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Comparative Proximate Analysis of Three Species of Tiger Nut (Cyperus esculentus) in Idah, Kogi State, Nigeria

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***Abstract*—** The comparative proximate composition of three species (black, brown and yellow) of *Cyperus esculentus* (Tiger nut) were carried out in this study. The parameters involved are moisture content, ash content, crude protein, crude fat, crude fiber and total carbohydrates. The results obtained gave; moisture content 53.75±0.250%, 54.05±0.071% and 54.54±0.040% respectively; ash content 1.77±0.024%, 3.55±0.038% and 2.55±0.010% respectively; crude fiber, 2.65±0.035%, 2.90±0.100% and 4.46±0.055% respectively; crude fat 9.47±0.030%, 7.13±0.125% and 4.05±0.050% respectively; crude protein 5.17±0.080%, 7.98±0.027% and 4.92±0.065% respectively and total carbohydrate 27.190%, 24.390% and 29.480% respectively for brown, yellow and black varieties. The results show that the tiger nut varieties are good sources of essential nutrients that are necessary for general human health.

***Keywords*—** Comparative; Proximate; Tiger nut; Food; Health.

I. INTRODUCTION

Food has long been recognized as one of the basic needs of life due to its ability to provide nourishment, health and vitality to the consumer [**1**]. Food in general consists of carbohydrates, proteins, fats as major components, vitamins and trace mineral elements as minor components. All these components are useful for living body to sustain health. There are two sources of food; plant and animal sources [**2**].

Proximate analysis is a chemical analysis carried out on the processed sample to determine the average percentage composition of parameters which accounts for its suitability for various domestic and industrial applications. The parameters includes; moisture content, ash content, fat content, protein content, crude fiber and total carbohydrate [**3**]. While ash of a biological material is an analytical term for the inorganic residue that remains after the organic matter has been burnt away which gives an estimate of protein, lipids, carbohydrate plus nucleic acid content in the sample [**4**], the crude fat content of a food substance are fat in food which can be extracted with the use of light petroleum or n-hexane [**5**], crude fiber is the washed, dried organic matter that remains after boiling the defatted material, crude protein is the determination of the total nitrogen in food subsequent conversation of the percentage of the nitrogen to protein in foods[**6**]. It is essential for growth and development of animals, as well as maintenance [**7**], and carbohydrate content of food is usually given as total carbohydrate by difference, that is sum of moisture content, crude protein, crude fat, crude fiber and crude ash subtracted from 100 [**8**].

The most obvious example of the food we get from plants are fruits and vegetables. However, not all the food we eat come from plants. The most popular edible nuts are almonds (*Prunus amigdalis*), walnuts (*Juglaus regia*) etc. [**9**]. Other common nuts are pine nuts (*Pinus pinea*), cashews (*Anucardium occidentale*) the consumer definition also includes peanuts (*Arachis hypoyea*), which botanically are groundnuts or legumes but are widely identified as part of the nuts food group [**10**]. Nuts are nutrient dense food, each with a unique composition. These foods contain healthy mono unsaturated and poly unsaturated fatty acids profiles; protein soluble and insoluble fibers; vitamins E, K, foliate, thiamine; mineral elements such as magnesium, copper, potassium and selenium, with recognized benefits to human health [**11**].

Tiger nuts usually grow along rivers and often cultivated on a small scale by local farmers, mostly in the northern parts of Nigeria. It is known as "Aya" in Hausa, "Akiausa", in Igbo and Ofio" in Yoruba [**12**]. Tiger nut is not a real nut, despite its name; it is a tuber [**13**]. Tiger nuts tuber contains digestive enzymes such as catalase, lipase and amylase. Its enzymes help to alleviate indigestion, flatulence and diarrhea. [**14**]. The vitamin E present in tiger tubers delay aging in human cells, bring about improvement in the elasticity of the skin and get rid of wrinkles, acne and undesirable changes that may affect the skin [**15**].

In recent years, the need to increase the production and utilization of locally available food resources has been highlighted at different national and international levels because food shortages and nutritional deficiency disorders remain a big concern **[16].**

The present study is therefore aimed at determining the proximate composition of three species of tiger nuts (*Cyprus esculentus*). The objective is to compare the proximate composition of the three species of tiger nut with the view of promoting further utilization in Nigeria and the world at large.

It also is expected that through the knowledge of its proximate compositions, tiger nuts may be exploited for use as food and drug in ethno-medicine. In addition, they could be regarded as good sources of medicinal and nutritional agents.
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The Origin and Background of Tiger Nut
The origin of tiger nut can be traced to ancient Egypt [**17**]. Back then in Egypt, tiger nut tubers were roasted and used as sweet meat. In Southern Europe and West Africa, the cultivation of tiger nut had been practiced since early [**18**]. Tiger nut is not a real nut, despite its name, tiger nut is a tuber. In many countries. Tiger nut is considered a weed and it is underutilized. It is not widely used in agriculture and therefore, has been poorly invested [**19**].

Tiger nut (*Cyprus esculentus*) is a crop that belongs to the family *Cyperaceae*, which is cultivated throughout the world, and it is widely found in the northern parts of Nigeria. Tiger nut is an annual perennial plant, growing to 90cm tall with solitary stems growing from a tuber. [**20**]. Tiger nut plant produces edible yellow to yellow brown spike tests flowers, mostly only 1 to 5cm long. The root system is a yellowish rhizome, ending in single tubers of 5-20mm in length, with a thin brown outer skin which darkens with maturity [**21**]. In it nonflowering state, it resembles *Cyprus rotundus* which is dark brown, slightly fragrant, unpleasant tasting tubers provided in a chain and blunt tipped leaves with no shoulders. Tiger nut tubers are of deferent varieties, the notable ones are black, yellow and brown with various sizes. Tiger nut are rich in energy content (starch, protein, fat and sugar), mineral elements (Phosphorous, potassium) and vitamin E and C [**22**].

II. RELATED WORK

It was reported that protein and ash contents of tiger nut flour separately obtained from two varieties of tiger nut tubers increased after the tubers were subjected to germination [**21**]. In terms of proximate composition, compared flour obtained from two varieties of tiger nut tubers and reported that the brown variety has higher protein. On the other hand, the yellow variety contains higher amount of carbohydrates, and crude fiber [**22**]. The quantity of protein content produced by the yellow variety are higher than the black variety. The size and planting period of brown and black varieties of tiger nut tubers have significant effects on the fat, protein, mineral and energy content of the tuber, which are different from the yellow varieties [**23**]. The starch, dietary fiber and digestive carbohydrate (monosaccharaides, disaccharides and polysaccharides) contents of tiger nut tubers are quite high [**24**].

III. METHODOLOGY

Sample Collection and Preparation: The three species of fresh raw tiger nut (yellow, brown and black) were purchased from Idah, Kogi State. They were manually removed and discarded. The three tiger nuts were washed thoroughly in two changes of clean water, drained and sun-dried. Each of the samples were carefully crushed using a mortar and pestle until a very fine consistency was achieved, sieved with 2mm mesh size sieve and stored in air-tight container prior to analysis.

Study Location and Duration: This research work was carried out at the Federal Polytechnic Idah, Kogi State, in the Department of Science and Laboratory Technology from December 2018 to December 2019.

Sample Size: 38g each of the three samples of tiger nuts were used in the whole experimental.

Experiments Procedure;
Determination of moisture content: Three crucibles were washed and oven dried in the hot-air oven at 105°c for 30 minutes. It was cooled in the desiccator and 2g of each of the samples were weighed into labeled crucibles, these were transferred to the hot air oven at a temperature of 105°c and normal atmospheric pressure to dry for 1 hour, removed, cooled in the desiccator and weighed. These procedures were repeated until a constant weight was obtained for each sample.

Calculation:

$$\text{Moisture (\%)} = \frac{\text{Initial Weight - Dry Weight}}{\text{Initial Weight}} \times 100$$

Determination of crude ash: Three empty heat resistant crucibles were dried with cover (silica dish) at 500°c for 1 hour. The official method of the Association of Official analytical chemist (AOAC, 2005) [**25**] was used. 2g of each samples were weighed into the crucible and reweighed. Each of the crucibles containing the samples were heated on a Bunsen-burner in a fume cupboard until smoke ceased. Each of the samples were transferred to the muffle furnace at a temperature of 550°c then transferred into a desiccator and cooled for 15-30 minutes. They were then weighed and percentage ash was calculated.

$$\text{Ash (\%)} = \frac{\text{Initial Weight - Dry Weight}}{\text{Initial Weight}} \times 100$$

Organic matter (%) = 100 – Ash (%)

Determination of crude fat: Soxhlet flask dried in an oven at 105°c, was allowed to cool and weighed (W_1). Solvent extraction as described by [**26**] was used. 29g of each sample was weighed (W_2) into a filter paper and introduced into a paper thimble and was transferred into a soxhlet apparatus. A round bottom flask was fitted up to three quarters to the extractor with the condenser was fitted. Heating proceeds on a heating mantle using a temperature of 50°c for 45 minutes. The solvent was recovered and estimated by weight (W_3) and the percentage fat calculated again, this was done in triplicate from each of the sample.

Calculation,

$$\text{Crude fat (\%)} = \frac{W_3 - W_1}{W_2} \times 100$$

Where:
W_3 - weight of fat
W_2 - weight of sample
W_1- weight of the flask

Determination of crude fiber: 3g of Sample was weighed into a beaker ($250cm^3$). 100ml of 1.25% of sulphuric acid was added to the sample and heated to boil for 30-40 minutes. Excess foaming was reduced by adding 2ml of antifoam solution and boiled for 30 minutes, maintaining a constant volume by addition of water. The container was heated every few minutes to mix the contents well and the particles washed down from the sides. An 11cm filter paper was fitted in a Buchner funnel and hot water poured into the funnel and allowed to stand until the funnel become hot. At the of the 30 minutes boiling, the acid was allowed to stand at approximately 1 minute and poured into a hot water in a prepared funnel. The suction of the filtration pump was adjusted in such a way that the buck of 200ml was filtered within 10 minutes. The insoluble matter was washed with boiling water until the washing became neutral to Litmus paper. The residue was washed into the beaker using 200mls measured at room temperature of 1.25% NaOH soluble and boiled for 30 minutes as described above and it was allowed to stand for approximately and was then filtered hot though, a filter crucible using gentle suction.

The whole of the insoluble materials was transferred to the crucible with hot washer and was washed with boiling water once with 10% HCl and then with H_2O again until the washings are neutral to Litmus paper and also washed twice with alcohol and three times with ether.

The crucible and its content was dried at 100°c and allowed to cool in a desiccator and was weighed. The crucible was placed in mantle furnace set at 450°c and the temperature maintained until washing was completed and finally the crucible was removed and cooled in a desiccator.

Crude fiber (%) = Weight of dried sample t-dish

$$\frac{\text{Weight of ash t-dish}}{\text{Weight of Sample}} \times 100$$

Determination of crude protein: The micro kjedahl method (AOAC, 2005) was used. 1 gram portion of the sample was weighed out and transferred into a kjedahl digestion flask. The sample was introduced without touching the walls of the flask. 2g of Na_2SO_4 was added and kjedahl flask was then placed in the heating mantle of the digester. The mixture was heated gently at first after which the temperature was increased to the highest to complete the digestion.

Digestion was achieved when the dark color of the mixture becomes clear after which the flask was brought out and allowed to cool. The mixture was then diluted and made up to 100ml using distilled deionizer water. An aliquot of 5ml was taken from the diluted digestion for distillation.

i. Distillation procedure:

10ml of 50% NaOH and 5ml aliquot of the digested was pipette into the distillation unit of the Markkham apparatus. The apparatus was switched onto steam distill the mixture in other to liberate $NH_3(g)$. Distillation was completed when the purple color of the mixed indicator turns green. 50ml of the distillate was then collected and sent over to the burette for titration.

ii. Titration procedure:

The 50ml distillate was titrated against 0.01 NHCl until and end point was reached which apparently is the appearance of a purple color. The titer values was recovered after wards. The crude protein content was calculated using the formula below:

% Protein = % N x Protein Factor (0.625)

$$\text{But \% N} = \frac{\text{Sample Titer - Blank Titer}}{\text{Weight of Sample}} \times 100$$

IV. RESULTS AND DISCUSSION

Results: Results for the proximate analysis of the three species of tiger nut; brown, yellow and black, used for the project work are as tabulated below.

Table 1: Proximate composition of three tiger nut species.

Parameter	Brown	Yellow	Black
Moisture content	53.75±0.250	54.05±0.071	54.54±0.040
Ash content (%)	1.77±0.024	3.55±0.038	2.55±0.010
Crude fiber (%)	2.65±0.035	2.90±0.100	4.46±0.055
Crude fat (%)	9.47 ±0.030	7.13±0.125	4.05±0.050
Crude protein (%)	5.17±0.080	7.98±0.027	4.92±0.065
Carbohydrate (%)	27.190	24.390	29.480

Note: Values are mean ± standard deviation of triplicate determinations.

Discussion:

The percentage moisture content of the three species of tiger nut brown (53.75±0.025%), yellow (54.05±0.071%) and black (54.54±0.040%) are found to be high, which indicates that they may be easily susceptible to spoilage if not well preserved. Moisture content influences the taste, texture, weight, appearances and shelf life of food stuffs [**27**]. Even a slight deviation from a defined standard can adversely impact the physical properties of a food material. Hence, obtaining, an optimal analytical value for moisture is of great economic importance to a manufacturer [**28**].

The ash content of the samples are within the range of 1.77±0.024 to 3.35±0.035%; with the yellow specie having the highest value of 3.55±0.035% followed by that black specie with a value of 2.55± 0.010%, while the brown specie had the least value of 1.77±0.024. The value obtained shows that the three species are rich in mineral element with the yellow specie being the highest and the brown specie being the lowest. The ash content of the three species of tiger nut are higher than 1.5% for tiger nut sample reported by [**29**]. Generally ash content being micronutrient varies between 1-2%, a reasonably high value, indicates the presence of adulterant [**30**].

The crude fiber values were found to be in the range of 2.65 ± 0.035% to 4.46±0.055% with black species having the highest value of4.46±0.055% and brown species the lowest value 2.56±0.035% the value obtained are considerably below the recommended value of 10-15% per day.

The percentage crude fat values were found to be in the range of 4.05±0.050% to 9.47±0.030%, with the brown specie having the highest value of 9.47±0.030% and black specie having the least value of 4.05±0.050%; while the yellow specie had the average value of 9.47±0.125%. Fats allow humans and animals to absorb fat-soluble vitamins and provide them with essential fatty-acids.

The crude protein content of yellow specie (7.98±0.027%) and brown specie (5.174±0.080%) are higher than that of black specie (4.92±0.063%). These values are slightly lower than the results of Alfa and Genwa (2013) [**30**], who reported an average crude protein content of 13.87% in tiger nut.

The carbohydrate content in black specie (29.48%) is slightly higher than that observed in brown specie (27.19%) while yellow specie had the lowest carbohydrate content. The values obtained for the carbohydrate content of the three species are low compared to the values of the results obtained for three species of tiger nut (yellow-46.99%, brown-41.22% and black-65.66%) by Waoguikpe (2010). Based on result obtained, the black specie with the lowest fat content could be useful for aged people as to maintain adequate weight.

In terms of proximate composition, Oladele *et al.*, (2007) compared flour obtained from two varieties of tiger nut tubers, and reported that the brown variety has higher fat, protein and ash content than the yellow variety which is slightly in agreement with the test result obtained from this experiment. The actual sourced location and handling may have affected the parameter.

The lower crude fat content observed in black specie of tiger nut as against those of yellow and brown species, suggests that it can be incorporated in weight reducing diet. The yellow variety contained comparably high protein hence, can help to repair and replenish the worn out tissues. The tiger nut samples contains high level of carbohydrate which provides energy and strength to the human body. Carbohydrate provide energy for human and other living organisms. Low level carbohydrate in food enhances less weight gain, better control of diabetes and blood sugar etc.

Based on the results obtained, the tiger nut species is considered to be nutritious, thus, the tiger nut and its product could be used in diets by young and old, pregnant and lactating mothers. Also the tiger nut can be used in complementing or supplementing nutrients from other food sources, such as fruits, cereals and legumes.

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P.J. Musa pursed National Diploma of Science Laboratory Technology from Federal Polytechnic Idah, Kogi State, in 2016 and Higher National Diploma of Chemistry/Biochemistry from the same Federal Polytechnic Idah, Kogi State, in year 2019. She has served as an Assistant Laboratory Technologist under the national youth service corps scheme in National Hospital, Central Area, Federal Capital Territory, Abuja., Nigeria, in 2021. Her research work titled "Comparative Proximate Analysis of Three Species of Tiger Nut" is her first work and is made available online. She has few years of teaching experience and 4 years of research experience.

S.O. Oguche a dedicated, detailed and capable research fellow with about 5 years of experience in graduate-level scientific research, has extensively published in **International Journal of Scientific Research in Chemical Sciences (IJSRCS)**, with related expertise in undertaking research, pursed National Deploma of Science and Laboratory Technology from Federal Polytechnic Idah, Kogi State, in 2016 and Higher National Deploma of Chemistry/Biochemistry from the same Federal Polytechnic Idah, Kogi State, in year 2019. He is currently a Post Graduate Diploma (PGD) student of Medical Biochemistry in Bayero University Kano, Nigeria and has served as an Assistant Laboratory Technologist under the National Youth Service Corps scheme in Amaryawa Model Primary Health Care, Roni LGA, Jigawa State, Nigeria. He became a member of British International Safety Organisation (**BISO**) in health, safety and environment in 2021, a member of the largest network for scientist; **ISROSET** and **ResearchGate** (RG). His has previously written five research publictions in Chemical Science and are made available online. He has over 4 years of industrial and clinical laboratory experience.

