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Effect of storage period and relative humidity on the quality of moringa oil

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ABSTRACT

This study investigated the influence of storage period and relative humidity on oil extracted from moringa seed using soxhlet extraction method and stored under controlled relative humidity for 90 days using saturated slurry salt method. Samples were taken after 1, 30, 60 and 90 days and the quality parameters like iodine value (IV), acid value (AV), saponification value (SV) and peroxide value (PV) were obtained and compared to FAO/WHO acceptable standards for edible oil. The obtained results showed that the acid value, peroxide value and saponification value increase as relative humidity increases, ranging from 2.47-3.44mg/g, 1.01-1.21Meq/Kg and 172.13-184.36mg/g, respectively, but still falls within the range stated by FAO/WHO for edible oils (4.00 mg/g, 4.00 Meq/Kg and 181±2.60 mg/g) for acid value, peroxide value and saponification value, respectively. Iodine value decreases as relative humidity increases, ranging from 61.28-71.92 g/100g and falls slightly below the standard given by FAO/WHO for edible oils (80-106 g/100g). It was concluded that moringa oil is stable within a wide range of humidity and will have a longer shelf life due to its very low peroxide level.

Introduction

Moringa (*Moringa oleifera*), also known as drumstick or horseradish (Aviara et al., 2015), is a multipurpose tree crop that is widely cultivated in Nigeria. The plant produces several seeds with oil content ranging from 27 to 38 % in the kernels (Aremu and Akintola, 2014). The seed oil is mostly used as raw material in the cosmetic industry and as lubricating oil for machineries (Adejumo and Abayomi, 2012; Ogunlade and Aremu, 2021). The large amount of oil in the seed raises concerns about the flour's consistency when stored for an extended period of time. Several studies have been published on the composition and properties of moringa oil derived from flour from various countries, e.g. Malawi (Tsaknis et al., 1998), Kenya (Tsaknis et al., 1999a, b), Pakistan (Farooq et al., 2006; Manzoor et al., 2007), Bangladesh (Rahman et al., 2009) and India (Ogunsina et al., 2014). However, the literature seems scanty on the impact of relative humidity and storage time on the chemical properties of oil extracted from moringa seed grit. Thus, this article provides information on the impact of varying relative humidity and storage period on some quality characteristics of oil extracted from moringa grit.

Materials and methods

Sample preparation

The moringa kernels were procured from Bodija market in Ibadan. The kernels were shelled and the seeds were washed to eliminate any unnecessary materials before being dried until equilibrium moisture content was attained. An electric laboratory burr mill (Gourmia GCG185 Electric Burr Coffee Grinder) was used to grind the dried seeds with methods similar to Alakali and Satimehin's (2007).

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The grit was then dried for seven days in desiccators over concentrated sulphuric acid to get rid of any remaining moisture and kept in airtight containers until it was analyzed (Ogunsina et al., 2014; Ogunlade and Aremu, 2019, Ogunlade and Aremu, 2020).

Oil extraction using Soxhlet method

The grounded seeds were placed in a porous cellulose thimble. The thimble was suspended above a flask containing the solvent and below a condenser in an extraction chamber. The solvent evaporated and moved to the condenser, where it was converted into liquid, which trickled into the extraction chamber containing the sample (Ibrahim and Onwualu, 2005). When the solvent covered the sample and reached a certain amount, the extraction chamber overflew and trickled back down into the boiling flask. At the end of the extraction process, the flask containing the solvent and lipid was extracted. In the oven, the solvent in the flask evaporated and the mass of the remaining lipid was measured.

Control of relative humidity

The use of saturated salts, as shown in Table 1, was used to keep relative humidity stable. Saturated salt slurries were created by mixing more than the soluble amount of salt with distilled water to achieve and maintain the correct relative humidity. The desiccators were prepared by putting the saturated salt slurry on the bottom and using wire gauze to lift the sample above the slurry after the saturated salt slurries were made. For each relative humidity, one desiccator was used. 100 grams of samples were weighed and placed on the wire gauze inside the desiccator in a disposable plastic sample holder. The desiccators were put at room temperature after the lids were secured with a tight seal and each sample was taken for analysis after 1, 30, 60, and 90 days.

Table 1. Quantities of salt and distilled water used in this research and their corresponding relative humidity values (Nyangena et al. 2020)

Salt	Salt (kg)	Water (kg)	Relative Humidity (%)
LiCl	0.075	0.042	11.2
CH_3COOK	0.200	0.075	22.6
K_2CO_3	0.200	0.090	43.8
NaBr	0.200	0.080	57.7
$SrCl_2.6H_2O$	0.200	0.050	70.8
$(NH_4)_2SO_4$	0.200	0.060	80.0
KNO_3	0.200	0.080	94.6

Measurement of the quality parameters

Saponification value

AOAC, 2010 was used to calculate the saponification value. Two grams of the sample were placed in a 200 mL conical flask, along with 25.0 mL of 0.5 mol/L potassium hydroxide ethanol. The mixture was gently heated and the flask was shaken periodically, while the heat was balanced so that no backflow ethanol reached the top of the cooling pipe. It was then titrated with 0.5 mol/L HCl until a slight pink colour appeared after heating for 30 minutes and cooling immediately.

$$\text{Saponification value (mg of KOH /g)} = \frac{(BL - EP) \times TF \times C \times K}{m}$$

EP : Titration volume (mL)

BL : Blank level (25.0mL)

TF : Reagent (HCl) factor (1.006)

C : Concentration conversion coefficient (28.05 mg/mL)
(Potassium hydroxide in Eq.:56.11×0.5)

K : Unit conversion coefficient (1)

m : Sample size (g)

Iodine value:

The number of reactive double bonds in oil was measured by the iodine value (IV). A higher IV suggests more double bonds and the possibility of oxidation. The AOAC, 2010, was used to calculate the iodine value. A 300 mL conical flask was filled with 0.1 g of the sample. In an ultrasonic washing machine, 20.0 mL of carbon tetrachloride was added and dissolved. 25.0 mL Hanus solution was applied and then the container was sealed. For 30 minutes, the mixture was kept in a dark room (around 20 °C). The mixture was shaken for 30 seconds after adding

10.0mL of 15% potassium iodide and 100 mL of water. To determine the iodine content, the mixture was titrated with 0.1 mol/L sodium thiosulfate to a colourless endpoint.

$$\text{Iodine value (mg of KOH /g)} = \frac{(BL - EP) \times TF \times C \times K}{m}$$

EP : Titration volume (mL)
BL : Blank level (47.0mL)
TF : Titrant factor (1.006)
C : Concentration conversion coefficient (1.269 mg/mL)
(Atomic mass of Iodine: 126.9/100)
K : Unit conversion coefficient (1)
m : Sample size (g)

Peroxide value

The peroxide value (PV) was used to determine how far oil spoilage has progressed. When the PV is between 20 and 40 Meq/Kg, a rancid taste and odour can be detected (Barakat and Ghazal, 2016). AOAC, 2010 was used to calculate the peroxide value. A conical flask with a stopper was filled with 5g of the sample. 30 mL of solvent was applied and gently shaken to fully dissolve the sample. The flask was then sealed and gently shaken for one minute after adding 0.5 mL of saturated potassium iodide. In the dark space, the flask was left at room temperature. After that, 30 mL of pure water was added and the flask was sealed. After that, the mixture was titrated with 0.01 mol/L sodium thiosulfate until a slight yellow colour emerged, which was used to determine the peroxide value.

$$\text{Peroxide value (mg of KOH /g)} = \frac{(EP - BL) \times TF \times R}{m}$$

EP : Titration volume (mL)
BL : Blank level (0.0mL)
TF : Reagent factor (1.006)
R : Constant (10)
m : Sample size (g)

Acid value

The acid value of the rmoinga oil was obtained from the information of the free fatty acids. The dish containing 5 g of oil sample was measured poured into a conical flask and re-weighed, yielding the actual weight of the oil taken. With a few drops of phenolphthalein, fifty milliliters (50 ml) of hot neutral alcohol was added and vigorously shaken. With continuous shaking, the solution was titrated with 0.5 M sodium hydroxide (NaOH) solution until the pink colour remained constant. The percentage of present acid was measured using the quantity of 0.5 M alkali, and the result was expressed in terms of oleic acid (Farooq et al., 2006).

$$\text{Acid value} = \frac{V_{NaOH} \times 5.61}{W}$$

where:

V_{NaOH}= Volume of sodium hydroxide titrant used (mL)
W = Weight of the fatty oil being examined (g)

Results

The impact of various relative humidity on the chemical properties of moringa oil at various time intervals was evaluated and compared to the FAO/WHO (2009) international standard for edible oil, as reported by Adejumo et al. (2013). Table 2 shows the effect of relative humidity and storage duration of 1 day, 30 days, 60 days, and 90 days on the chemical properties of moringa seed oil. The influence of relative humidity on saponification, iodine, peroxide and acid values is presented in Figures 1 to 4, respectively.
The determined parameters increased as relative humidity increases, but still fall within the range specified by FAO/WHO (2009) for edible oils, except for the Iodine value, which decreases as relative humidity increases and falls slightly below the range. This clearly shows that moringa oil is stable over a large range of relative humidity and over time. These findings are consistent with previous studies by Tsaknis et al. (1998), Tsaknis et al. (1999a, b), Lalas and Tsaknis (2002), Farooq et al. (2006), Manzoor et al. (2007), Rahman et. al. (2009) and Ogunsina et al. (2014).

Table 2. Chemical characteristics of moringa oil a day after extraction

	RH %	**11**	**23**	**43**	**57**	**70**	**80**	**94**	
	Days								***Standard for edible oil**
Acid value (mg of KOH/g)	1	2.47	2.62	2.66	2.73	2.77	2.92	2.92	4.00
	30	2.62	2.66	2.69	2.77	2.81	2.95	3.07	
	60	2.73	2.84	2.92	2.99	3.14	3.33	3.44	
	90	2.73	2.84	2.95	2.99	3.14	3.33	3.44	
Peroxide value (Meq/Kg)	1	1.01	1.01	1.01	1.14	1.21	1.21	1.21	4.00
	30	1.01	1.01	1.01	1.01	1.07	1.21	1.21	
	60	1.01	1.01	1.07	1.14	1.21	1.21	1.21	
	90	1.07	1.14	1.21	1.21	1.21	1.21	1.21	
Iodine value (g/100g)	1	71.92	70.64	69.36	68.51	66.81	64.26	62.98	80-106
	30	69.79	69.36	68.09	66.81	65.96	64.68	62.55	
	60	68.94	68.09	67.24	66.38	64.68	63.83	61.28	
	90	68.94	68.51	67.66	66.81	66.81	65.53	63.83	
Saponification value (mg of KOH/g)	1	174.48	174.95	176.83	177.78	181.07	182.01	183.89	181.4±2.6
	30	174.48	175.89	177.30	177.78	180.60	182.01	183.89	
	60	173.07	174.95	176.83	177.78	180.60	182.48	183.89	
	90	172.13	174.01	175.42	177.30	180.13	182.48	184.36	

***FAO/WHO, 2009

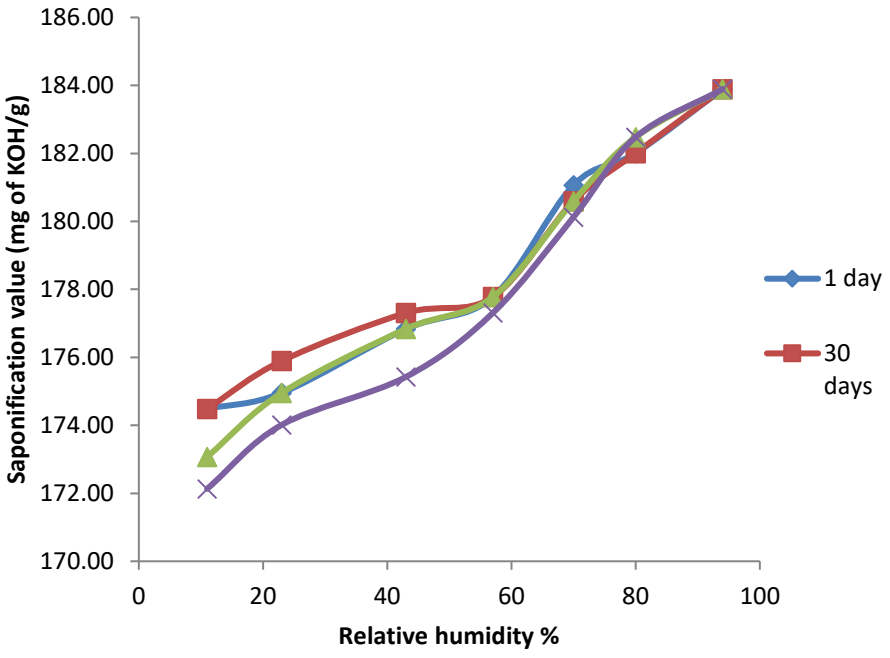

Figure 1. Saponification value of stored moringa oil at various relative humidity

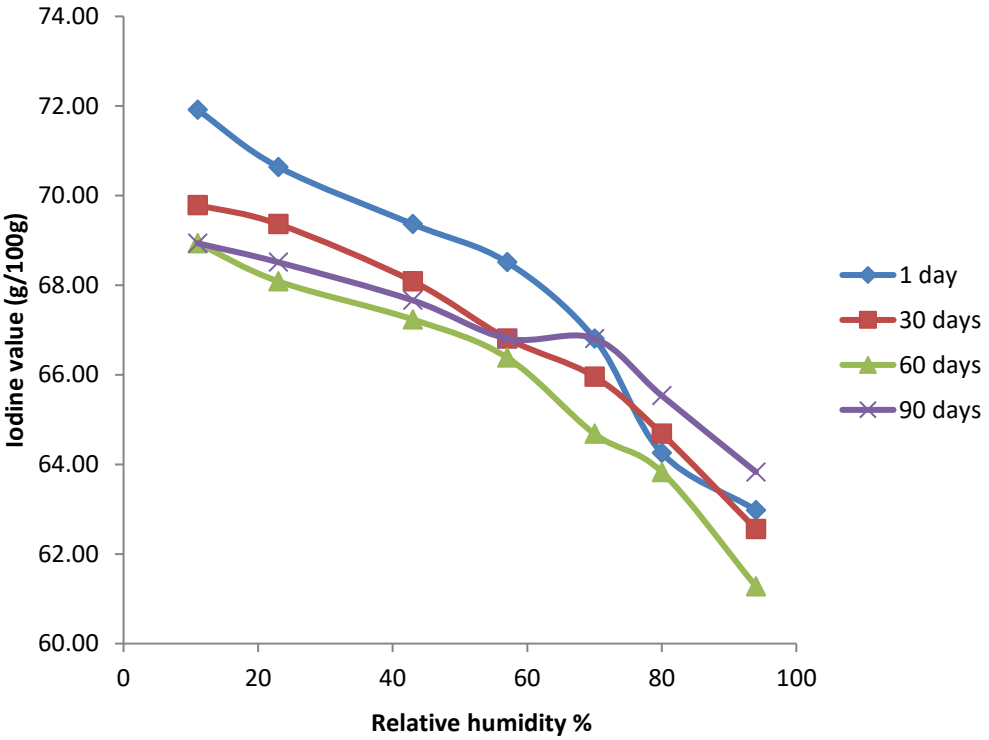

Figure 2. Iodine value of stored moringa oil at various relative humidity

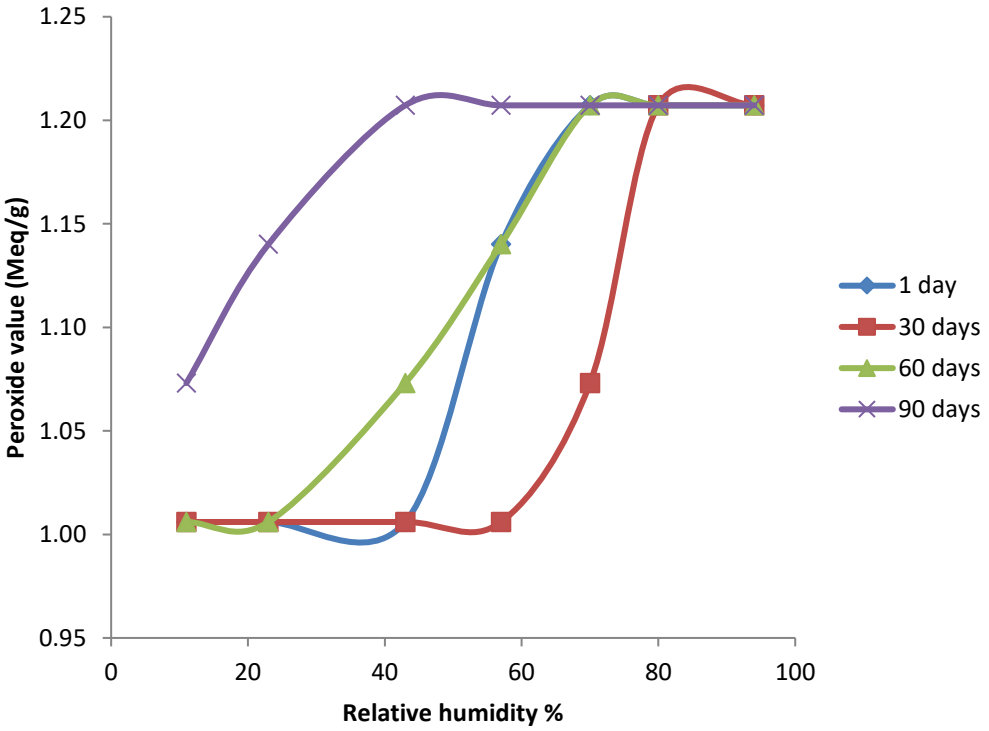

Figure 3. Peroxide value of stored moringa oil at various relative humidity

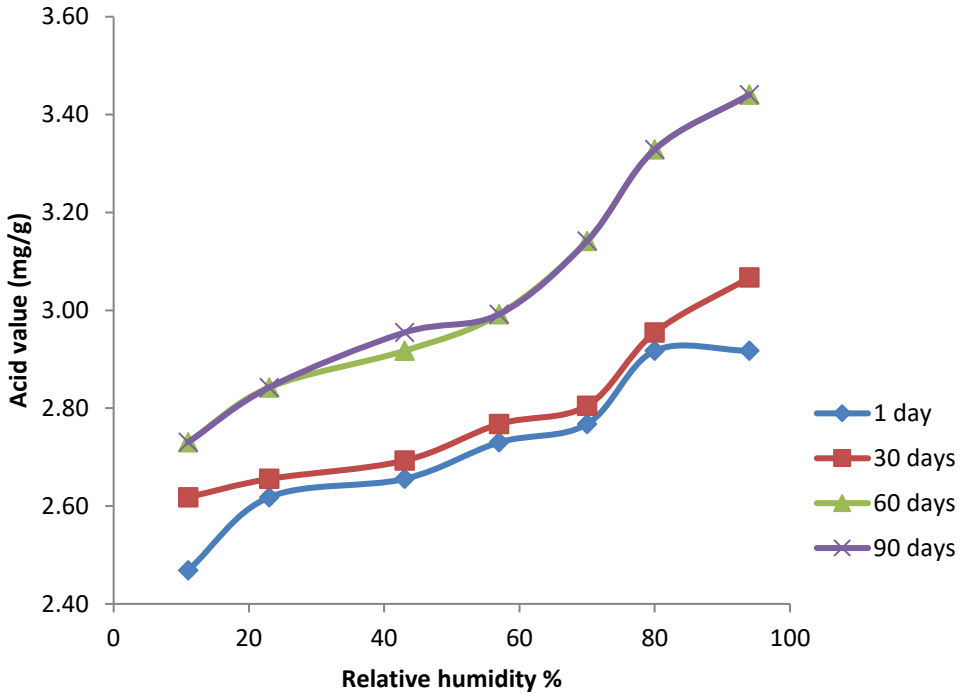

Figure 4. Acid value of stored moringa oil at various relative humidity

Discussion

As shown in Figure 1, the saponification values of moringa seed oil were between 173.09 and 183.89 mgKOH/g oil, with the highest value at 94 % RH. According to Adejumo et al. (2013) the values for all of the samples are within the range of the recommended international standard for edible oil. The saponification values reveal the nature of the fatty acid contained in the oil as well as the water solubility of the soap extracted from it. A high saponification value suggests a low fatty acid content in the oil. This indicates that rancidity is unlikely to occur while the product is being stored. Saponification is at the heart of soap-making involving a chemical reaction in which the building blocks of fats and oils (triglycerides) react with lye to form soap.

The iodine value of moringa seed oil was found to be between 61.28 and 71.92 g of Iodine/100 g of oil, as shown in Figure 2, with the highest value at 11 % RH, which is consistent with the studies by Tsaknis et al. (1999), Lalas and Tsaknis (2002), Anwar and Bhangar (2003). The FAO/WHO (2009) standard for edible oil is between 80 and 106 g/100 g. Despite the fact that they all fall below the edible oil level; the iodine value decreases in a consistent manner. The iodine value of an oil is an indicator of the amount of unsaturated acid present, as well as the oil's non-drying properties. The greater the unsaturation, the greater the liquidity and therefore, the higher the iodine value. The lower the amount of iodine value, the lower the degree of unsaturation.

The peroxide value of moringa seed oil was found to be between 1.01 and 1.21 Meq/kg, which is very low when compared to the FAO/WHO (2009) norm for fresh edible oil, which is 10 MEq/kg. As shown in Figure 3, the peroxide values of the oil increased minimally between 11 and 94 % RH, which is consistent with the findings of Onilude et al. (2010). The peroxide value of a product is a measure of its oxygen content that is used to monitor the progression of rancidity by calculating the amount of peroxide produced in the product. Moringa seed oil has a lower peroxide content, which means it is less likely to go rancid, resulting in a longer shelf life and greater stability.

As shown in Figure 4, the acid value increased in a linear fashion from 11 % RH to 94 % RH, and it also increased as the storage time increased. This indicates that if moringa oil is stored for a longer period of time, the acid value will surpass the FAO/2009 WHO's international standard for edible oil.

Conclusions

It was concluded that moringa flour with a high percentage of oil stored in a wide range of humidity is stable. Although relative humidity has an impact on the oil, it is still within the edible oil's standard range. Its edibility is indicated by the high free fatty acid content. Due to its low peroxide content, moringa seed oil has a longer shelf life. Moringa seed oil can be used as a lubricant and a supplement for other vegetable oils in the kitchen.

Author Contributions: Akintunde Akintola conceptualized the research, searched for methodology, carried out the experiments and wrote the original draft.
Ademola Kabiru Aremu assisted in search for methodology, investigations and supervised the research.
Clement Adesoji Ogunlade also worked on investigation and methodology, writing review and editing.

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