with varieties of potential value [4].

Drumstick grows well in all types of soil, humus rich forest soil being the most ideal. *Moringa oleifera* is one of the nature's gifts to humanity because of its numerous wealth in vitamins and minerals as well as natural anti-oxidants. *Moringa oleifera* is considered as one of the world's most useful trees because almost every part of the tree is useful in one way or another [5].

It was noted that in the tropics, *Moringa oleifera* is used as forage for livestock [6]. As a traditional food plant item in Africa, *Moringa oleifera* has the potential to improve nutrition, boost food security, and foster rural development by enhancing and sustaining rural households as well as supporting sustainable land use and care [1, 2]. All parts of the plant are used in a variety of traditional medicines. The press cake, obtained following oil extraction, is useful as a soil conditioner, and used for water treatment. It is also used as fuel wood source; as an intercrop with other crops and the wood pulp may be used for paper-making. The green pods, fresh and dried leaves are used as vegetable [7].

Due to the high dependence of humans on oil used for both domestic and industrial uses, there is need to look for new source of oil with better method to give a higher yield. This study focuses on the comparison of *Moringa oleifera* seeds oil characterization produced by solvent extraction (chemically) and mechanical press (mechanically). On the other hand, the particle size effect of *Moringa oleifera* seeds on oil yield was studied as well.

2. Material and Method

Dry *Moringa oleifera* seeds were obtained from Kota Bharu, Kelantan, Malaysia. The solvent (n-hexane) was obtained from the Faculty of Chemical and Natural Resources Engineering Laboratory. The mechanical press oil was obtained from MitoMasa Sdn. Bhd., Sabah, Malaysia.

2.1. Pre-treatment

Pre-treatment starts with collection of dry *Moringa oleifera* seeds and continues with the cleaning. In order to get the seeds, the dry pods were removed together with the three papery wings and light wooden shells (figure 1). Cleaning process is crucial because a clean seeds yield clean oil without any impurities. The seeds were crushed using mortar and pestle, and then sieved using sieve shaker and three particle sizes of 2mm, 1mm, and 500 μ m were collected.



Figure 1. *Moringa oleifera* seeds

2.2. Oil extraction

Oil extraction was carried out using thermal soxhlet apparatus with n-hexane as solvent. Around 20g of the grinded and sieved sample was poured into the thimble. A volume of 200ml of solvent was poured into round bottom flask and heated up to 60-70°C. As the solvent was heated continuously, it

starts to evaporate and condenses back into the sample in the thimble. The oil extracted, containing some portion of the solvent was then recycled back to the round bottom flask as it refluxes and the total process of reflux continues until total oil extraction was achieved when the solvent become colourless. A rotary evaporator was used to separate the solvent from the oil, at temperature of 65°C.

2.3. Oil properties

The oil properties were measured by standard methods of analysis such as: ASTM D445 and Cannon–Fenske viscometers to obtain the kinematic viscosity of oil produced. Density was determined by ASTM D4052. Pour point and Cloud point were measured using K46100 Cloud point and Pour point apparatus by implementing ASTM D2500 standard for Cloud point and ASTM D97 standard for Pour point. pH value was measured using pH meter. Fatty acids composition was determined by gas–liquid chromatography (GLC) [8].

3. Results and Discussion

3.1. Effect of sample size on oil extraction

The percentage of oil yield was calculated using the equation (1):

$$\{(W_o - W_1) / W_o\} \times 100(1)$$

Where: W_o and W_1 are the weight of seeds before and after oil extraction, respectively.

The percentage of oil yield was studied by carrying out 3 batches of oil extraction using 200ml of solvent with 20 g of seeds. After each extraction, the residue cake was dried in oven for 1 hour at 50°C and as the drying process ended, the residue cake was weight using electronic weighing machine. From Table 1, it can be concluded that the oil yield was increasing as the particle size decreases which give more exposure of seeds to solvent and more oil was extracted. Figure 2 shows the trend of the oil yield% based on size of samples.

Table 1. Oil yield percentage using different size of samples

Size of sample	Solvent volume (ml)	Weight of seeds (g)	Oil yield %			
			Batch 1	Batch 2	Batch 3	Average
2mm	200	20	36.7	38.1	33.5	36.1
1mm	200	20	39.4	42.6	40.4	40.8
500µm	200	20	42.5	41.3	40.7	41.5

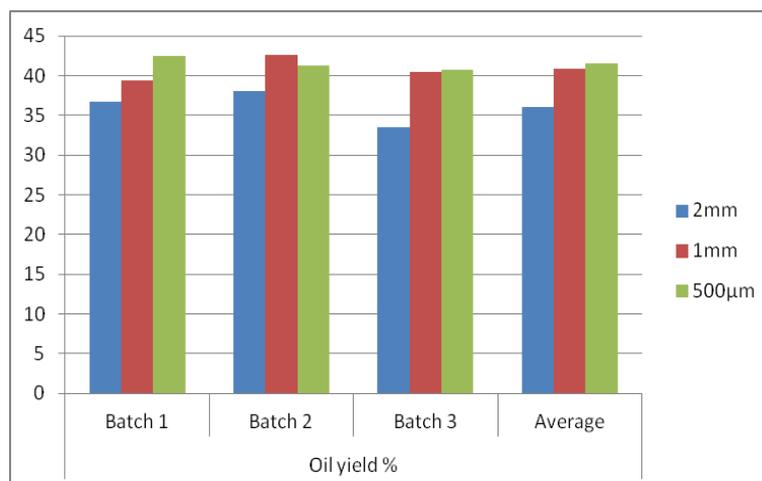


Figure 2. Oil yield percentage using different sample size

3.2. Comparison between oil properties produced by the two methods

Some properties were measured to compare between two methods of oil extraction:

3.2.1. Kinematic viscosity

Kinematic viscosity was measured according to ASTM D445 standard method. The measurement of time of flow for 30ml of oil at 40°C through calibrated capillary tube number No. 200. The viscosity of oil produced by mechanical press was 12.2 mpas which is more than that from solvent extraction method 9.12 mpas, and this might be due to some suspended particles in the oil produced from mechanical press (Table 2).

3.2.2. Density

The density of oil was measured using Digital Density Analyzer. There was no significant difference in the density of *Moringa oleifera* seeds oil using solvent extraction and mechanical 880 kg/m³, and 873 Kg/m³, respectively, as shown in (Table 2).

3.2.3. Cloud point and Pour point

About 50ml of *Moringa oleifera* seeds oil was poured into test tube until it reached the indicated level on the test tube. The sample was placed inside a refrigerator and observed for every one minutes until solid-crystals appeared. Cloud point was measured at the bottom of test jar while pour point was measured at the centre of *Moringa oleifera* seeds oil. The cloud and pour point for *Moringa oleifera* oil was 18°C, and 12°C respectively, for both methods. The results are shown in Table 2.

3.2.4. pH

The measurement for pH showed that both methods produced oil of pH value of 6, which means that the extraction method does not affect the pH value of oil produced (Table 2).

Table 2. Oil properties for two methods

Properties	Mechanical Press	Solvent Extraction
Kinematic viscosity (mpas; 40° C)	12.2	9.12
Density (kg/m ³)	873	880
Cloud point (°C)	18	18
Pour point (°C)	12	12
pH	6	6

3.2.5 Fatty acids

Total fatty acids were more than 90%; the major fatty acid was oleic acid (C18:1) with concentrations of 75.39% (chemically) and 73.60% (mechanically), followed by Gadoleic acid (C20:1) [2.54% (chemically), and 2.40% (mechanically)]. Behenic acid at concentrations of 5.83% (chemically), and 6.73% (mechanically), followed by Palmitic acid (C16:0) with percentage of 5.73% and 6.04% for chemical and mechanical methods, respectively. Traces of C8:0, C16:1, C22:1, and C26:0 were also found in *Moringa oleifera* seeds oil. There was no statistical difference (at the level of 95%) in the fatty acid compositions of the oils produced from the two different ways of extraction. On the basis of the results obtained, the fatty acid composition of *Moringa oleifera* seeds oil showed that it falls in the oleic acid oil category. The *Moringa oleifera* seeds oil had about the same content of C18:1 with olive oil. The fatty acid contents in both methods oil are shown in Table 3. The results obtained here is in agreement with [9-12]. The fatty acid composition of the oil shows that it falls in the category of high-oleic oils and contains a high ratio of monounsaturated to saturated fatty acids. High-oleic oils, although genetically hard to reproduce, recently are gaining importance because of their superior stability and nutritional benefits. A research work showed that high oleic acid *Moringa oleifera* seeds oil to be with high frying quality and stability in comparison with canola oil, soybean, and palm olein oil in frying applications and this will reduce the risk of heart disease and high cholestrol problems [11].

Table 3. Fatty acid percentage in oil produced by two methods.

Fatty Acid	Fatty acid %	
	Solvent extraction	Mechanical press
Oleic acid (C18:1)	75.39	73.6
Gadoleic acid (C20:1)	2.54	2.4
Behenic acid (C22:0)	5.83	6.73
Palmitic acid (C16:0)	5.73	6.04

Fatty acid composition was determined by gas–liquid chromatography (GLC) according to the method used by Tsaknis et al., [8]. Analysis was performed on a Varian 3600 gas chromatograph (Varian, Palo Alto, CA, U.S.A.) equipped with a Supelcowax 10 (Supelco, INC., Supelco Park, Bellefonte, PA) fused silica capillary column 30m X 0.32mm i.d., and 0.25 mm film thickness. The temperature program was 60°C for 10 min and then 2°C/min up to 220°C. Injector and FID temperatures were set at 160 and 280°C, respectively, sample volume was 0.2 mL, the carrier gas was N₂ at a flow rate of 30mL/min, The internal standard used was nonadecanoic acid. Samples were prepared and measured separately in triplicate. The results of GLC are shown in figure 3, and 4, for mechanical press and solvent extraction method, respectively.

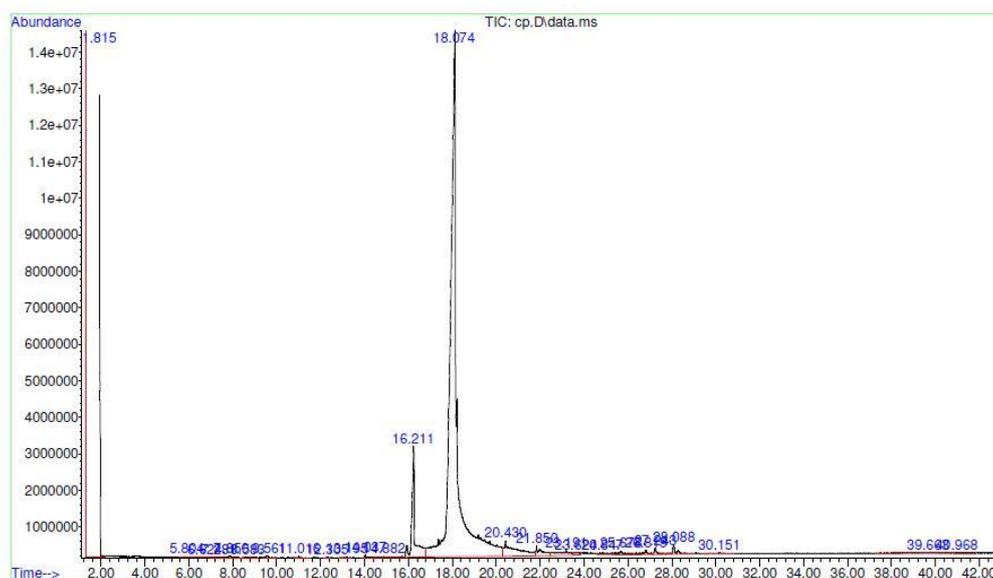


Figure 3. Fatty acids for mechanical method

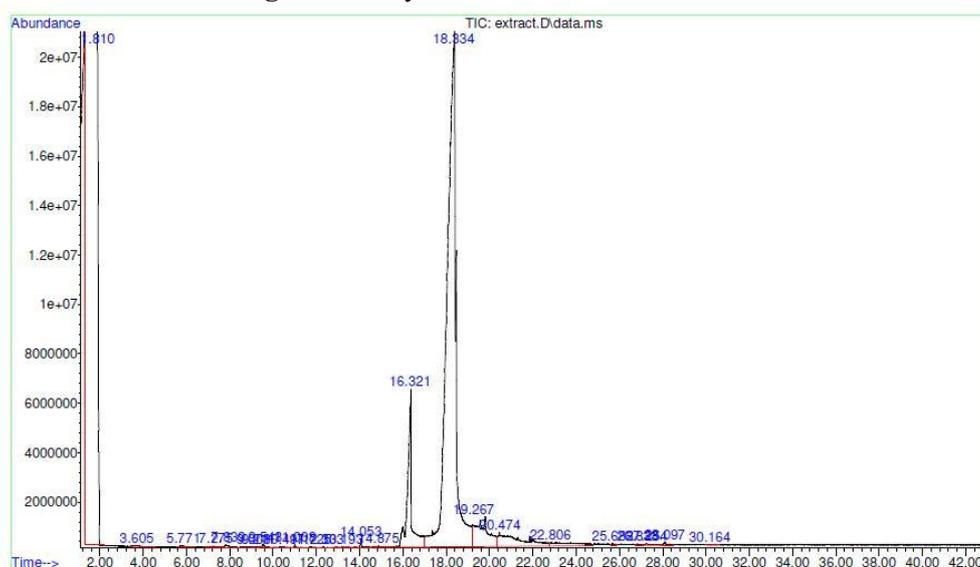


Figure 4. Fatty acids for chemical method

4. Conclusion

Based on results obtained in this research work, it was observed that the particle size of *Moringa oleifera* seeds is affecting the oil yield extracted from seeds. The smaller particles (500 μm) is producing higher oil yield of 41.5% compared to 1mm and 2 mm particle size which produce 40.8%, and 36.1 % , and this might be due to the higher exposure of seeds to the solvent. The oil produced by solvent extraction and mechanical press showed same properties, which means that it is possible to use any available method to get the product with the same quality. The fatty acid analysis showed that *Moringa oleifera* seeds oil has a high Oleic acid percentage which is considered as high quality edible oil with high nutrition value as good as olive oil. The olive oil is imported in Malaysia as a healthy product with high prices. Therefore, it will be of great importance to pay attention to *Moringa oleifera* tree to be cultivated in Malaysia for this purpose and for many other products that can be produced from this tree. In addition, it will generate good income and give more job opportunities in the country.

5. References

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