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Original Research Article

Quality Characteristics of oil Extracted from three Local Varieties of Pumpkin (*yar awo, yar bahaushiya and yar madana*) Seeds

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Abstract: Pumpkin oil-seed bearing fruit is of economic importance to many cultures across the globe used as food. The characteristics of the oil bearing seeds (*'Yar madana, 'Yar bahaushiya* and *'Yar awo*) were quantitatively and qualitatively analyzed. Extraction was carried out by the use of solvent extraction method. The physicochemical properties, percentage yield, extraction rate, sensory attributes of the oils were also determined. The mean values of oil yield for *'Yar awo* was significantly higher in acid value, FFA, moisture content were 54.64 %, 1.96 mg KOH/ g oil, 0.982 %; than *'Yar madana* pumpkin 23.63%, 3.23 mg KOH/ g oil, 1.47 %; and *'Yar bahaushiya* 28.34%, 2.95 mg KOH/ g oil, 1.61% respectively. Significance difference exits (<0.05) in saponification, peroxide and iodine values for *'Yar madana* variety 173.23 mg KOH/g oil, 5.50 mEq O_2/g oil, 24.16 mg I_2/100g; Yar Awo 197.70 mg KOH/g oil, 5.10 mEq O_2/g oil, 29.28 mg I_2/100g; and *'Yar bahaushiya* 190.70 mg KOH/g oil, 2.00 mEq O_2/g oil, 31.84 mg I_2/100g. Specific gravity, refractive index, smoke point, flash point, fire point, moisture content for *'Yar madana* variety were 0.92g/ml 1.44, 183.7°C, 261.9°C, 323.1°C, *'Yar Awo* 0.90g/ml, 1.44, 186.4°C, 268.3°C, 318.6°C and *'Yar bahaushiya* 0.94g/ml, 1.44, 183.7°C, 267.3°C, 314.4°C. The mean sensory attributes of *'Yar Awo* variety was found to be most acceptable than the *'Yar madana* and *'Yar bahaushiya*. Low level of acid values and other properties obtained from the three local varieties of the pumpkin showed that the oil was edible.

Keyword: Pumpkin, Pumpkin oil extraction, Pumpkin oil yield.

1.0 INTRODUCTION

Oil is a part of a class of food called lipid that is generally made up of fatty acids chain. It differs from its counterpart (fat) by some characteristics such as types of fatty acids makeup, state/ form at room temperature, types of crystals present, source, etc. Oils can majorly be obtained from either animal source or originate from plants which commonly known as vegetable oil. Vegetables oils are essential in meeting global nutritional demands and are utilized for many food and other industrial purposes (Idouraine, *et al*., 1996). Pumpkin is an important seed-bearing vegetable tropical vine of high nutritional and medicinal values (Nkang *et al*., 2003). Pumpkin with oily seeds belongs to the family Cucurbitaceae. Although many varieties are grown over the world the most common commercially species include*: C. maxima, C. pepo, C. moschata, C. ficifolia, C. mixta, C. stilbo and C. turbaniformis* in which *C. pepo* exhibits the widest variation especially with respect to afruit characteristics (Gemrot, *et al*., 2006). Pumpkin which is among the perishable crops exhibit excessive losses when encounter in appropriate handling, which are cultivated worldwide for many purposes varying from agricultural uses, commercial and decorative uses (Amin, *et al*., 2019). The consumption rate of pumpkin seed is increasing in many African countries and elsewhere due to the important benefits (Aktas, *et al*., 2018). Considerably, the seeds are consumed directly as snacks, for preparation of soups and as a roasted seeds, which are rich in antioxidants, water soluble (Vitamin C) and fat soluble vitamins (A and E); the pumpkin has obtained revival of use in the United State and Europe (Caili, *et al*., 2006). Despite the broad range of sources for vegetable oils, the world consumption is dominated by soybean, Palm, rapeseed and sunflower oils with 31.6, 30.5, 15.5 and 8.6 million tons consumed per year respectively (Stevenson, *et al*., 2007). This conventional source of vegetable oils no longer meets the ever

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increasing demands of domestic and industrial sectors. The research is aimed for utilization of the most common varieties of pumpkin seed grown in Nigeria, evaluation of the quality parameters of the oil extracted using a soxhlet methods and their yield.

2.0 MATERIALS AND METHODS

2.1 Sample Preparation and Oil Extraction

A measured quantity of the pumpkin seeds were removed, washed, dried in an oven, ground into powder. 22 g of the samples was used for the extraction. A continuous process up to three hours was adopted by using solvent extraction method until maximum oil yield was recovered. The study was conducted in the food processing laboratory in the department of Food Science and Technology, Kano University of Science and Technology Wudil, Kano State Nigeria.

2.2 Determination of Oil Yield and Extraction Rate

The percentage yield and extraction rate could be attributed to different parameters which includes the type of organic solvent (chloroform, hexane, petroleum ether etc.) used. The following output parameters were measured from the extraction operation to determine the; percentage oil yield and percentage extraction rate according to the method of Banat *et al*., (2013).

2.2.1 Determination of percentage oil yield

Oil from the 22 g of the seed sample was recovered and percentage oil yield was calculated as follows:

Percentage oil yield = $W_{OE}/ W_{OE} + W_{CK}$ x 100 %

Where:

OY = Oil yield
W_{OE} = Weight of oil extracted
W_{CK} = Weight of cake (g)

2.2.2 Determination of percentage extraction rate

The percentage extraction rate is defined as optimum expressing capacity of the solvent and was determined mathematically as:

Percentage ER= W_{OE}/ T x 100 %

Where:

Percentage ER = percentage extraction rate
W_{OE} = Weight of oil extracted (g)
T = Time Taken for the Extraction

2.3 Determination of Physical Analysis

The specific gravity, refractive index, flash point, fire point, smoke point was determined according to the method of Onwuka (2018) while moisture content was determined according to AOAC (2012). The physical analyses of the oils were carried out to measure the quality indices of the oil for further processing.

2.4 Determination of Chemical Analysis

The chemical analysis such as the Acid value, Free Fatty Acids, Iodine Value, Saponification and Peroxide Values were determined using the method of Onwuka (2018), in order to know the general condition and edibility of the oil.

2.5 Sensory Evaluation of the Samples

The oil samples were subjected to sensory evaluation using selected sensory attributes to determine their overall acceptability. A nine 9-point hedonic scale was used to evaluate oil produced as described by Ihekoronye and Ngoddy (1985).

2.6 Statistical Analysis

Data were collected and analysed using SPSS version 15.0. Standard deviation and analysis of variance were obtained.

3.0 RESULTS AND DISCUSSION

3.1 Physical Properties of the Oil

The physical properties of the three pumpkin seeds oil were evaluated as shown in the Table 1 which shows that moisture content range from 0.97 to 0.40 %, specific gravity 0.94 to 0.90, refractive indices 1.44 for all the samples, smoke point 186.4 to 183.7 °C, flash point 268.3 to 261.9 °C and fire point 323.4 to 314.4 °C.

Moisture is a chemical contaminant which is usually well mixed with oil. Presence of moisture in oil affects the quality of the oil, it has been reported that significant amount of moisture in oil support microbial growth (Alirezali, *et al*., 2011). Results obtained on the moisture contents of samples YBS, YMD and YAW as presented in Table 4.1 were found to be 0.73 %, 0.97 % and 0.40 % respectively which is less than the moisture content of shea butter oil of 2.29 and 0.12 % for crude and refined oils respectively as reported by Munir, *et al*., (2014). The results of the specific gravity of the three pumpkin oil varieties does not differ from those of other vegetable oils compares to that for coconut(0.908 - 0.921), rape seed (0.910 - 0.920) and canola (0.914 - 0.920) oils (Nichols and Sanderson, 2003). Also the results ranges (0.9042 - 0.9368) of the three pumpkin oils varieties and was similar to the result obtained by Alfawaz, (2004) of 0.913 and Akhalifa, (1996) of 0.928. Also correspondingly the effects of variety were not significant on the specific gravity of pumpkin seed oil. The result in this study shows that pumpkin seed oil is less dense than water.

There is no significant difference in the refractive indices of the three pumpkin seed oil varieties at ($p < 0.05$) as shown in table 4.1. All types of the three varieties yielded nearly similar refractive indices 1.44, 1.44, and 1.44 for *Yar bahaushiya, Yar madana and Yar awo* respectively. These results were similar to the refractive index of *Cucurbita maxima* and *Cucurbita pepo* of 1.4656 and 1.4710 reported by Alfawaz, (2004) and Al-Khalifa, (1996) respectively. It is also similar to the refractive index of fluted pumpkin of 1.4323 reported by Michael, *et al*., (2015). The refractive indices obtained in this study do not differ from those of other oils, i.e. according to Orhevba and Efomah, (2012), the

Refractive index of cotton seed oil was 1.464 and that of soybean oil was 1.474 as reported by Alfawaz, (2004). the refractive index of the oil which can be used to establish the purity of fats and oils when suspected to be adulterated as well as one of the important physical characteristics for identification of oils and fats,this implies that the refractive index of Pumpkin seed oil is not dependent on the pumpkin variety.

The result of the smoke point of the three different varieties of the pumpkin seed oil shows a significant difference at ($p < 0.05$) as shown from the table the smoke point ranges (183.7 ºC - 186.35 ºC) which was in good agreement when compares to the reported by Lazos, *et al*., (1997) of 181.1 ºC for crude oil and 205.2 for purified oil. Also the result was similar to the result reported by Anonymous, (1995) for cotton seed oil (185 - 225 ºC). The slight difference of the smoke point could be attributed to the free fatty acid reduction, which are more volatile than glycerides and hence smoke points depend on the free fatty acid content.

Correspondingly there was a significant difference in the flash point of the three pumpkin seed oil varieties as shown in the table 4.1 at ($p < 0.05$) implying that flash point of pumpkin seed oil depends on the type of pumpkin. The flash point in this study was greater than that of flaxseed oil of 120 - 135 ºC and similar to that of rapeseed oil 275 - 290 ºC and coconut oil 288 ºC as reported by Anonymous, (1995). Also the fire point obtained as shown in the table 4.1 at ($p < 0.05$) above shows a significant difference on the pumpkin seeds oils. The range of the fire point was (314.4 ºC - 323.1 ºC) which was in good agreement with fire point of other vegetable oils such as coconut oil (329 ºC) and lower than that of soybean oil (342 ºC – 360 ºC), rapeseed (344 ºC), sunflower oil (341 ºC) as reported by Earl, *et al*., (2005). The result indicated that the pumpkin seed oil is good for frying and other heating processing.

3.2 Result and Discussion of the Chemical Properties of the Extracted Oil

The chemical analysis of the three pumpkin seeds oil were determined as shown in the Table 2 which shows that the acid value ranges from 3.23 to 1.96 mg KOH/ g oil, Free fatty acid from 1.61 to 0.982 % as oleic acid, peroxide value from 5.50 to 2.00 mEq O_2/ kg oil, saponification value from 191.7 to 173.0 mg KOH/ g oil and Iodine value from 31.84 to 24.16 mg I_2/ g oil.

There was a significant difference in the acid values of the pumpkin seed oil from the different varieties as shown in table 4.3 at ($p < 0.05$), implying that the acid value is dependent on the type of pumpkin. This indicates that the oil of the *Yar awo* type pumpkin requires less refining and hence is safer for human consumption compared to those of *Yar bahaushiya* and *Yar madana*. Oil from *Yar bahaushiya* and *Yar madana* requires further processing such as refining to remove free fatty acids before human consumption. Also the result suggests that the oil from *Yar madana* is more likely to undergo deterioration due to its higher acid value. The acid value ranges in this study of (1.964 - 3.226) mg KOH/ g oil was similar to the acid value reported by Tonny, *et al*., (2015) at (2.24 - 3.74) mg KOH/ g oil and is higher than that reported by Alfawaz, (2004) on *C. maxima* (0.53 mg KOH/ g oil), similarly it is lower than that for *C. pepo* (62.6 mg KOH/ g oil) and *C. maxima* (12.6 mg KOH/ g oil) as reported by Bwade, *et al*., (2013). In comparison to other seed crops, the pumpkin seed oil acid value in this study was lower than the acid value of soybean 9.86 mg KOH/ g oil (Onimawo, 2002) and coconut oil 6.36 mg KOH/ g oil as reported by Obasi, *et al*., (2012). For some kind of oil the maximum permitted acid value is 10 mg KOH/ g oil (Marija, *et al.,* 2012).

Correspondingly, there was a significant difference of free fatty acid among the three pumpkin seed oil varieties as shown in table 4.3 at ($p < 0.05$), the free fatty acid ranges (0.9818 - 1.613) % as oleic acid was higher than that of reported by Arsalan, *et al*., (2017) of (0.26 - 0.27) % as oleic acid of pumpkin seed oil. The free fatty acid contents of all the three studied varieties were also within the codex limit of up to 2 % oleic acid of virgin and cold pressed oils (Arsalan, *et al*., 2016) and codex standard, 1999. The free fatty acids which indicate enzymatic activity were detected as shown from the studied oil from the three pumpkin varieties.

The result shows that there was a significant difference of peroxide value in the pumpkin seed oil from the three different varieties as shown in table 4.3 at ($p < 0.05$), the peroxide value of the study ranges (2.00 - 5.500) m Eq O_2/ kg oil which was in good agreement with the peroxide value reported by Marija, *et al*., (2012) of 3.82 - 4.07 mEq O_2/ kg oil for the pumpkin seed oil and is lower than that reported by Tsaknis, *et al*., (2000) of peroxide values 9.20 - 9.04 m Eq O_2/ kg oil for *C. pepo* crude and refined seed oil and hence the peroxide values of the studied pumpkin are in limitations legislated by the Codex Alimentarius commission. For some kinds of oils, the permitted maximum peroxide value is 10mEq O_2/ kg oil. The studied peroxide values are lower than that of cotton seed oil (10 mEqO_2/ kg oil), maize oil (10 mEqO_2/ kg oil) and rapeseed oil (10 mEqO_2/ kg oil) as stated by Codex Alimentarius. It has been shown that oils become rancid when the peroxide values ranges from 20.0 - 40.00 m Eq O_2/ kg oil (Ajayi, *et al*., 2006). Peroxide value is a valuable measure of oil quality as it provides an indication to the stability of the oil and the level of deterioration of fats. Saponification value is the number of milligram of potassium hydroxide required to neutralize the fatty acid present in a hydrolysis reaction. The higher the saponification value of the oil, the higher is the lauric acid content of that oil. The lauric acid content and the saponification value of the oil are important parameters in determining the suitability of the oil in soap making. The result of the saponification value for the three pumpkin seed oils from the table 4.3 showed that there was significant difference at ($p < 0.05$). The saponification value of the YBS, YMD and YAW were 190.68 mg KOH/ g oil, 172.98 mg KOH/ g oil and 191.68 mg KOH/ g oil respectively. The studied saponification values fell in the range of 174 - 197 reported for the pumpkin seed oil (Nichols and Sanderson, 2003). These values indicated that the pumpkin seed oil from the three varieties have fatty acids with higher number of carbon atoms in comparison with coconut (248 - 265) mg KOH/ g oil and palm kernel (230 - 254) mg KOH/ g oil, oils (Nichols and Sanderson, 2003). These results were in good agreement with the 185.5-195.3 mg KOH/ g oil range of Markovic and Bastic (1976). However, it was lower than 200 - 218 mg KOH/ g oil range reported by Al-Khalifa (1996), 206 mg KOH/ g oil of El-Adawy and Taha (2001) and 201 mg KOH/ g oil of Tsaknis, *et al.,* (1997) and was higher than 132.3 mg KOH/ g oil reported by Younis, *et al.,* (2000) for *C.* spp. Furthermore it fell in the range reported for olive, canola, corn and sunflower oils (Nichols and Sanderson, 2003).

There was a significant difference in the iodine value of the three different pumpkin seed oil varieties as shown in table 4.3 at ($p < 0.05$), in this study the iodine value of the pumpkin seed oil ranges (24.16 - 31.84) mg I_2/ g oil which was similar to the iodine values reported by Tonny, *et al*., (2015) which ranges (25.3 - 26.6) mg I_2/ g oil and that of *C. maxima* (16 mg I_2/ g oil) and *C. pepo* (15.8 mg I_2/ g oil) reported by Bwade, *et al*., (2013). The result obtained was lower than that reported by Alfawaz (2004) of *C. maxima* as high as 105.12 mg I_2/ g oil. it was also lower than that of soybean oil (132.7 mg I_2/ g oil) and castor seed oil (87.72 mg I_2/ g oil) reported by Earl, *et al*., (2005) and Orhevba (2012) respectively. The low iodine value implies non-drying of the oil and it also suggests that the oil contains few unsaturated bonds and therefore has a low susceptibility to oxidative rancidity.

3.3 Percentage Yield and Extraction Rate Analysis of the Oil

The yield and extraction rate of the oil from the samples as shown in Table 4.2 which shows that the percentage oil yield is as follows; *Yar bahaushiya*, *Yar madana,* and *Yar awo* are 28.34%, 23.63%, and 54.64% respectively, also the percentage extraction rate is 85.00 % for the three samples, and percentage cake ranges from 71.66 to 45.36%.

This imply that the oil content of the three different pumpkin seed oil varieties were dependent on the variety of the pumpkin, type of solvent used during extraction, particle size and drying method adopted for the seed as described by Onwuka (2018).

In comparison to the oil yield of other seeds/ fruits the pumpkin seed oil was higher than soybean oil (19% - 21%) as well as cotton seed oil (15% - 20%) as reported by Shukla, *et al*., (1992). The result also shows that the pumpkin varieties have higher oil yield as reported by Bwade, *et al*., (2013) in a study on *Cucurbita maxima (*27.83%). This may also imply that factors such as environment, weather and agricultural practices have an impact on oil content. Nevertheless, the oil content in this study (23.63% - 54.64 %) were lower when compared with the oil content of rubber seed (68%), coconut (60%) and castor seed oil (67.7%) as reported by Shukla, *et al*., (1992). Oil contents of agricultural materials provide information on whether it is justifiable to process industrially from a given seed/ fruit. According to Bwade, *et al*., (2013), any seed containing greater than 17% of oil is considered to be an oil seeds as such a pumpkin seed of the three varieties shown in the table conforms and can be utilized for industrial vegetable oil processing.

Correspondingly, the percentage extraction rate for the three varieties of the pumpkin seeds shows that there was no significant difference at ($p < 0.05$) that indicate the capacity of the solvent used i.e. petroleum ether was 85.0 % for each sample, as similarly reported by Michael, *et al*., (2015).

Table 1: Physical Properties of the Oils

Parameters	Samples		
	YBS	YMD	YAW
Moisture content %	0.97 ± 0.10^a	0.73 ± 0.01^b	0.40 ± 0.24^c
Specific gravity g/ml	1.44 ± 0.01^a	4 ± 0.01^a	1.44 ± 0.01^a
Refractive index	0.92 ± 0.01^b	0.94 ± 0.00^a	0.90 ± 0.03^c
Smoke point ^oC	183.7 ± 0.08^b	183.7 ± 1.98	186.4 ± 1.5^a
Flash point ^oC	261.9 ± 2.12^c	267.3 ± 1.56^b	268.3 ± 0.64^a
Fire point ^oC	323.1 ± 1.49^a	314.4 ± 1.13^c	318.6 ± 1.29^b

Table 2: Chemical properties of the oils

Properties	Samples		
	YBS	YMD	YAW
Saponification value mgKOH/g	190.7 ± 6.61^b	173.0 ± 5.00^c	191.7 ± 6.05^a
Acid value mgKOH/g	2.95 ± 0.2^b	3.23 ± 0.2^a	1.96 ± 0.79^c
Free fatty acid value %	1.61 ± 0.1^a	1.47 ± 0.1^b	0.98 ± 0.04^c

Properties	Samples		
	YBS	YMD	YAW
Peroxide value mEq O_2/g	$2.00±0.28^c$	$5.50±2.12^a$	$5.10±0.14^b$
Iodine value gI_2/g	$31.84±7.76^a$	$24.16±0.35^c$	$29.28±0.70^b$

Table 3: Percentage yield and extraction rate of the oil

Properties	Samples		
	YBS	YMD	YAW
Percentage oil yields %	$28.34±0.90^b$	$23.63±0.05^c$	$54.64±0.01^a$
Percentage cake extraction %	$71.66±0.02^b$	$76.37± 0.04^a$	$45.36± 0.01^c$
Percentage extraction rate %	$5.0±0.03^a$	$5.0±0.04^a$	$5.0±0.07^a$

Table 4: Sensory attributes of the oils

Sample	Appearance	Flavour	General acceptability
YMD	$7.47±0.19^b$	$7.07±0.10^b$	$6.93±0.96^b$
YBS	$6.80±0.77^c$	$6.47±0.19^c$	$6.80±0.21^c$
YAW	$8.47±0.63^a$	$7.67±0.18^a$	$8.20±0.68^a$

Values are means of three replicate± standard deviation, number in the same column followed by the same letters are not significant different at ($p<0.05$) level.

Keys: YBS = *Yar bahaushiya,* YMD = *Yar madana*, YAW = *Yar awo.*

3.4 Sensory Analysis of the oil

Sensory evaluation of the pumpkin seed oil showed that there was significant difference i.e. at ($p < 0.05$) in appearance, flavour, and general acceptability. From the result shown in the table below indicate that YAW pumpkin seed oil is more acceptable in terms of the sensory attributes used than the remaining oil of the YBS and YMD.

CONCLUSION

It was concluded that higher amount of oil was attributed to *Yar Awo*, followed by *Yar Bahaushiya* and lastly *Yar Madana*. As compared to other seeds oils it serve as a substitute that can be utilize for large scale production. The quality parameters of the oils determined shows a variation in their amount which accordingly felt within the range that can served the varieties as an edible oil that can be consumed and utilize for other industrial purpose. The sensory attributes evaluated shows the higher preference for *Yar Awo,* followed by *Yar Bahaushiya* and lastly *Yar Madana.* Moreover, the % extraction rate of the oil was efficient for determination of the higher yield by employing petroleum ether as a solvent for the extraction process.

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