



**CHEMICAL AND SENSORY PROPERTIES OF RECONSTITUTED TIGER-NUT MIX
(*CYPERUS ESCULENTUS*) FROM SEEDED POWDER AS FUNCTIONAL DRINK IN
GASHUA YOBE STATE**

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Abstract

Production and acceptability of a reconstituted tigernut drink from dry powdered tigernut mix were carried out to compare the chemical and sensory properties with the regular, fresh tigernut drink. Proximate analysis revealed that protein, fiber, moisture and carbohydrate content were higher in regular tiger nut drinks compared to the powdered sample drink mix. But the crude fiber and ash content were observed to be higher in powdered mixed drinks than in the regular tiger nut drink. The pH and emulsifying properties of the regular drink show a significant difference at $p \leq 0.05$ from the powdered mixed drink. The total acidity of the powdered mix drink reveals better samples compared to the regular fresh drink mix. Sensory evaluation results indicated that regular tiger nut drink had higher mean values for flavor, taste, consistency and overall acceptability. No significant difference was seen in appearance, flavor, taste, consistency and overall acceptability between the regular and the powder with vanilla flavor. However, the regular drink sample also had the lowest values of $3.7 \pm 1.8b$ for texture. The high sensory values for the regular drink sample could be due to panelists, familiarity with tiger nut milk products and their acidity levels. The study suggests that tigernut drinks are good sources of carbohydrates and protein. The wet milling process (regular drink) retains more nutrients than dry milling (powdered sample). Sensory properties vary significantly between production methods; the study provides valuable insights into the nutritional and sensory characteristics of tiger nut drinks, highlighting the potential benefits of wet milling and the importance of production methods on final product quality.

Keywords: Tiger nut, powder, reconstitution, chemical, sensory, drink

Introduction

Tiger-nut (*Cyperus esculentus*) is a perennial grass-like plant that is cultivated between March and December in Nigeria with spherical tubers of dimension 8 mm-16 mm (Sanchez-Zapata, 2012). It is a pale yellow cream kernel surrounded by a fibrous sheath that has been cultivated for over 400 years ago in both commercial and substantial quantity depending on its demand (Sanful, 2009). Tiger nuts are edible, sweet, nutty-flavoured tubers that contain protein, carbohydrates, sugars, and lots of oil and fibre and can be processed into many other edible products (Gambo and Da'u, 2014). Tiger nut (*Cyperus esculentus*) drink is the aqueous extract derived from the sweet nut-like tuber of the perennial grass-like tiger nut plant (Cos kuner, 2002). The nut is nutritious, and drink from the nuts has found wide application, especially in Spain, where it is used for the commercial preparation of horchata de chufa (Sanchez-Zapata, 2012). It has also been used as flavouring in ice cream and bakery products and for the preparation of Kunu, a beverage with low viscosity and a sweet-acidic taste. (Sanful, 2009). Richard, Djomdi and Robert (2005) examined the characteristics of tiger-nut (*Cyperus esculentus*) tubers and their performance in the production of local drinks. The study analysed the effect of site and variety on some physicochemical characteristics of tiger nuts (*Cyperus esculentus*) and, consequently, on their drink production. Two varieties (black and brown) from three different sites (Guily, Mémé and Mayo-Oulo) in the Far North Province of Cameroon and three drink-processing conditions (grain size, soaking temperatures and grinding time) were assessed in the study (Gambo and Da'u, 2014). The sample with the best overall performance in terms of its contents of proteins, lipids, ash, total sugars, saponification values, and iodine values was the brown variety of tubers from Mémé.

Water absorption is at its maximum between 80 and 100°C and for a period of 5 h. At lower temperatures, water absorption was slow (Ukpabi and Ndimele, 1990, Gambo and Da'u, 2014,). Extraction is influenced by soaking temperature, grain size, and grinding time, except for proteins; temperature of soaking and grinding time reduce significantly the different parameters analyzed. Thus, in terms of performance, drink extracted from the largest tubers soaked at 60°C and ground for 20 min is the best condition for extraction. Nazir *et al.* (2014) analyzed the characteristics of tiger nut drink using a standard method that has been introduced. It has been shown that, although milling duration improves the yield of tiger nut drink, soluble solids, and its nutrient composition, there is a quantifiable loss of nutrients in the pressing residue during drink extraction (Sanful, 2009). But milling duration improved the colloidal stability of the drink against creaming during 16 h of storage. A higher milling intensity resulted in the aggregation of biological polymers, which resulted in colloidal destabilization. Milling improved the lightness and stability and reduced the browning rate of the tiger nut drink during storage (Nazir *et al.*, 2014). This report is important for the production of tiger nut drink for consistent and comparable characteristics. Milling has been introduced as a processing method for the qualitative and quantitative modulation of the properties of tiger nut drink (Gambo and Da'u, 2014). It is recommended to develop further strategies to improve the colloidal stability of tiger nut drinks as a beverage. Gambo and Da'u (2014) examined the history and the composition of tiger nuts, ranging from proximate, mineral, and amino acid contents. The paper further explains the kinds of phytochemicals and anti-nutrients that can be found in tiger nuts. Tiger nuts can also be eaten raw, processed into flour, and be used for different purposes such as bread and a substitute in animal feed

manufacture (Maduka and Ire, 2018). Tiger nuts can be used to produce a drink, which can serve as a substitute for traditional cow's

a local snack, “Dakuwa” (Sánchez-Zapata *et al.*, 2012). Tiger nuts also contribute to the reduction of cholesterol; they reduce the risk of coronary heart disease and arteriosclerosis and are recommended for those who have heavy digestion, flatulence, and dysentery. Based on the empirical studies reviewed above, none of these studies were carried out (Kayode *et al.* 2021). The composition of tiger nuts is extensively reviewed in much literature (Gambo and Da’u, 2014; Nazir *et al.*, 2021), but little is known about the feasibility study on the production of reconstituted tiger nut drink. The production insights can be gained into the formulation and production process required to create a tiger nut drink suitable for individual consumption and for business.

Materials and Method

Research Design

The research is a controlled experimental design. The composition of the tiger nut samples was determined through laboratory analysis. The controlled sample was used for accurate measurements and comparisons of reconstituted tiger nut powder made into a drink from tiger nuts, seeded with coconut, date, cloves, and ginger samples.

Materials

Tiger nuts, coconut, dates, cloves, and ginger were purchased from Gashua Central Market and transported to the food and nutrition laboratory of the Federal University Gashua. A bowl, spoon, sieve (0.1 mm), Ziploc pack, tiger nuts, 2 coconuts, date fruits, ginger,

milk. Different types of tiger nut drinks are also produced, and it can also be used to produce cloves, an analytical balance, a Dumas analyzer, a muffle furnace, and a drying oven were instruments used to process the powder and the control sample.

Sample preparation

About 2kg of tiger nuts were weighed, and the following ingredients were used as the dried seeding: 2 medium-sized coconuts, 250g of date fruits, 2.5kg of ginger, and 2.5g of cloves.

Sample Processing:

Dried tiger nuts were sorted to remove damaged nuts and unwanted materials like stones before washing with clean tap water. The tiger nuts and all seeding adjuncts such as coconut, dates, cloves, and ginger were sorted, cleaned, washed, dried, and dry-ground to finally get tiger nut mix powder. The tiger nut powder was tested for homogeneity. This was done by collecting multiple samples from different parts of the dried powdered tiger nut (Udeozor, 2012).

Processing of the control sample:

Fresh tiger nuts were sorted to remove damaged nuts and unwanted materials like stones before washing with clean tap water. The tiger nuts and all seeding adjuncts such as coconut, dates, cloves, and ginger were sorted, washed, and finally mashed and ground with the tiger nut and made into a drink (Udeoz

Fig 1: Stages in the Production of Tiger Nut Dried and Wet samples

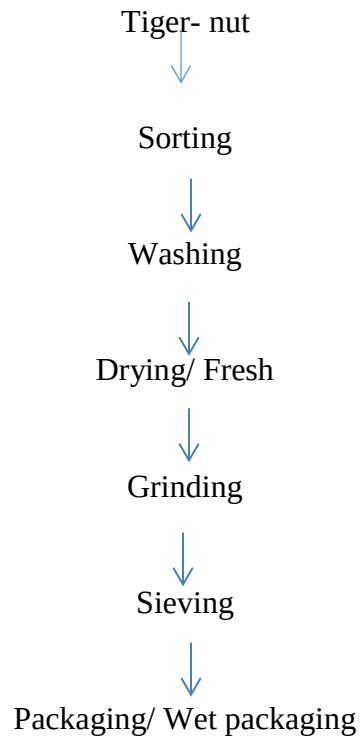
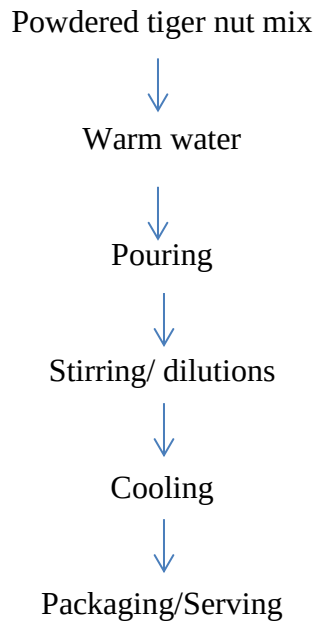


Fig2: Stages in the Reconstitution process of Tiger Nut powder mix



Methodology

Protein determination

Two grams of samples were measured into a Kjeldahl digestion tube, and 15 ml of tetraoxosulfate (IV) acid (conc. H_2SO_4) was added for rapid dissolution. The Kjeldahl catalyst was added to accelerate the process, which then yields a clear solution. Distilled water (75 ml) was added to the tube after digestion; the mixture was distilled to 50 ml using a dilute 40% NaOH solution and then into 25 ml of 40% boric acid. The mixture was titrated with 0.47 M HCl to the first gray color. A blank titer was titrated, and the value was recorded (AOAC, 2012).

$$\begin{aligned} \% \text{ Total Nitrogen} &= \text{Titre value} \times 14.01 \\ &\times 0.47 \text{ Weight of sample} \times 100 \% \text{ Protein} \\ &= \text{Total nitrogen} \times \text{conversion factor} \\ \text{Molecular weight of Nitrogen} &= 14.01 \\ \text{Molarity of HCl} &= 0.47 \text{ Conversion} \\ \text{factor} &= 6.25 \times \text{N} \end{aligned}$$

Ash Content

Two grams (2 g) of the samples were measured into an empty porcelain ignitable crucible that was ignited, cooled, and measured. The sample was ignited over a hot plate in a fume cupboard to char organic matter. The ignitable crucible was placed in the muffle furnace maintained at 60°C for 6 hr. After ash, it was then cool in a desiccator and measured (AOAC, 2012).

Ash = $\frac{(\text{Weight of the crucible} + \text{Ash}) - (\text{Weight of empty crucible})}{\text{Weight of sample}} \times 100$

Crude Fat

The method of the AOAC (2012) was used. The empty Soxhlet dye was measured as W₁. Five (5) grams of the sample were then added and measured as (W₂). The Soxhlet bottom flask was cleaned and measured empty as W₃, then filled with petroleum ether to three quarters of the flask. The Soxhlet extractor was attached with a condenser to adjust the heat sources so that the solvent boiled gently. The thimble well containing the sample solution was then placed in the Soxhlet apparatus, and the extraction was performed for 6 hours. At the end, the vial containing the oil was dried in a hot air oven for one hour at 100°C to remove traces of water and solvent. Then it was cooled and weighed as W₄. Percentage Fat content = $\frac{W_4 - W_3}{W_2 - W_1} \times 100$ W₁ = Empty thimble W₂ = Thimble and sample before extraction W₃ = Empty round bottom flask W₄ = Flask and extracted oil.

Crude fiber determination

Crude fiber content was analyzed using the AOAC (2012). Two (2) grams of sample were measured and placed in a 250 ml beaker. The mixture was boiled for 30 minutes with 100 milliliters of H₂SO₄ at a molar concentration of 0.12 and then filtered. The filtrate was washed with boiled water until no acidic traces were detected. This procedure was performed twice and filtered

with hot water and methylated spirits three times. The residue was transferred to a flammable crucible and dried in the oven at 1030°C for 1 hour. The crucible with its contents was cooled in a desiccator and then weighed as W₁. The residue was then introduced into an oven to be ashed at 600°C for 1 hr. The ashed sample was removed from the furnace and placed in a desiccator to cool and measured as W₂.

Crude Fiber = $\frac{W_1 - W_2}{\text{Weight of sample}} \times 100$ Where: W₁ = crucible and residue, W₂ = final ash sample

Carbohydrate content determination

The carbohydrate content of each of the samples was obtained by difference according to (Sengev *et al.*, 2010). That is, the difference between the total summation of percentages.

pH Measurement

A 10% w/v suspension of each sample in distilled water was prepared. The suspension was mixed thoroughly with a stirrer, and the pH was measured with a digital pH meter.

Total Acidity

The total acidity was determined according to AOAC (2012), an official method by direct titration of 2 g of the samples with 0.1 M sodium hydroxide using phenolphthalein as an indicator. The total acidity (as % citric acid) was calculated as follows: Citric acid % = $\frac{\text{Mole of NaOH} \times \text{Vol. of (Base)} \times \text{Mole Mass (acid)}}{\text{Volume of sample}} \times 100$

Emulsification property.

The emulsion sample was prepared by bashing using a blender, R1006, Germany, Inco. Lind. The mixture was allowed to stand for 30 minutes at room temperature. The

Sensory evaluation:

Four coded samples produced from the tiger mix drink and fresh samples as a control were presented to 20 semi-trained panelists familiar with drinks. Samples were evaluated for appearance, flavor, texture, taste, and consistency, and acceptability assessment was done on a nine-point hedonic scale.

Result and Discussion

The results of the proximate analysis of the samples were shown in Table 1. The results showed that the carbohydrate and protein contents were highest in the regular sample (4.33% and 2.34% tiger nut wet-milled drink) and lowest (2.07% and 2.11%) in the powdered sample (dry sample), respectively. All the samples analyzed generally have high carbohydrate contents with the values ranging between 2.07 - 4.33% and protein 2.34% and 2.11%, respectively. The high amount of protein in the regular sample could be due to the high amino acids in the tiger nut wet-milled drink. Also, the highest carbohydrate content in the same sample was due to the high source of tiger nuts since the source of tiger nuts could contribute carbohydrates and other nutrients in tiger nuts, Gambo, and Da'u. (2014). Tiger nut milk has been reported to be used in the treatment of flatulence, indigestion, diarrhea,

mixtures were then centrifuged at 3100×g for 30 minutes, and the supernatant, containing excess water or oil, was drained for 15 minutes. The centrifuge tubes were reweighed to determine the weight of water or oil retained per gram of samples.

Data Analysis:

The data in the analysis were reported as the mean $\pm$ standard deviation from triplicate determinations. Statistical analysis of one-way ANOVA and Duncan's multiple-range test of $p < 0.05$ was performed using SPSS version 26.1

and dysentery due to its carbohydrate content (Mohdaly, 2019). In addition, starch content of this product has been reported to provide probiotic properties for colon bacteria (Pondei and Adenike, 2021). Lipid, moisture and crude ash contents were highest at 2.54%, 92% and 0.28% in the powdered sample, respectively, and lowest at 1.68%, 91% and 0.20% in the regular sample, while crude fibre was high in the powdered sample and lowest in the regular sample. The high content of lipid, 2.54%, in the powdered sample could be a result of the high unsaturated fatty acid content of tiger nuts, similar to that of olive oil as reported by Sanchez-Zapata *et al.* (2012). The product required cold storage to prevent deterioration due to its high moisture and fat content. There were significant differences in the proximate composition measured between regular mix and powdered mix products except for protein and ash.

The results of pH and total acidity (TA) are shown in Table 2. It was observed that the regular sample has the highest pH (7.24), and the lowest TA was observed in powdered TA (0.48). These pH values were within neutrality and were similar to those reported by Belewu and Abodunrin (2016) and so could be kept better than the regular sample mix. The result of the emulsification property showed that the regular sample has the highest emulsification capacity of $444.4 \pm$ R – Regular tiger nut drink, and P-Reconstituted Tiger nut drink (powdered),

R706- regular, R234- powdered with Vanilla flavor, **P659**-powdered only and **P162**- with warm water. The results of the sensory evaluation in Table 3 showed that the regular tiger nut drink sample has the highest mean values for appearance, texture, taste, and overall acceptability among the test samples when compared with the powdered nut sample. High sensory values obtained for the regular drink sample may be due to the familiarity of the panelists with products from tiger nut milk. There was no significant difference at $p < 0.05$ in terms of flavor and consistency. The same regular drink sample has the lowest values in terms of taste, flavor, aroma, and overall acceptability. The findings in this study considering sensory evaluation of regular tiger nut drink fruits are in line with Asare *et al.* (2020).

0.24 mg/100 g, while the powdered sample had the lowest value of 391.5 ± 0.71 mg/100 g. The study showed a significant difference between the samples in terms of pH, TTA, and emulsification property, which was in line with Asare *et al.* (2020), who said that dry and powdered tiger nuts will last for three to eight weeks at room temperature as compared to tiger nut drink, which can only last between 12 and 72 hours in an adequate refrigerator.

Conclusion

The overall acceptance of the panelists in terms of taste, color, flavor, aroma, and general acceptability indicated that the regular tiger nut drink products are appealing and could gain substantial acceptance by the public. Due to more familiarity, the dried powdered sample is more significant when it comes to life span at room temperature. The study suggests that Tiger nut drinks are good sources of carbohydrates and protein. The wet milling process (regular drink) retains more nutrients than dry milling (powdered sample). Sensory properties can vary significantly between production methods; the study provides valuable insights into the nutritional and sensory characteristics of tiger nut drinks, highlighting the potential benefits of wet milling and the importance of production methods on final product quality

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Table1: Proximate Analysis of Tiger-nut milk drink and Tiger nut powder						
Sample	Carbohydrate (%)	Protein (%)	Crude fat (%)	Moisture (%)	Ash (%)	Fiber (%)
Regular	4.33± 0.02 ^a	2.34±0.02 ^a	1.68± 0.01 ^c	91.07±0.16 ^b	0.20±0.00 ^a	0.41±0.21 ^c
Powder	2.07± 0.01 ^c	2.11±0.01 ^a	2.54± 0.02 ^a	92.90± 0.02 ^a	0.28±0.02 ^a	0.12±0.01 ^d

Values are mean ± standard deviation of triplicate determinations. Means on the same column with different sets of superscripts are statistically different ($p \leq 0.05$)

Table 2: pH, otal Acidity and Emulsifying Properties of Tiger-nut milk drink and Tiger nut powder.			
Sample codes	pH	Total acidity (%)	Emulsifying property mg/100ml
Regular	7.24± 0.014 ^a	0.14± 0.00 ^b	444.4± 0.24 ^a
Powder	7.13± 0.04 ^b	0.48± 0.00 ^a	391.5± 0.71 ^b

Values are mean ± standard deviation of triplicate determinations. Means on the same column with different sets of superscripts are statistically different ($p \leq 0.05$)

Table 3. Sensory attribute of all sample on both regular and powdered tiger nut drink

Sample	Appearance	Flavour	Texture	Taste	Consistency	Acceptability
R706	4.3±0.05 ^a	4.5±1.6 ^a	3.7±1.8 ^b	4.3±2.1 ^a	4.4±2.3 ^a	4.4±1.9 ^a
R234	4.4±0.05 ^a	4.3±1.7 ^{ab}	4.1±1.9 ^{ab}	4.2±2.0 ^a	4.2±2.1 ^a	4.3±2.2 ^{ab}
P659	4.1±0.05 ^a	3.8±1.8 ^b	4.3±1.7 ^a	3.8±1.9 ^a	3.9±1.8 ^a	4.0±2.0 ^{ab}
P162	4.0±0.05 ^a	3.8±2.1 ^b	4.4±2.2 ^a	3.7±2.1 ^a	3.8±2.3 ^a	3.8±1.8 ^b

Values are mean ± standard deviation of triplicate determinations. Means on the same column with different sets of superscripts are statistically different ($p \leq 0.05$)