

Research Article

Effect of drying methods on the physicochemical properties and Fatty Acid composition of Moringa Seeds Oil

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Abstract

Effect of drying methods (sun-drying and cabinet oven drying) on the physicochemical properties and fatty acid composition of oils extracted from moringa seeds was investigated. Oil from the seeds was extracted using solvent (hexane) after drying. Drying increased the yield from 30.30-33.11%. The oil samples were less dense than water with specific gravities of 0.9032, 0.9075 and 0.9030 respectively. A significant difference exists in the moisture contents (0.11-0.21%); smoke point (202-2250C), flash point (310-3170C) and fire point (360-3690C). Sun-drying and cabinet oven drying brought about a decrease in the acid value (1.80-1.08mgKOH/g), saponification value (174.87-105mgKOH/g), iodine value (16.10-13.90w/w) and peroxide value (11.24-2.3-Meq/kg). The decrease is an indication of quality improvement of the oils. More unsaturated fatty acids were present in the samples between 76.61% and 81.66%. Oleic acid was predominant (44.92% raw, 45.71% sundried and 43.60% cabinet oven dried). Sun-drying and cabinet oven drying did not have much significant effect on the physical, chemical and fatty acid compositions of the oil. The results obtained from this study showed that the three oil samples are good as edible oil and for commercial purpose.

Introduction

Moringa oleifera is the most widely cultivated species of monogenetic family, the moringaceae, which is indigenous to south Asia, where it grows in the Himalayan foot hills from northeastern Pakistan, to northern west Bengal, India [1]. It has been introduced and become naturalized in other parts of India. It is now widely cultivated and has become naturalized in many locations in the tropics [2,3]. Moringa oleifera is the best known of the thirteen species in the genus moringa of family moringaceae [4]. It is fast growing for human food, medicine, dye, and fodder and water clarification. It has an impressive range of medical uses with high nutritional value.

Moringa seed has a fairly soft kernel, so the oil can be extracted by hand using a screw press (also known as spindle or bridge press). The seed is first crushed, 10% by volume of water is added, followed by gentle heating over a gentle fire for 10-15 minutes, taken care not to burn the seed. One such test yields 2.6 litres of oil from 11kg of kernels [5]. Once the best processing conditions are marked out, an extraction efficiency of 65% could probably be expected. Mature seeds yield 38-40% edible oil called ben oil from its high concentration of behenic acid [6]. The refined oil is clear and odourless, and resists rancidity. The seed cake remaining after oil extraction may be used as a fertilizer or as a flocculent to purify water. Moringa seed also has potential for use as a bio-fuel [7].

Also, the characteristics of Moringa oleifera seed oil can be highly desirable especially with the current trend of replacing polyunsaturated vegetable oil with those

containing high amounts of monounsaturated acids [8]. High oleic acid vegetable oils have been reported to be very stable even in highly demanding applications like frying. The press cake obtained after oil extraction has positively changed protein molecules that have coagulant properties [9]. These properties have been exploited in water clarification and wastewater treatments. Previous studies on *Moringa oleifera* have been focused on its medicinal uses and nutritional aspects of the tree parts and on the uses of the seed in the clarification of waste water during treatment [9].

However, little or no studies have been done on the effect of processing method(s) such as drying on the qualities of oil extracted from moringa seed. This work, therefore, was aimed at evaluating the effect of drying methods on the physicochemical properties and fatty acid composition of oil extracted from moringa seeds.

Materials and Methods

Collection of Moringa seeds

The *Moringa oleifera* seeds used for this work were obtained from a Moringa plantation at Emure-Ile, Ondo-State, Nigeria.

Processing of Moringa seeds

Moringa oleifera kernels were cleaned to remove stones, dirt, sand and other extraneous materials. The cleaned kernels were cracked by hand to remove the shell from the nuts. The seeds were divided into three equal parts; a part of the seeds were dried in the cabinet oven at 60°C for 2 hours; after which it was milled to flour in an attrition mill to obtain a smooth *Moringa oleifera* seeds flour. Another portion was sundried at the normal atmospheric temperature for 4 days and milled to obtain the flour while the last part was not subjected to any drying method (serves as control sample).

Extraction of Moringa seed oil

The smooth flours (500g each) were transferred inside a jar bottle and 400ml of hexane was poured inside the jar for 24hours. The samples were mixed together by shaking and was turned into a round bottom flask of the soxhlet extractor and covered with the reflux condenser subjecting the bottom of the flask to heat. The solvent was allowed to boil gently and left to siphon over a period of 2 hours. The boiling point of hexane is lower than that of the oil, hence hexane was evaporated leaving the oil; and hexane was collected. The oil obtained from the extract was allowed to dry in an oven at 105°C for 2 hours and cooled in a desiccator before using for experimental work. The oil obtained is called crude oil because it has not been refined. Oil sample was also extracted from freshly harvested *Moringa oleifera* seeds without subjecting it to any processing as the control sample.

Physicochemical properties and fatty acid composition determination

The physicochemical properties (oil yield, specific gravity, smoke point, flash point, fire point, moisture, acid value, peroxide value, saponification value and iodine value) and the fatty acid composition of the moringa seed oil were done using the methods of AOAC (2000) and Ibitoye respectively [10,11].

Results and Discussion

Comparative physical properties of Moringa oil sample

Percentage yield is an important tool used to know the percentage or quality of oil that is derived from any seed. The yield of oil extracted from raw, sundried and cabinet dried moringa seeds oils were 30.30, 32.21 and 33.11% respectively. This is in agreement with what was reported in the literatures. Anwar et al, reported a yield of between 30.00- 38.31% (Table 1). The oil yield in the three samples makes moringa seeds a good potential for the oil industry [12].

Most popular oil has specific gravity ranging from 0.9100 to 0.9400 and that 0.9200 is considered a pretty good number for any cooking oil [13]. Moreover, some authors have stated that specific gravity suitable for edible oils ranges from 0.8800 to 0.9400 [14]. Values obtained in the study ranging between 0.9032 and 0.9075 shows that moringa seed oil are in the range of edible oil. The moisture contents of the three samples (0.21% for raw; 0.16% for sundried and 0.11% for cabinet oven-dried) were higher than the maximum acceptable level of 0.1% [15]. The decrease in the moisture contents of oils extracted from sundried and cabinet oven-dried seeds could be due to evaporation of moisture from the seeds during the drying process.

The result of the smoke points, flash points and fire points (202, 310 and 360°C for raw; 205, 315 and 365°C for sundried and 225, 317 and 369°C for cabinet oven-dried oil samples) shows slight difference and is an indication that the oils have combustion characteristics [16]. These values were higher than what were obtained from oils extracted from two melon seed varieties [17].

Comparative chemical properties of Moringa oil samples

Table 2 shows the chemical properties of oils extracted from raw, sundried and cabinet dried moringa seeds. The acid value in the oils decreased after drying in the sun and cabinet oven from 1.80 to 1.34 and 1.08mgKOH/g respectively. However, these values were lower when compared to that obtained from Moringa oleifera oil from India (1.97mgKOH/g) and that heat is reported to have a reduction effect on acid value [18,19]. The values obtained in this study were lower than the stipulated permitted maximum value of 10mgKOH/g and 4mgKOH/g for virgin oil and coconut oil respectively [20]. The low acid values in this study indicate that the oil samples will be good edible oils.

Saponification value (SV) is a measure of both free and combined acids [19]. The SV of the moringa oils decreased from 174.87mgKOH/g to 162.10mgKOH/g after drying in the sun and 105.19KOH/g after drying in the cabinet oven. This decrease is significantly different and could be due to the neutralization of fatty acids which may have resulted from the hydrolysis of the oils [18]. However, these values were lower when compared to the findings of [21] Anwar and Rashid of 181.4mgKOH/g and also lower than the recommended range of 188 to 198mgKOH/g for edible oils [22]. This is an indication that the oils are composed of long chain fatty acids since the SV is lower than 200mgKOH/g [19].

Table 1: Physical Properties of Oils Extracted from Raw, Sundried and Cabinet Dried Moringa Seeds.

| Physical Properties | Processing Raw | Methods Sundried | Cabinet Drying |
|----------------------|----------------|------------------|----------------|
| Oil Yield (%) | 30.30 | 32.21 | 33.11 |
| Specific gravity | 0.9032 | 0.9075 | 0.9030 |
| Moisture content (%) | 0.21 | 0.16 | 0.11 |
| Smoke point(°C) | 202 | 205 | 225 |
| Flash point (°C) | 310 | 315 | 317 |
| Fire point (°C) | 360 | 365 | 369 |

Table 2: Chemical Properties of Oils Extracted from Raw, Sundried and Cabinet Dried Moringa seeds.

| Chemical Properties | Drying Raw | Methods Sundried | Cabinet |
|--------------------------------|------------|------------------|---------|
| Acid Value (mgKOH/g) | 1.80 | 1.34 | 1.08 |
| Saponification value (mgKOH/g) | 174.87 | 162.10 | 105.19 |
| Iodine value (wij's) | 16.10 | 13.90 | 15.51 |
| Peroxide value (Meq/kg) | 11.24 | 9.45 | 2.30 |

The results of the iodine values showed that there was a decrease from 16.10Wij's (raw) to 13.90Wij's (sundried) and 15.51Wij's (cabinet oven dried) which were not quite significant. These values were lower than what was reported (20.30–29.24Wij's) for moringa oils by Bello et al [23]. Higher values up to 60Wij's were reported by several authors [12,21,24]. Based on the iodine values of the three samples which were far below 100Wij's, the oils could be classified as non-drying oils and not easily prone to rancidity [25].

The result of the peroxide value of raw moringa seed oil (11.24Meq/kg) was higher when compared to the ones from sundried seeds (9.45Meq/kg) and cabinet oven dried seeds (2.30meq/kg). The decrease was more pronounced in the cabinet oven-dried sample. The peroxide values from this study were below the maximum 15meq/kg for cold pressed and virgin oils [26], showing that the oil samples obtained in this study are good and safe for human consumption. Peroxide value is an indication of oil deterioration leading to rancidity.

Comparative evaluation of the fatty acid composition of Moringa seed oil samples

Results from this study shows that oils from raw, sundried and cabinet dried moringa seeds contained 79.21%, 81.66% and 76.61% unsaturated fatty acids; and 20.79%, 18.34% and 23.39% of saturated fatty acids respectively. However, the differences in these values are slightly pronounced.

The unsaturated fatty acids in the three oil samples' contained predominantly Oleic acid (C18:1) with 33.22%, 34.38% and 31.44%, Erucic acid (22:1) with 0.82% and 1.15%; Linolenic acid (C18:3) with 0.14%, 0.40% and 0.23% and Palmitoleic acid (C16:1) with 0.11%, 0.09% and 0.19% respectively. Only Arachidonic acid (C20:4) was undetectable in the three oil samples among the unsaturated fatty acids (Table 3).

The saturated fatty acids are predominantly palmitic acid (C16:0) with values of 10.97%, 9.9% and 12.77% for raw, sundried and cabinet oven dried oil samples' followed by Arachidic acid (C20:0) with 3.74%, 3.40% and 4.06%; Behenic acid (C22:0) with 2.75%, 2.25% and 1.96%; Stearic acid (C18:0) with 1.18%, 0.96% and 1.20% respectively. However, caprylic acid (C8:0), Capric acid (C10:0), Lauric acid (C12:0), Myristic acid (C14:0) and Margaric acid (C17:0) were undetectable in the three oil samples' extracted from moringa seeds.

Table 3: Fatty Acid Composition of Oils Extracted from Moringa Seeds.

| Fatty acid methyl Ester | Fatty Acids | Carbon Number | Oil Raw | Samples Sundried | Cabinet |
|-------------------------|-------------|---------------|---------|------------------|---------|
| Methyl Caprylate | Caprylic | 8:0 | 0.00 | 0.00 | 0.00 |
| Methyl caprate | Capric | 10:0 | 0.00 | 0.00 | 0.00 |
| Methyl Laurate | Lauric | 12:0 | 0.00 | 0.00 | 0.00 |
| Methyl Myristate | Myristica | 14:0 | 0.00 | 0.00 | 0.00 |
| Methyl Palmitate | Palmitic | 16:0 | 10.97 | 9.91 | 12.77 |
| Methyl Margarate | Margaric | 17:0 | 0.00 | 0.00 | 0.00 |
| Methyl Stearate | Stearic | 18:0 | 2.16 | 1.80 | 3.39 |
| Methyl Arachidate | Arachidic | 20:0 | 3.74 | 3.40 | 4.06 |
| Methyl Behenate | Behenic | 22:0 | 2.75 | 2.25 | 1.96 |
| Methyl Lignocerate | Lignoceric | 24:0 | 1.18 | 0.96 | 1.20 |
| Methyl Palmitolate | Palmitoleic | 16:1 | 0.11 | 0.09 | 0.19 |
| Methyl Oleate | Oleic | 18:1 | 44.92 | 45.71 | 43.60 |
| Methyl Linoleate | Linoleic | 18:2 | 33.22 | 34.38 | 31.44 |
| Methyl Linolenate | Linolenic | 18:3 | 0.14 | 0.40 | 0.23 |
| Methyl Arachidonate | Arachidonic | 20:4 | 0.00 | 0.00 | 0.00 |
| Methyl Eruate | Erucic | 22:1 | 0.82 | 1.08 | 1.15 |

Since the saturated fatty acids in the oil samples were lower when compared to the unsaturated fatty acids, the moringa oil samples may not congeal at ordinary temperature. It is however reported that saturated fatty acids plays an important role in the structure of tissue [27]. Moreover, Stearic acid has been reported to lower blood cholesterol [28]. The results from this study showed that sun-drying and cabinet oven drying did not have much significant effect on the fatty acid composition of oils extracted from moringa seeds.

Conclusion

Oils were extracted from raw, sundried and cabinet dried moringa seeds and the physical, chemical and fatty acid compositions of the oils were evaluated. The high oil yield of 30.30% (raw), 32.21% (sundried) and 33.11% (cabinet oven dried) after extraction shows that moringa seeds has a good potential for commercial production. The oils were less dense than water with specific gravities which were less than 1 (0.9032, 0.9075 and 0.9030 respectively): moisture contents obtained (0.21%, 0.16% and 0.11%) were higher than the maximum accepted level of 0.1%. the smoke, flash and fire points (202, 310 and 360°C for raw, 205, 315 and 365°C for sundried, and 225, 317 and 369°C for cabinet oven dried oil samples) shows slight difference and is an indication that the oils have combustion characteristics.

The results of the chemical analysis showed that sun-drying and cabinet drying have a significant effect on the chemical properties of the oil. The acid, saponification and peroxide values decreases from raw to cabinet oven dried samples' from 1.80-1.08mgKOH/g, 174.87-105mgKOH/g and 11.24-2.30 Meq/kg respectively. However, the iodine value of cabinet oven dried oil samples (15.51wij's) was higher than that of the sundried oil sample (13.90wij's). The decrease is an indication of quality improvement of the oil.

Results from this study shows that the oil sample's contained more unsaturated fatty acids in the range of 76.61% and 81.66% than the saturated fatty acids in the range of 18.34% and 23.39%. Oleic acid was predominant in the three oil samples while Arachidonic acid, Caprylic acid, Capric acid, Lauric acid, Myristic acid and Margaric acid were undetectable in the oil samples'. However, sun-drying and cabinet oven drying did not have much significant effect on the fatty acid composition of the oil samples extracted from moringa seeds.

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