

Some characteristics of fluted pumpkin oil extracted at three heating temperatures

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ABSTRACT: The effect of heat treatment on the characteristics and oil yield of fluted pumpkin seeds was investigated. The fluted pumpkin seed samples was divided into four portions A, B, C and D. Samples A, B, C were heated at 100°C, 130°C and 150°C respectively for 30 minutes, while sample D served as the control for the experiment. The oil extraction was done using soxhlet extraction method and the extracted oil was characterized using standard methods. The results showed a percentage oil yield of 40.68% for sample A, 44.32% for sample B, 46.37% for sample C and 36.20% for sample D. The specific gravity and density (kg/m³) for extracted oil are 0.95, 0.97, 0.96 and 0.93 and 19.95, 27.47, 24.32 and 23.92 for samples A, B, C and D respectively. Saponification (mg/KOH/kg) and iodine (g/100) values are 274.87, 325.31, 375.87, 173.56 and 109.93, 108.98, 107.53, 105.48 for samples A, B, C and D respectively. The acid value (mg/KOH/g) is 2.22 for sample A, 4.46 for sample B, 6.03 for sample C, and 3.02 for sample D while peroxide value(m/mol/kg) for the extracted samples are 2.38 for sample A, 2.38 for sample B, 2.18 for sample C, and 1.18 for sample D. The free fatty acid (mg/KOH/kg) values are 1.10, 2.32, 3.00, 1.66 for samples A, B, C and D respectively for oil samples extracted. It can be concluded that the oil yield, saponification value, free fatty acid, acid value increases with increase in heating temperature while iodine and peroxide values decreases with increase in temperature. However heating temperature has no significant effect on the specific gravity of the oil. It is therefore recommended that further research should be carried out by extracting the oil after heating at a lower temperature range.

KEYWORDS: Acid value, free fatty acid, iodine value, oil yield, saponification value, peroxide value.

1 INTRODUCTION

Fluted pumpkin (*Telfairia Occidentalis*) belongs to the family *Cucurbitaceae* (Hook F). It is a tropical vine grown in West Africa as a leaf vegetable and for its edible seeds. The crop is grown in the southern part of Nigeria across lowland humid tropics and it is also a drought tolerant – perennial crop. Fluted pumpkin is grown primarily for leaf which is popular for use in preparing assorted diet in many West African countries [1] [2]. Fluted pumpkin, also known as *Fluted gourd*, is an important staple vegetable grown in Nigeria. The young shoots and leaves are the main ingredients of a Nigerian soup, *Edikang Ikong* a popular delicacy of the *efiks/ibibios* in Cross River and Akwa Ibom States in Nigeria [3]. The leaves contain vitamins and minerals that the body needs to stay healthy. The leaves are also a good source of iron [4] [1]. Higher potassium content further confirmed that the leaves of this plant can serve as better diets for hypertensive patients. Thus adequate consumption of this leaves may help in preventing adverse effects of dietary deficiencies. The leaf is of high nutritional, medicinal and industrial values.

The seeds can also be eaten whole, ground or fermented into *Ogiri* which serve as condiments for making sauce. The seeds contain about 30.1 and 47% of protein and oil, respectively and the essential amino acid content compare favourably with those of other legumes such as groundnut and soya bean. Fluted pumpkin seed is a good source of Iron, Vitamin A, C, protein, unsaturated fatty acids, which form 61% of the oil and possesses many therapeutic properties [5] [6]. It has been reported that seeds which germinate to female plants are larger in size than those that germinate to male plants. There is also speculation among indigenous farmers that seeds extracted from the head and tail portions of the fluted pumpkin pod develop into male plants, while those extracted from the middle portion develop into female plants [1] [6] [7].

The pod has effect on the sex, growth, and yield of the crop. Fluted pumpkin is dioeciously, having separate male *staminate* plant and female *pistilate* plant. The male plant bears only male flowers, while the female plant bears only female flowers and consequently bears the pod that contains the seeds. This is known as sexual polymorphism. In fluted pumpkin production, preference is on large succulent leaves. The female plants are known to produce large succulent leaves that attract high premium prices in the markets. The male plants, on the other hand, produce small and less attractive leaves [3] [7].

Fluted pumpkin seed oils are important sources of nutritional oils, industrial raw materials and nutraceuticals, its seed is a good source of edible oil. Its fatty acids composition is comparable to that of some conventional oils. The seed contains oil which is used for cooking and manufacturing of margarine [8] [2]. The oily seeds have lactating properties and are widely consumed by the nursing mothers [1]. Fluted pumpkin oil is reddish brown in colour and has a unique flavour (Roberts and Tammy, 2008). Pumpkin seed oil has many health benefits derived from its consumption. It contains essential fatty acids that help maintain healthy blood vessels, nerves and tissues. Pumpkin seed oil is known to alleviate and avert prostrate and bladder problems, it is often prescribed to men over fifty years with prostrate problems [9] [10].

Parameters such as temperature, time, volume of solvent and particle size affect the oil yield of oil bearing seeds. Fluted pumpkin seed oil has the qualities that are suitable for the production of soap, margarine and also for consumption. The oil is semi-drying and it is relatively low in free fatty acid value which is a good attribute for the oil to be used in the food industry as ingredient in food manufacturing. Fluted pumpkin is largely consumed in Nigeria, Ghana and Sierra Leone [1] due to the low labour requirement for production compared to other crops so its seed oil can be a substitute for vegetable oil. There are limited or no information on the processing parameters necessary for the extraction of fluted pumpkin seeds oil. Therefore the knowledge of the appropriate set of parameters for the extraction of fluted pumpkin seed oil will improve the production and quality attributes of fluted pumpkin seed oil. The aim of this study is to evaluate the effects of heating temperature on the oil yield and characteristics of oil from fluted pumpkin seeds.

2 MATERIALS AND METHODS

2.1 SEED SAMPLE COLLECTION AND PREPARATION

Fluted Pumpkin pods were obtained from *Kure* Market in Minna Niger State. The pod was broken to remove the seeds; the seed samples were cleaned thoroughly to remove dirt and spoilt seeds. The cleaned seeds were shelled and the initial moisture content of the kernel was determined using standard procedure with the sample heated for 6h at 100°C [12] [13] [14]. The seed sample was then divided into samples A, B, C and D of 267.2 g each. Samples A, served as the control, while samples B, C and D were heated for 30 minutes at 100°C, 130°C and 150°C respectively. A laboratory oven was used for heat-treating the fluted pumpkin seed samples through the selected temperatures prior to oil expression.

2.2 OIL EXTRACTION USING SOXHLET METHOD

The Soxhlet method is the most commonly used semi-continuous process for the extraction of lipids from foods [15]. According to Soxhlet procedure, oil and fat from solid material are extracted by repeated washing (percolation) with an organic solvent, usually hexane or petroleum ether. The n-hexane was used for the purpose of this work. The grounded fluted pumpkin seed samples were placed in a porous cellulose thimble. The thimble is then placed in an extraction chamber which is being suspended above a flask containing the solvent and below a condenser. Heat is being applied to the flask and the solvent evaporates and moves to the condenser where it is converted into liquid that trickles into the extraction chamber containing the sample. The extraction chamber is made in such a way that when the solvent surrounding the sample exceeds a certain level it overflows and trickles back down into the boiling flask. The flask containing solvent and lipid is removed at the end of the extraction process. The solvent in the flask is evaporated in an oven and the mass of the lipid remaining is measured. The percentage of the lipid in the initial sample is then calculated.

2.3 DETERMINATION OF PERCENTAGE OIL YIELD AND CHARACTERISATION OF THE EXTRACTED OIL

The extraction of oil using soxhlet extractor was repeated for each of the sample and the oil was recovered by solvent evaporation. It was heated at a temperature higher than that of the solvent until the solvent finally evaporates leaving behind the extracted oil. The procedure was carried out for all samples. The average oil yield on each sample was obtained. The percentage oil yield was calculated as follow;

$$\% \text{ oil yield} = \frac{\text{weight before extraction} - \text{weight of sample after extraction}}{\text{weight of sample before extraction}} \times 100$$

2.4 ANALYSIS OF EXTRACTED OIL

Some of the characteristics of the extracted fluted pumpkin seed oil evaluated are oil yield, specific gravity, density, saponification value, acidic value, iodine value, peroxide value and free fatty acid (FFA). The procedures for the determination of these properties of fluted pumpkin oil are as prescribed using standard methods [12]. The data obtained from the above experiment was subjected to data analysis using the software package SPSS 15.0 (statistical package for social science).

3 RESULTS AND DISCUSSION

The results show that the seeds sample A, B, C and D had initial moisture contents of 64.04%, 60.20%, 42.07% and 38.11% respectively before the extraction process. The results of the effect of heating temperature on some characteristics of fluted pumpkin seed oil are as presented in Table 1.

Table 1 Effect of heat treatment on oil yield and quality of fluted pumpkin seeds

Sample	Oil Yield	Specific gravity	Density	Saponification value	Acid value	FFA	Peroxide value	Iodine value
A	36.20 ^a	0.93 ^a	23.92 ^b	173.56 ^a	3.02 ^c	1.66 ^c	1.18 ^c	105.48 ^a
B	40.68 ^b	0.95 ^a	19.95 ^a	274.87 ^b	2.22 ^d	1.10 ^d	2.38 ^a	109.93 ^a
C	44.32 ^c	0.97 ^a	27.47 ^c	325.31 ^c	4.46 ^b	2.32 ^b	2.38 ^a	108.98 ^b
D	46.37 ^d	0.96 ^a	24.32 ^b	375.87 ^d	6.03 ^a	3.00 ^a	2.18 ^b	107.53 ^c

3.1 THE EFFECT OF HEATING TEMPERATURE ON THE OIL YIELD OF FLUTED PUMPKIN SEEDS.

The percentage oil yield of fluted pumpkin seeds was compared with the results obtained from the oil yield of some crops within the *cucurbitaceae* family such as "sesoswane" (24.8%), "egusi" (30.0%), "wrewre" (27.5%), "tsama" (24.8%) and the desert variety of melon (28.0%) as reported [16]. The physical and chemical properties were compared with the FAO/WHO international standard for edible oil [17]. The oil yields for fluted pumpkin seeds heated at 100 °C, 130 °C, and 150 °C were 40.74%, 44.34% and 46.39% respectively while the unheated seed (control) had an oil yield of 36.55%. The results showed that percentage oil yield increases with the increase in heating temperature. The oil yield for all pre-treated samples were higher than 38-40% oil content for fluted pumpkin seed as reported [16]. It has been reported that any seed containing more than 17% of oil is considered to be an oil seed [18] as such fluted pumpkin seed can be classified as an oil bearing seed, and can be utilized for the industrial vegetable oil processing.

3.2 THE EFFECT OF HEATING TEMPERATURE ON THE SPECIFIC GRAVITY OF FLUTED PUMPKIN SEED OIL

The specific gravity for fluted pumpkin seeds heated at 100 °C, 130 °C, 150 °C and the unheated seeds (control) are 0.95, 0.97, 0.96, and 0.93 respectively. The values are within the range recommended by FAO/WHO for edible oil which is 0.9-1.16. Statistical analysis showed that heating temperature has no significant effect on the specific gravity of fluted pumpkin oil.

3.3 THE EFFECT HEATING TEMPERATURE ON THE DENSITY OF FLUTED PUMPKIN SEED OIL

The densities for fluted pumpkin seeds heated at 100 °C, 130 °C, 150 °C and the unheated seeds (control) are 19.95, 27.47, 24.32 and 23.92 (kg/m³) respectively. However, heating temperature had significant effects (p<0.05) on densities of the pre-treated samples such that 130 °C have the highest density than the others with 100 °C having the lowest density. The non uniform pattern in the density of the fluted pumpkin oil maybe due to the fact that when oil bearing seeds are being heated, they tend to lose some of their properties such as weight, thereby affecting density drastically [19].

3.4 THE EFFECT HEATING TEMPERATURE ON THE SAPONIFICATION VALUE OF FLUTED PUMPKIN SEED OIL

The saponification values for fluted pumpkin seeds heated at 100°C, 130°C, 150°C, and the unheated seeds (control) are 274.87, 325.31, 375.87 and 173.56 (mg/g) respectively. The values show a deviation from the range recommended by FAO/WHO international standard for edible oil which is 181±260. The saponification value increases significantly with increase in heating temperature, such that samples heated at 150°C resulted in the highest value and the control the least. The oil has saponification value that is beyond the range for most oils of plant origin and less than that of palm oil, meaning that the oil has larger molecular weight than the common oils [20].

3.5 THE EFFECT HEATING TEMPERATURE ON THE ACID VALUE OF FLUTED PUMPKIN SEED OIL

The acid value of fluted pumpkin seeds heated at 100°C, 130°C, 150°C and the unheated seeds (control) are 2.22, 4.46, 6.03 and 3.02 (mg/KOH/g) respectively. These are within the range specified for edible oil as recommended by FAO/WHO which is 4mg/KOH/g. The acid value increases significantly with increase in heating temperature, such that samples heated at 150°C resulted in the highest amount of acid. Thus seed oil of *Telfaria occidentalis* could be suitable for cooking [21]. Its low acid value also indicates that the oil is edible [2].

3.6 THE EFFECT HEATING TEMPERATURE ON THE FREE FATTY ACID VALUE OF FLUTED PUMPKIN SEED OIL

The free fatty acid value for fluted pumpkin seeds heated at 100°C, 130°C, 150°C, the unheated seeds (control) are 1.10, 2.32, 3.00 and 1.66 (mg/KOH/g) respectively. Free Fatty Acid increased significantly with increase in temperature, such that 150°C had the highest value (4.6). These show a deviation from the standard specified for edible oil as given by FAO/WHO which is 5.78-7.28 [17]. Thus the seed oil could be suitable for deep frying purpose.

3.7 THE EFFECT HEATING TEMPERATURE ON THE PEROXIDE VALUE OF FLUTED PUMPKIN SEED OIL

The peroxide value of fluted pumpkin seeds heated at 100°C, 130°C, 150°C, and the unheated seeds (control) are 2.38, 2.38, 2.18, and 1.18 (m/mol/kg) respectively. These are within the range specified by F.A.O/W.H.O for fresh edible oil which is below 10mEq/kg. Low peroxide value indicates resistance of the oil to peroxidation during storage. The peroxide value of fluted pumpkin seed oil is low compared to the maximum acceptable value of 10mEq/kg. The oil is thus stable and would not easily go rancid [22]. The peroxide value increased significantly with increase in heating temperature, as compared to the control sample. There were no significant differences within the peroxide values of the oil extracted after heating at 100°C and 130°C. The lowest peroxide value was obtained in the control sample.

3.8 THE EFFECT HEATING TEMPERATURE ON THE IODINE VALUE OF FLUTED PUMPKIN SEED OIL

The iodine value (100/g) of samples heated at 100°C, 130°C, 150°C, and the unheated seed (control) are 109.93, 109.98, 107.53, 105.48 (g/100g). This shows a deviation from the standard specified by FAO/WHO for edible oil which is 80-106. The unheated seed (control) has the lowest value, which falls within the FAO/WHO standard. The iodine value is high and this reflects the presence of high percentage of unsaturated fatty acids. The iodine value is the measure of the degree of unsaturation in oils and could be used to qualify the amount of double bonds present in the oil which reflects the susceptibility of the oil to oxidation [23]. Iodine value increases with heating of the seeds, however iodine value was significantly higher at 100°C. It also has high iodine value compared to palm oil, indicating that it has high content of unsaturated fatty acids relative to palm oil [21].

4 CONCLUSION

It can be concluded that fluted pumpkin seed oil yield increases with increase in heating temperature. Heating temperature has no significant effect on the specific gravity of fluted pumpkin oil, but it however increases the saponification value, free fatty acid, acid value, peroxide value and iodine value. Heating fluted pumpkin seed at 150°C for 30 minutes gave the highest oil yield.

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