QUALITIES OF TIGER NUT OIL AS INFLUENCED BY HEATING TEMPERATURE

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ABSTRACT
The effect of heating temperature on the oil yield and characteristics of tiger nut was investigated. The tiger nut samples was divided into four portions A, B, C and D. Samples B, C and D were heated at 100^{o}C, 120^{o}C and 140^{o}C respectively for 30 minutes, while sample A, which was not heated served as the control for the experiment. The oil extraction was done using solvent extraction method and the extracted oil was characterized using standard methods. The results showed a percentage oil yield of 28.18%, 26.83%, 24.14% and 21.19% for samples A, B, C and D respectively. The acid (mg/KOH/g) and peroxide (m/mol/kg) values are 2.81, 2.53, 2.24, 1.40 and 2.8, 2.0, 1.0, 2.0 for samples A, B, C and D respectively. The free fatty acid (mg/KOH/kg) values are 5.61, 5.05, 4.49, 2.81 for samples A, B, C and D respectively for oil samples extracted. The oil yield, acid value, peroxide value and free fatty acid decreases with increase in heating temperature. The heating temperature however had no significant effect on the specific gravity, density, refractive index, saponification value and iodine value of the extracted oil. It can be concluded that tiger nut should not be heat treated above 100^{o}C prior to oil extraction for optimum oil yield and reduction in peroxide value. However further research work should be carried out on tiger nut by heating at temperature below 100^{o}C prior to oil extraction.

Keywords: *Acid value, free fatty acid, oil yield, Tiger nut , peroxide value, refractive index*

1.0 INTRODUCTION

Tiger nut (*cyperus esculentus*) is commonly known as earth almond, *chufa*, yellow nut sedge and *zulu* nuts. In Nigeria, three varieties the black, brown and yellow varieties are cultivated, it is known as "*Ayaya*" in Hausa, "*ofio*" in Yoruba and "*Akiausa*" in Igbo [1]. Among these three varieties, only the yellow and brown varieties are readily available in the market. Tiger nut can be eaten raw, roasted, dried, baked or made into a refreshing beverage called "*Horchata dechufa*" or tiger nut milk [2]. It is also used as a flavorings agent for ice cream and biscuit [3].

The nuts were valued for their nutritious starch content, dietary fiber and carbohydrate. The nut is also very rich in mineral such as sodium, calcium, potassium, magnesium, zinc and traces of copper. Its tubers are also said to be aphrodisiac, carminative, diuretic, emmanogogue, stimulant and tonic. Tiger nut has also been reported to be used in the treatment of flatulence, indigestion, diarrhea, dysentery and excessive thirst. In addition, tiger nut has been demonstrated to contain higher essential amino acid than that proposed in the protein standard for satisfying adult need [4]. Tiger nut has been reported to be a good substitute for cereal grains [5]. Tiger nut is used as a close substitute for milk in patients intolerable to lactose as a nutritional supplement.

Tiger nut oil was first used by Egyptians many thousand years ago in preference to olive oil as a healthier alternative. The oil is golden brown in colour with a rich nutty taste. Tiger nut oil is also a good component of beauty products; it is high oleic acid, fatty acid and vitamin E, which makes it excellent for the skin [5].

The advantages of using tiger nut oil are:

i. Tasty and stable oil.
ii. Tiger nut oil is high quality due to its extraction without adding any external heat (cold pressed oil)
iii. Highly recommended for cooking above other oils because it is more resistant to chemical decomposition during high heat treatments.
iv. Provides daily minimum necessary quantity of polyunsaturated acids (10g) [5].

Despite the high qualities and advantages of tiger nut oil, there are limited or no information on the processing parameters needed for the optimum extraction of tiger nut oil. The knowledge of the appropriate set of parameters for the extraction of tiger nut oil will enhance the utilization of tiger nut as well as its production and quality attributes of tiger nut oil. Therefore the aim of this study is to determine the effect of heating temperature on the yield and qualities tiger nut oil.

2.0 MATERIALS AND METHODS

The tiger nut samples were cleaned, crushed and sieved to coarse particle size of 3.35 mm. The moisture was obtained by oven drying 10g sample of tiger nut at 100°C for 6hrs [7]. The sample was divided into four equal portions A, B, C and D, of 65g each. Sample A was used as control for the experiments while B, C and D were heated for 30 minutes at 100°C, 120°C, 140°C. A laboratory oven was used for heat-treating the tiger nut prior to oil extraction. The moisture content of each of the sample was determined [8] prior to oil extraction using soxhlet extraction method.

The soxhlet extraction method was used with organic n-hexane as solvent. The grounded tiger nut samples were placed in a porous cellulose thimble, the thimble was then placed an extraction chamber which was suspended above a flask containing the solvent and below a condenser. Heat was applied to the flask and the solvent evaporates and moves to the condenser where it was converted into liquids that trickle into the extraction chamber containing the sample [9] [8] [10]. The extraction chamber was made in such a way that when the solvent surrounding the sample exceeds a certain level, it over flows and trickle back into the boiling flask. The flask containing solvent and lipids was removed at the end of the extraction process. The solvent in the flask was evaporated in an oven and the mass of the oil remaining was measured. The percentages of the oil in the samples were then calculated.

The moisture content, specific gravity, density, peroxide value, iodine value, saponification value and free fatty acid were determined [8] [9] [11] [12]. The data obtained were analyzed using the software package SPSS 20.0 (Statistical Package for Social Science)

3.0 RESULTS AND DISCUSSION

3.1 Effect of heating temperature on the oil yield of tiger nut

The result showed that the control sample A, had 8.61% moisture content while sample B, C, and D heated at 100°C, 120°C and 140°C had 6.35%, 4.91% and 2.21% moisture content respectively before the extraction process. The oil yield for tiger nut sample A, B, C and D are 28.18%, 26.83%, 24.14% and 21.19% respectively. This result showed that the oil yield for the control sample A had the highest percentage yield of 28.18% while sample D (140°C) at 2.21% moisture content had the lowest percentage yield of 21.19% (Figure 1). The oil yields of the samples were all within the range of 22.8 – 32.8% oil content reported for tiger nut [3] [13], except for the sample D. The lower oil yield in sample D maybe probably due to the low moisture content and the heating temperature prior to extraction.

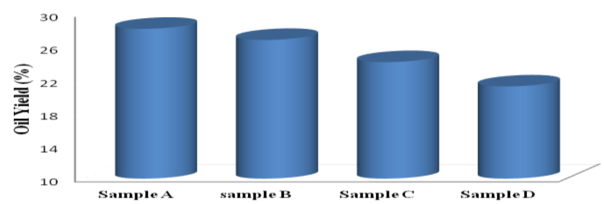

Figure 1: The effect of heating temperature on the oil yield of tiger nut

3.2 Effect of heating temperature on the physical properties of tiger nut oil

Samples A, B, C and D had the same specific gravity value of 0.87. The value was within the range given for edible oil which is 0.9 – 1.16 [14]. Statistical analysis shows that heating temperature has no significant effect of the specific gravity of tiger nut oil. The density (Kg/m^3) of the samples A was 28.05, while samples B, C and D had the same value of 8.67. The control had higher density value than other samples. Heating generally decreases the density, while the heating temperature had no significant effect on the density of tiger nut oil. When oil bearing seeds are being subjected to heat, it tends to lose some of its properties and also its weight, thereby affecting the density of its oil. Density of substance to that of water decreases with increase in heat treatment [15].

The results also showed that heating has no significant effect on the refractive index of tiger nut oil. The refractive index of 1.46 was obtained for all the samples. This value is within the range recommended by the international standard for edible oil which is reported to range between 1.460-1.465 [16].

3.3 Effect heating temperature on the chemical properties of tiger nut oil

The results of the effect of heating temperature on the chemical properties of tiger nut oil are as presented in Table 1.

Table 1: Chemical properties of tiger nut extracted at different heating temperature

Properties	Sample A	Sample B	Sample C	Sample D	FAO/WHO Standard
Saponification value (mg/g)	168.30	168.30	154.28	168.30	181.4 ± 260
Free Fatty Acid (mg/KOH/g)	5.61	5.05	4.49	2.81	5.78 – 7.28
Acid Value (mg/KOH/g)	2.81	2.53	2.24	1.40	4.00
Peroxide Value (m/mol/kg)	28.00	2.00	1.00	2.00	10.00
Iodine Value (g/100g)	74.80	78.90	78.40	78.17	80 – 106

Sample A= control sample, Sample B = sample heated at 100°C, Sample C = sample heated at 120°C, Sample D = sample heated at 140°C

i. The effect of heating temperature on the Saponification value of tiger nut oil

The lowest saponification value (mg/g) of 154.3 mg/g was observed in the sample C (heated at 120°C), while all the other samples had the same value of 168.3 mg/g. Statistical analysis showed that heating temperature had no significant effects on the saponification value of tiger nut oil. These values are lower than the range recommended for edible oil which is 181 ± 260 [14]. The saponification values gives information concerning the character of the fatty acid present in the oil and the stability of the soap derived from it in water, high saponification value contains low portion of fatty acids [17] [4]. This indicates that the oil could not be used in soap making.

ii. The effect of heat treatment on the free fatty acid of tiger nut oil

The free fatty acid (mg/KOH/g) of samples A, B, C and D are 5.61, 5.05, 4.49 and 2.81, respectively. The values obtained for the free fatty acid are within the range recommended for edible oil [14]. The free fatty acid decreases with an increase in heat treatment. The control sample had the highest free fatty acid value of 5.61 mg/KOH/g. The free fatty acid measures the extent to which the glycerides in the oil had been decomposed by lipase action, which is accelerated by light and heat [17] [18] [4] [13]. Hence as rancidity is usually accompanied by free fatty acid formation, heat treated tiger nut oil will not easily go rancid, which is an indication of longer shelf life. Statistical analysis shows that heating temperature will significantly decrease the free fatty acid of tiger nut oil.

iii. The effect of heat treatment on the acid value of tiger nut oil

The acid value (mg/KOH/g) for the samples A, B, C and D are 2.81, 2.52, 2.24 and 1.40 respectively. These values are within the range recommended for edible oil which is 2.89 ± 0.01 [14]. The acid value decreases with increase in heating temperature, hence the higher the heating temperature, the lower the acid value. The lower acidity value indicates the extent of the edibility of the oil [4].

iv. The effect of heat treatment on the peroxide value of tiger nut oil

The peroxide values (m/mol/kg) of sample A, B, C and D are 2.8, 2.0, 1.0 and 2.0 respectively. The control sample had the highest value of 2.8. The values of the heat treated samples are within the range recommended for fresh edible oil which is below 10 m/mol/kg [14]. Peroxide value is used to monitor the development of rancidity through the evaluation of the quantity of peroxide generated in the product (initiation product of oxidation). The peroxide value is usually less than 10 per gram of a fat sample when the sample is fresh. The peroxide value decreases in a non-uniform linear manner with increase in heating temperature. The lower peroxide value of tiger nut oil indicates that it will not easily go rancid [1] [17].

v. The effect heat treatment on the iodine value of tiger nut oil.

The iodine value (100/g) for sample A was 74.80 while samples B, C, and D had the same value of 78.90. The standard iodine value specified for edible oil ranged between 80 -106 100/g, all the extracted tiger nut oil samples were lower than the standard for edible oil [14] [16]. The results showed that heat treatment increased the iodine content, but the heating temperature does not have any significant effect on the iodine content of tiger nut oil.

4.0 CONCLUSION

It can be concluded that tiger nut oil yield and density decreases with heat treatment, while it increases its iodine value. Increase in heating temperature decreases the oil yield, acid value, free fatty acid and peroxide value of tiger nut oil. Heating temperature has no significant effect on the specific gravity and the refractive index of tiger nut oil. Tiger nut that was not heat treated prior to oil extraction had the highest oil yield of 28.18% followed by the sample heated at 100°C which gave an oil yield of 26.83%. It is therefore recommended that tiger nut should not be heat treated above 100°C to enhance its oil yield and reduce the peroxide value. However further work should be carried out on the effect of heat treatment on the yield and quality of oil from tiger nut using temperature below 100°C.

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