EFFECTS OF MOISTURE CONTENT AND SOLVENT TYPE ON OIL PROPERTIES AND YIELD OF FLUTED PUMPKIN SEED OIL

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ABSTRACT

The quantity of extractable oil obtained from oilseeds is usually influenced by the moisture content of the oil seeds at the time of extraction. This work was conducted to study the effect of moisture content and extraction solvent on the oil yield from fluted pumpkin seed (Telferiaoccidentalis).The oilseed were conditioned to three different moisture contents of 5, 8 and 10 %. The two extraction solvents used were n-hexane and petroleum ether, using the soxhlet equipment the extracted oils were also characterized. The highest oil yield of fluted pumpkin seeds was 49.40 % at 5 % moisture content, while the lowest oil yield of 34.19 % at 10 % moisture content using n-hexane solvent. In the case of petroleum ether, the results were 49.73% at 5% moisture content. The result of the physicochemical analysis showed that there is significant difference between n-haxane and petroleum ether; for n-hexane, the values of free fatty acid FFA(mg/KOH/g), saponification value SV(mg/g), Iodine value IV(g/100g), Peroxide value PV(mmol), Specific gravity SG, Refractive index RI, and Viscosity VIS values were15.98, 415.23, 96.45, 12.33, 0.82, 1.45, and 119.23, respectively, while petroleum ether had, 15, 415.15, 99.5, 12.55, 0.78, 1.48, and 121.32, respectively. It was concluded from this study that moisture content and solvent type had great influence in determining oil yield, also n-hexane extraction was more efficient. The highest oil yield was obtained at 5% moisture content using n-hexane.

Keywords: Moisture content, oil yield, fluted pumpkin seed, petroleum ether, n-hexane.

1.1 INTRODUCTION

Seeds have nutritive and calorific values which make them important in diets. They are also good sources of edible oils and fats (Odoemelam, 2005). Fats and oils are essential nutrients, comprising about 40% of the calories in the diet. Seed oils have extensive demands both for human consumption and for industrial applications (Kyari, 2008).

Edible oils can be obtained from animals and plants, Oils from plants are termed as vegetable oil. There is a universal demand for vegetable oil due to their increasing home and industrial purposes. Oil content of vegetable oil-bearing plants ranges between 3 and 70 % of the total weight of the nut, kernel and seed (Bachman 2004). The vegetable oil consumption is increasing compared to animal fat due to its health factors (Akinoso,2006).

1.1.1 Origin and Distribution of Fluted Pumpkin

Fluted pumpkins (*Telfairiaoccidentalis)* are tropical vinethat is grown in West Africa as a leafy vegetables and for its edible seeds. The following are its common names for the plant Ugu, Fluted gourd and Fluted pumpkin. *Telfairiaoccidentalis*belong to family member of the curcurbitaceaeand is indigenous to southern Nigeria (Akorodaand Adejoro, 1990).The fluted gourd grows in many nations of West Africa but is mainly cultivated in Nigeria, used primarily in soups and herbal medicines (Nwanna,2008). Fluted pumpkin gourd and seeds are shown in Plates **1.1.1** and **1.1.2.**

Plate 1.1.1: Fluted pumpkin gourd

Plate 1.1.2: Fluted pumpkin seeds

1.1.3 Composition and Uses of Fluted Pumpkin leafs, seeds and oil

The seeds of fluted pumpkin are valuable both as an oilseed (54%) and also as a protein source (27%) with a fairly well balanced amino acid composition (Hamed, *et al*.,2008).

The tender vine and foliage are used and consumed as pot herbs. Oil can be extracted from the seeds, which can be used to manufacture soap and is also use for cooking (Agatemor, 2006). The seeds are used as propagating materials eaten roasted, boiled or ground to paste as soup thickener (Odiaka, *et al*., 2008). The seeds of *Telfairiaoccidentalis* can be boiled and eaten whole, or fermented and added to soup as “ogili”. The fluted pumpkingourd has been traditionally used as blood tonic likely due to its high protein content by indigenous tribes, the shoots and leaves areconsumed as vegetables (Akoroda and Adejoro, 1990).

Other medicinal properties are as follows; the powdered seed is used to increase spermatogenesis and regenerate testicular damage (Alegbejo, 2012).Activated carbon that is produced from fluted pumpkin (*Telfairiaoccidentalis*) seed shell can be used for the removal of lead (II) ion from simulated wastewater. Activated carbon has been used as an adsorbent for removal of heavy metal pollutants from wastewater and has proven to be effective (Okoye, *et al*., 2010). Dietary incorporation of *Telfairiaoccidentlis* seeds into animal feeds can be used to supplement animal feed. Pumpkin seed oil can be transesterified to biodiesel with properties similar to those of diesel fuel and within the ASTM limits for biodiesel. Thus it can be used as alternative fuel for diesel engines, of particular advantage is the high flash point which makes it a safe fuel(Bello, *et al*., 2012).

One major problem usually encountered in processing oil from oilseed is to know the appropriate moisture content at which to obtain the best oil yield from the seed. This also varies with the type of oilseed used. Another problem is the type of solvent used and the effects on the oilyield as well as the quality of oil obtained. It is thus desirable to investigate these factors and their influence on the oilyield and quality of oil from fluted pumpkin seed, hence the need for this study.

1.2 MATERIALS AND METHOD

Fluted pumpkin gourd (*Telfairiaoccidentalis)* was purchased from local market in Minna Nigeria. The seeds were removed, washed cracked and sun dried for four days at temperature and relative humidity ranging between 24-30 ^{o}C and 30-40 %. Seed samples were thoroughly screened to remove stones, bad and rotten seeds.

1.2.1 Determination and conditioning of seed samples moisture content

The initial moisture content of the samples were determined on wet basis (wt) using oven drying method at 105°C as described by AOAC, (1990) standard methods, Moisture content was calculated from the relationship.

$$M.C = \frac{A-B}{A} \text{x } 100$$

M.C = Moisture Content
A = Initial Moisture content
B = Final Moisture content

The seeds were then divided into three parts and conditioned to the desired moisture contents. Seeds were grounded into fine powder with an electric blender to increase the surface area for oil extraction. Extraction of oil was done in Agricultural and Bio-resources Engineering Laboratory. Oil samples were analysed in Crop Production Laboratory, Federal University of Technology, Minna, Niger State.

The initial moisture content of fluted pumpkinseeds after drying was determined to be 5 %, The samples were then divided into three A, B, and C. Calculated amount of distilled water were added to samples B, and C, sample were sealed in separate polythene bags and refrigerated for seven days to achieve the desired moisture content of 8 %, 10 % respectively while sample A was retained at the initial moisture content of 5 %. The quantity of water added was calculated from the following relation as given by Sacilik, *et al.*(2003).

$$Q = \frac{Wi \times (Mf - Mi)}{(100 - Mf)}$$

Q = is the quantity of water (g).
M_f = is the final moisture content of the sample in % wet basis.
M_i = is the initial moisture content of the sample in % wet basis.
W_i = initial mass of the sample in grams.

1.2.2 Oil extraction

A Completely Randomize Block Design statistics was used to conduct the experiment. Two factors, moisture content(3 levels) and solvent type(2 levels) were investigated. The oil extraction was carried out in three replicates for each of the moisture content level using the two solvents(2x3x3=18). Oil extraction was done using the soxhlet method, using the n-hexane and petroleum ether as solvent of extraction at the temperature of 50 ^{o}C. The most commonly used semi-continuous process for the extraction of lipids from foods (Obikili, 2010). According to Soxhlet procedure, oil and fat from solid material are extracted by repeated washing (percolation) with an organic solvent.

1.2.3 Determination of oil yield and physicochemical properties

Extraction of oil using soxhlet method was replicated on each of the seed sample and the oil was recovered using solvent evaporation. It was heated at the temperature that is higher, the solvent finally evaporates and leaving behind oil extracted, this process is known as distillation method. The process was done for all sample, the average percentage oil yield on each sample was obtained. This method was also used for oil yield determination for moringa seed by (Adejumo, *et al.*,2013). Oil yield in percentage was calculated as follows;

$$\%\ Oil\ yield = \frac{weight\ of\ extracted\ oil\ sample}{weight\ of\ seed\ samples} \times 100$$

The physicochemical properties of oil samples from fluted pumpkin seeds, at three moisture content, using two different solvents were determined, according to the method described by the AOAC (2000).

1.3 RESULTS AND DISCUSSION

1.3.1 Effect of moisture content and solvent type on oil yield from fluted pumpkin seed

Table 1.3.1 shows the mean percentage of oil yield from fluted pumpkin seeds at different moisture contentsusing the two solvent types.

Table 1.3.1: Mean percentage oil yield at different moisture content and solvent of fluted pumpkin seeds

Moisture content	Oil yield	
	n-hexane	petroleum ether
5	49.401	49.728
8	47.539	38.668
10	34.194	34.927

The results showed that the highest percentage of oil was obtained at 5 % moisture content irrespective of the solvent type used. The percentage ofoil yield decreased with increase in moisture content for all the samples. It has been shown that a decrease in moisture content and an increase in temperature improve oil yield (Singh *et al.,* 2000). Similar results have also been reported for neem seed and moringa seed (Orhevba, *et al.,* 2013: Adejumo *et al*., 2013). It has also been shown in literature that, n-hexane solvents provided better oil yield than petroleum ether solvents(Reginaldo *et al*., 2003)**.** The ANOVA (Table 1.3.2) below shows that both solvent and moisture have significant effect at($p\leq 0.05$) on the percentage of oil yield.

Table 1.3.2: **Analysis of Variance of oil yield due to variation of moisture and solvent on Pumpkin Seed**

Source	Sum of Square	Df	Mean Square	F	Sig.
Corrected Model	804.664[a]	5	160.933	167.266	.000
Intercept	26069.273	1	26069.273	27095.242	.000
SOLVENT	38.888	1	38.888	40.419	.000
MOISTURE	745.505	2	372.752	387.422	.000
SOLVENT * MOISTURE	20.271	2	10.135	10.534	.002
Error	11.546	12	.962		
Total	26885.483	18			
Corrected Total	816.210	17			

a. R Squared = .986 (Adjusted R Squared = .980)
b. ^{ns} = not significant at 5% level, *= significant at 5% level.

The result shows that there were significant differences between the mean percentage oil yield at three moisture content levels and two solvents. The result here is in agreement with other studies, it is also noted that higher percentage of oil yield was obtained from extraction performed with n-hexane solvent (49.401 %) at 5%, and least value of (34.194 %) at 10 % moisture content. However, those extracted using petroleum ether was 49.728 % at 5 %, and least value of 34.927 % at 10 % moisture content. Studies that compared the methods of extraction using pressing methods, bio-renewable solvent and traditional fossil solvent (hexane) by (Brossard-González, *et al*., 2010), Ribeiro *et al.* (2010), (Ferreira-Dias, *et al*., 2003) and (Drummond, *et al*., 2006), revealed similar results that n-hexane produced higher percentage of oil yield than other solvents. The seeds that were used in the experiment showed similar characteristics of oil content extracted using different solvent and moisture parameters to the ones reported by Drummond, *et al*. (2006), Melhorança, *et al*.(2010) and Rosseto, *et al*.(2012).

1.3.2 Characteristics of oil from fluted pumpkin using n-hexane and petroleum ether

The ANOVA data on the physicochemical properties of fluted pumpkin seed oil is shown in Table 1.3.3.

Table 1.3.3: Effect of solvent on physicochemical properties of fluted pumpkin seed oil

		Sum of square	df	Mean Square	F	Sig.
FFA(Mg/KOH /g)	Between Groups	3.197	1	3.197	17.975	0.013*
	Within Groups	.712	4	.178		
	Total	3.909	5			
SV(Mg/g	Between Groups	.232	1	.232	.017	0.903^{ns}
	Within Groups	55.374	4	13.843		
	Total	55.606	5			
IV (g/100g)	Between Groups	7.238	1	7.238	7.581	0.051^{ns}
	Within Groups	3.819	4	.955		
	Total	11.057	5			
PVmmol	Between Groups	1.162	1	1.162	16.395	0.015*
	Within Groups	.283	4	.071		
	Total	1.445	5			
RI	Between Groups	.000	1	.000	2.000	0.230^{ns}
	Within Groups	.001	4	.000		
	Total	.001	5			
SG	Between Groups	.003	1	.003	15.077	0.018*
	Within Groups	.001	4	.000		
	Total	.004	5			
VIS	Between Groups	.028	1	.028	.017	0.901^{ns}
	Within Groups	6.411	4	1.603		
	Total	6.439	5			

* = significant at 5% ($p\leq 0.05$), ^{ns} = not significant at 5% ($p\leq 0.05$).

The free fatty acid value of 14.67 using petroleum ether and 15.87 using n-hexane were significantly different at ($p \leq 0.05$). These values were lower than those obtained in earlier studies (Olatidoye, *et al*., 2011).The values are within the free fatty acid recommended limit for edibleoil, this oil cantherefore be used as edible oil. The Saponification values of pumpkin seed oils extracted using two solvents were not significantly different at ($p \leq 0.05$), saponification value using n-hexanehad (413.83 mg/KOH/g) and petroleum ether (415.17 mg/KOH/g). The saponofication value in this study was higher when compared to the saponification value of cocosnucifera oil 246 mgKOH/g(Eka*et al*., 2010). The Iodine value of pumpkin seed oil extracted using the two solvents were not significantly different at ($p \leq 0.05$). The iodine values in this study were higher when compared to the iodine values for the refined castor oil (87.72 g/100g) and unrefined castor oil (84.8 g/100g) as reported by Akubugwo, *et al.*(2008). These results suggest that pumpkin seed oil is suitable for biodiesel production. The refractive index of pumpkin seed oil extracted using the two solvents were significantly different at ($p \leq 0.05$). Specific gravity of pumpkin seed oil extracted using n-hexane 0.820 and petroleum ether (0.78) were significantly different at ($p \leq 0.05$). The specific gravity of the oil was higher compared to those of *Treculia Africana* oil (0.81), egusi (0.874),and lower when compared to the specific gravity of refined castor oil 0.9589 (Akpan, *et al.*,2006). The specific gravity of pumpkin seed oil is less than one which indicates that pumpkin seed oil is less dense than water. The viscosity of pumpkin seed oils were not significantly different, petroleum ether had viscosity (121.4) and n-Hexane (120.03).

1.4 CONCLUSION

The effects of moisture content variation on the oil yield and the solvents type used for oil extraction were investigated. It can be concluded that oil yield decreases with increase in moisture content, with the highest oil yield obtained at 5 %.The extraction with hexane solvent was significantly more efficient than the extraction with petroleum ether solvent regardless of the moisture content.The solvent type affects some physicochemical properties of the oil.

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