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Comparative Evaluation of the Proximate, Vitamins, Minerals, Phytochemicals, and Anti-Nutrients Compositions of Purchased and Laboratory-Prepared Indigenous Snacks Commonly Consumed in Bida Nigeria

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Abstract:

Background: The knowledge of the chemical composition of indigenous snacks will help consumers make informed choices for healthy living. Objectives: This experimental study evaluated the comparative composition of purchased and laboratory-prepared indigenous snacks commonly eaten in Bida, Nigeria. Materials and Methods: Four commonly eaten snacks (Kilishi, Kuli Kuli, Kunu aya, and Donkwa) identified by some selected indigenes of Bida based on availability were purchased and reproduced in the laboratory. The samples were evaluated for proximate, vitamins, minerals, phytochemicals, and anti-nutrient composition using standard procedures. Data generated were analyzed using the IBM Statistical Product for Service Solution (version 21.0) and presented as means and standard deviations. The means were compared with Analysis of variance, separated by the Duncan Multiple Test Range, and significance was accepted at $p < 0.05$. Results: The proximate range of the purchased and prepared snacks were 1.20 to 72.55% protein, 0.40 to 14.70% fat, 0.03 to 2.40% fibre, 0.40 to 3.60% ash, 4.58 to 90.68% moisture, and 2.68 to 60.85% carbohydrates. The vitamins content ranged from 0.95 to 7.43µg vitamin A, 1.06 to 2.10mg thiamin, 0.87 to 1.59mg vitamin B2; 1.05 to 1.40 vitamin B3. The minerals ranged from 11.69 to 286.32 calcium, 8.10 to 290.62 magnesium, 0.27 to 2.40mg zinc, 0.25 to 8.40mg iron, 7.18 to 228.38mg potassium, 12.55 to 529.27mg. The anti-nutrients, and phytochemicals ranged from 0.03 to 0.12mg tannin, 0.02 to 0.59mg alkaloids, 0.09 to 0.48mg phytate, 0.03 to 7.43mg saponin. There were statistically significant differences between the chemical compositions of the purchased and the laboratory-prepared indigenous snacks at $p<0.05$. Kilishi is a good protein source, Kunu aya can quench thirst and Donkwa can sustain hunger. The

indigenous snacks are nutrient-dense and can contribute to dietary intake. Conclusion: Indigenous snacks have varied nutrient contents to support health.

Keywords:
Indigenous, Snacks, Chemical Composition, Nutrient Intake, Consumer

1. Introduction

The need and desire to eat constantly exist in every consumer, but the adequacy of what is eaten depends on the choices made by the consumers. This adequacy is determined by the quality and effective utilization of the nutrient consumed. In Nigeria, most consumers depend on convenient foods to make up for their nutritional requirements. These foods are referred to as snacks, and are widely consumed, most times inexpensive, and include ready-to-eat foods like groundnuts and bananas, biscuits, bread, cakes, roasted corn, roasted plantain (‘‘booli’’), plantain chips (‘‘kpekere’’), fried maize paste (‘‘Kokoro or Akara’’), fried yam, bean pudding, and others. A snack can also be defined as a type of food that assuage a person’s hunger between meals to provide a brief supply of energy for the body [1]. Many people generate their main income from the sales of snacks, it is not meant to be eaten as a main meal of the day, but sometimes, it serves as main meals or in between foods for a great majority of consumers [2]. For such people, snacks constitute an essential part of daily intake and life. Some individuals usually do not eat enough at meals to obtain the nutrients needed for a day. These people run on deficit energy/nutrient load and are vulnerable to health challenges and low productivity. Eating a healthy snack will enable one to obtain all the nutrients needed in the day to keep one healthy and full of energy [3].

Human nutrition and the improvement of human health have been associated with food consumption. FAO [4] revealed that human performance and well-being, both physical and mental depend primarily on what is eaten. Food intake is closely related to the sense of well-being and advances in knowledge about nutrition have a great effect on the diet. Many consumers seek more nutritional information and pay closer attention to what they eat. Different snacks exist in different localities. Some of them may form the bulk of intake for a great majority of people. They are referred to as indigenous snacks when they originate from or are native to a particular region or area. Most times are tied to the culture and tradition of the people and are usually made from fresh ingredients that are distinguished by their unique local flavor. They vary in season, nutrients, and taste. Indigenous snacks are most often purchased on the sidewalk, without entering any building [5]. They are usually sold by wandering sellers from trays or boxes on their heads, from stalls in the markets, in schools, or by the wayside in small rural towns as well as larger urban centers. In Bida Nigeria, the most commonly eaten snacks are Kuli kuli, Donkwa, Kunu aya, and Kilishi. kuli-kuli is a groundnut-based delicacy made from dried roasted groundnut mixed with onions, pepper, ginger, salt, and water. The mixture is ground into a paste, pressed into desired shapes, and fried, ready to eat. It can be eaten with gruel (cereals), soaked Garri, a garnish with cabbage and lettuce in local salad, or used as a major ingredient for meat frying, popularly known as Kilishi. Properly fried kuli-kuli have a shelf-life of two weeks [6]. Kilishi is another delicacy made from cow, sheep, or goat meat (after the removal of bone) that originated from Hausa land. Kilishi is a snack that has

financially sustained many families in northern Nigeria and has provided markets for buyers and dealers from outside the region and overseas. It is a form of suya made from selected meat muscles sliced into sheet-like sizes of one meter or less, dried, and immersed in Labu (peanuts paste diluted with enough water, spices, salt, ground onions, and sometimes sweeteners like honey). The Labu coated sheets of meat are dried for hours and roasted on a wire mesh. The shelf-life of Kilishi is between six months to a year [7]. Donkwa is a savory snack made with cornmeal, groundnuts, sugar, and chili without cooking. The mixture is blended into a fine powder, mixed with drops of water and oil, and molded into desired shapes, very common among the locals. Kunu Aya (Tiger nut milk) is a traditional creamy milk-like beverage with a spicy nutty taste made from fresh tiger nuts, dry tiger nuts, or a combination of the two, blended with dates/sugar, coconuts, ginger, and water. The extracted milk drink can be chilled and served cold [8]. The ingredients used in making these indigenous snacks are varied and nutrient-dense. Most of the ingredients when eaten in moderation are a great way to maintain a healthy weight [9]. Some like meat, cereals, and nuts have a lot of health benefits [10].

The apprehension for cleanliness and freshness often discourages people from eating these indigenous snacks. Non-indigenous /continental snacks are mainly sold in restaurants and fast-food joints. They take advantage of the modern processes and represent class, status, and wealth structures. Most of these snacks do not provide the best balance of nutrients, although they may provide energy for a short while, they are usually made from highly refined, and processed ingredients. Some indigenous snacks are processed in a way that increases the oil contents. Excess consumption of such fatty snacks poses various health threats like obesity, cardiovascular diseases, and so on. Healthy snacks in addition to a healthy supply of vitamins and nutrients should be low in sugar, fats, and salt [11]. Unhealthy snacks are high in sugar, fat, and salt. Large amounts of food are not good for the body regardless of whether or not they are healthy snack choices.

Widespread convenience stores and packaged snack foods are now a significant business. Snacks are typically designed to be portable, quick, and satisfying. Processed snacks are processed to be less perishable, more durable, and more appealing than prepared foods. [12]. Usually, snacks are perceived to have high fats and sugar contents, and are therefore “bad” and can lead to excess weight. Evidence has shown that snacking did not promote obesity. People who snack more and are less active are likely to gain more weight because they tend not to burn up the extra calories taken, but more active people will lose the extra calories [13]. Although a lot of research is needed in the areas of fats and sugars in the blood, some short-term studies have revealed that eating frequently is associated with more favorable control of circulating levels of blood fats and blood sugar [14]. It is therefore essential to evaluate the nutrient composition of the snacks we consume, to allow for informed use and the ability to incorporate them into daily meals to benefit health. At this point it becomes pertinent to ask the following research questions: what are the commonly eaten indigenous snacks? How can the recipes be standardized? What are the chemical compositions of these snacks?

2. Materials and Methods

Study design: The study employed an experimental study design.

Study area: Bida is a local government area and the second-largest community in Niger State Nigeria. It is located southeast of the capital city Minna and has a dry climate with excessive heat. The town is rich in culture and history ranging from its opposition to the colonial rule before its final conquest and famous traditional horse race. The indigenes are known for trading in melon and wheat, bead making, brass and glassworks, and the production of indigenous locally made snacks [15].

2.1. Collection and Identification of Raw Materials

A mini questionnaire structured to obtain information on the most frequently consumed indigenous snacks, and recipes (ingredients and method of preparations) were interviewer-administered to 20 adults randomly selected from indigenes of Bida. Four snacks (Kilishi, Kuli Kuli, Kunu aya, and Donkwa) were selected among other snacks based on availability and most commonly consumed in Bida, Nigeria. The ready-to-eat snack samples and ingredients for preparation were purchased from different vendors in the General market in Bida Niger state, packaged, and transported to Umudike Abia state. The raw materials were identified by an agronomist E. N. in the Department of Crop and Soil, Michael Okpara University of Agriculture, Umudike.

2.2. Preparation of the Snacks Samples

The four snacks: Kuli kuli, Kilishi, Donkaw, and Kunu aya were prepared as described in the recipe provided by the indigenes, packaged in zip lock bags, and refrigerated. A total of eight (8) samples (four purchased and four laboratory-prepared) were made ready for chemical evaluation

Chemical analyses: The proximate compositions of the snack samples were determined using standard procedures [16], total carbohydrate was obtained by difference and the energy values were calculated using the Atwater factors. The minerals (calcium, magnesium, iron, zinc, potassium, and sodium), vitamins (beta carotene, thiamin, niacin, and riboflavin), and phytochemicals (saponins) were determined as described [16]. Anti-nutrients (total tannins, phytate, and alkaloids) were determined using standard methods [16,17].

Statistical analysis: Data generated from the study were reported as the mean of duplicate analyses. One-way analysis of variance (ANOVA) using the Statistical Product for Service Solution version (23.0) was used to compare the mean values while treatment means were separated using Duncan multiple range test at a 95% confidence level ($p<0.05$).

3. Results and Discussion

3.1. Results

Table 1 shows the proximate contents of the purchased and prepared indigenous snacks commonly consumed across Bida in Nigeria. The protein content ranged from 1.20g/100g (Kunu aya purchased) to 72.55g/100g (Kilishi purchased). Crude fat content ranged from 0.40g/100g (Kunu aya prepared) to 14.70g/100g (Kuli kuli prepared). Purchased Kuli Kuli had a statistically significant ($p<0.05$) lower crude fat content (12.70%) than prepared Kuli Kuli (14.70%). The crude fat content of purchased and prepared Kilishi (10.23%, 13.50%), and Donkwa (9.60%, 8.65%) were also significantly different ($p<0.05$) respectively. Kunu-Aya purchased (0.55%) and

prepared (0.40%) had the least fat contents. Crude fibre content ranged from 0.03g/100g (Kunu aya purchased) to 2.40g/100g (Kilishi purchased). Total ash content ranged from 0.40g/100g (Kunu aya purchased) to 3.60g/100g (Kilishi purchased). The moisture content ranged from 4.58g/100g (Kuli kuli purchased) to 90.68g/100g (Kunu aya purchased). There was a statistically significant difference ($p<0.05$) between the moisture contents of the purchased and prepared indigenous snacks. The purchased Kuli kuli (4.58%), kilishi (6.98%), and Donkwa (10.35%) had lower moisture contents relative to the prepared ones except for Kunu aya purchased which had a higher moisture value (90.68%) compared to the prepared Kunu aya (88.68%). Total carbohydrates content ranged from 2.63g/100g (Kilishi prepared) to 60.85g/100g (Donkwa purchased). The purchased Kuli Kuli had a greater carbohydrate content (58.201%) than prepared Kuli Kuli (48.95%).

Table 1. *Proximate composition of purchased and laboratory-prepared commonly eaten snacks in Bida Nigeria.*

Snack samples	Crude protein (%)	Crude fat (%)	Crude fibre (%)	Ash (%)	Moisture content (%)	Carbohydrates (%)
Kuli kuli purchased	$19.73^{c} \pm 0.18$	$12.70^{c} \pm 0.14$	$2.30^{ab} \pm 0.14$	$2.50^{c} \pm 0.00$	$4.58^{h} \pm 0.25$	$58.20^{c} \pm 0.07$
Kuli kuli prepared	$17.45^{d} \pm 0.35$	$14.70^{a} \pm 0.00$	$2.20^{bc} \pm 0.00$	$2.30^{d} \pm 0.00$	$6.45^{d} \pm 0.21$	$48.95^{d} \pm 0.07$
Kilishi purchased	$72.55^{a} \pm 0.21$	$10.23^{d} \pm 0.11$	$2.40^{a} \pm 0.00$	$3.60^{a} \pm 0.14$	$6.98^{g} \pm 0.18$	$4.25^{g} \pm 0.14$
Kilishi prepared	$65.68^{b} \pm 0.32$	$13.50^{b} \pm 0.28$	$2.10^{c} \pm 0.00$	$3.30^{b} \pm 0.14$	$10.80^{e} \pm 0.14$	$2.63^{h} \pm 0.60$
Donkwa purchased	$16.25^{e} \pm 0.00$	$9.60^{e} \pm 0.14$	$1.05^{d} \pm 0.07$	$1.53^{e} \pm 0.11$	$10.35^{f} \pm 0.21$	$60.85^{a} \pm 0.00$
Donkwa prepared	$13.53^{f} \pm 0.25$	$8.65^{f} \pm 0.00$	$0.95^{d} \pm 0.07$	$1.35^{e} \pm 0.00$	$13.83^{c} \pm 0.11$	$59.70^{b} \pm 0.42$
Kunu aya purchased	$1.20^{g} \pm 0.00$	$0.55^{g} \pm 0.07$	$0.03^{e} \pm 0.01$	$0.40^{f} \pm 0.00$	$90.68^{a} \pm 0.11$	$7.15^{f} \pm 0.05$
Kunu aya prepared	$1.45^{g} \pm 0.00$	$0.40^{g} \pm 0.00$	$0.06^{e} \pm 0.10$	$0.50^{f} \pm 0.00$	$88.68^{b} \pm 0.11$	$8.93^{e} \pm 0.11$
LS	***	***	***	***	***	***

*LS=Level of significance; ***=highly significant @ alpha= 0.05; Means with the same superscripts are not significantly different from each other (p>0.05)*

Table 2 shows the vitamin contents of purchased and prepared indigenous snacks commonly consumed in Bida Nigeria. The vitamin A contents ranged from 0.95µ/100g (Kunu aya prepared) to 7.43µ/100g (Kilishi prepared). The vitamin B1(thiamin) contents ranged from 1.06mg/100g (Kilishi prepared to 2.10mg/100g (Donkwa purchased and prepared respectively). The vitamin B2 (riboflavin) contents ranged from 0.87mg/100g (Kilishi purchased) to 1.59mg/100g (Kunu aya purchased), and the vitamin B3 (niacin) contents ranged from 1.09mg/100g (Kuli kuli) to 1.40gm/100g (Kunu aya purchased and prepared respectively). No statistically significant difference ($p>0.05$) was found between purchased kuli kuli and prepared kuli kuli in the content of vitamin A (2.40mg/100g; 2.65mg/100g), vitamin B1 (1.32mg/100g; 1.36mg/100g), vitamin B2 (1.10mg/100g; 1.13mg/100g), and vitamin B3 (1.09mg/100g; 1.11mg/100g).

Table 2. *Vitamins compositions of purchased and laboratory-prepared commonly eaten snacks in Bida Nigeria.*

Snack samples	Vitamin A µ/100g	Vitamin B1 mg/100g	Vitamin B2 mg/100g	Vitamin B3 mg/100g
Kuli kuli purchased	$2.40^{c} \pm 0.00$	$1.32^{d} \pm 0.02$	$1.10^{b} \pm 0.01$	$1.09^{bc} \pm 0.01$
Kuli kuli prepared	$2.65^{bc} \pm 0.00$	$1.36^{cd} \pm 0.01$	$1.13^{b} \pm 0.02$	$1.11^{b} \pm 0.02$
Kilishi purchased	$7.10^{a} \pm 0.00$	$1.06^{e} \pm 0.01$	$0.87^{d} \pm 0.04$	$1.05^{d} \pm 0.03$
Kilishi prepared	$7.43^{a} \pm 0.32$	$1.08^{e} \pm 0.01$	$0.96^{c} \pm 0.03$	$1.05^{d} \pm 0.02$
Donkwa purchased	$2.90^{b} \pm 0.21$	$2.10^{a} \pm 0.01$	$1.12^{b} \pm 0.01$	$1.11^{b} \pm 0.03$
Donkwa prepared	$2.43^{bc} \pm 0.39$	$2.10^{a} \pm 0.03$	$1.10^{b} \pm 0.01$	$1.13^{b} \pm 0.02$
Kunu aya purchased	$1.35^{d} \pm 0.14$	$1.38^{bc} \pm 0.04$	$1.59^{a} \pm 0.01$	$1.40^{a} \pm 0.03$
Kunu aya prepared	$0.95^{d} \pm 0.00$	$1.42^{b} \pm 0.02$	$1.56^{a} \pm 0.03$	$1.40^{a} \pm 0.01$
LS	***	***	***	***

*LS=Level of significance; ***=highly significant @ alpha= 0.05; Means with the same superscripts are not significantly different from each other (p>0.05)*

$290.62^{a} \pm 0.65$

The mineral compositions of purchased and prepared indigenous snacks commonly consumed in Bid Nigeria are presented in Table 3. Calcium contents ranged from 11.69 mg/100g (Kunu aya purchased) to 286.32mg/100g (Kilishi purchased). The magnesium contents ranged from 8.10mg/100g (Kunu aya prepared) to 290mg/100g (Kuli kuli purchased). The zinc content (2.40mg/100g) was significantly higher in Kuli kuli purchased, while the iron content was significantly higher in Kilishi purchased. Kilishi prepared had the highest potassium content (206.40mg/100g), and Kuli kuli purchased had the highest sodium content (529.27mg/100g).

Table 3. *Minerals compositions of purchased and laboratory-prepared commonly eaten snacks in Bida Nigeria (mg/100g).*

Snack samples	Ca (mg)	Mg (mg)	Zn (mg)	Fe (mg)	K (mg)	Na (mg)
Kuli kuli purchased	$102.53^{c} \pm 0.11$	$290.62^{a} \pm 0.65$	$2.40^{a} \pm 0.00$	$2.80^{c} \pm 0.14$	$85.53^{e} \pm 0.53$	$529.27^{a} \pm 1.59$
Kuli kuli prepared	$94.32^{d} \pm 0.00$	$182.03^{d} \pm 0.18$	$1.90^{b} \pm 0.00$	$2.32^{d} \pm 0.19$	$80.19^{f} \pm 0.00$	$435.43^{b} \pm 0.46$
Kilishi purchased	$286.32^{a} \pm 0.38$	$128.75^{e} \pm 0.86$	$0.95^{e} \pm 0.00$	$8.40^{a} \pm 0.00$	$228.38^{a} \pm 0.74$	$56.46^{e} \pm 0.34$
Kilishi prepared	$264.44^{b} \pm 0.45$	$124.27^{f} \pm 0.12$	$0.82^{f} \pm 0.00$	$6.90^{b} \pm 0.00$	$206.40^{b} \pm 0.11$	$142.53^{f} \pm 0.33$
Donkwa purchased	$84.86^{e} \pm 0.76$	$208.66^{c} \pm 0.08$	$1.62^{c} \pm 0.00$	$2.23^{d} \pm 0.11$	$105.45^{c} \pm 4.17$	$390.48^{c} \pm 0.53$
Donkwa prepared	$80.14^{f} \pm 0.00$	$216.45^{b} \pm 0.48$	$1.43^{d} \pm 0.06$	$2.63^{c} \pm 0.10$	$97.43^{d} \pm 0.16$	$348.69^{d} \pm 0.05$
Kunu aya purchased	$11.69^{h} \pm 0.05$	$8.55^{g} \pm 0.29$	$0.27^{h} \pm 0.04$	$0.33^{e} \pm 0.11$	$8.68^{g} \pm 0.11$	$12.55^{h} \pm 0.21$
Kunu aya prepared	$13.50^{g} \pm 0.33$	$8.10^{g} \pm 0.00$	$0.38^{g} \pm 0.00$	$0.25^{e} \pm 0.00$	$7.18^{g} \pm 0.00$	$14.70^{g} \pm 0.00$
LS	***	***	***	***	***	***

*LS=Level of significance; ***=highly significant @ alpha= 0.05; Means with the same superscripts are not significantly different from each other (p>0.05)*

The anti-nutrients and phytochemical compositions of purchased and laboratory-prepared commonly eaten snacks in Bida Nigeria are shown in Table 4. Total tannin contents ranged from 0.03mg/100g (Donkwa prepared) to 0.12mg/100g (Kuli kuli purchased). The alkaloids contents ranged from 0.06mg/100g (Donkwa prepared) to 0.59mg/100g (Kuli kuli prepared). Kuli kuli prepared had significantly higher phytate content (0.57mg/100g), and Kuli kuli purchased had the highest saponin content (0.41mg/100g). Purchased Kuli Kuli had the highest tannin (0.12mg/100g), and saponin (0.41mg/100g). The prepared kuli kuli contained more alkaloids (0.59mg/100g) and phytate (0.57mg/100g). Furthermore, phytate (0.13mg/100g; 0.09mg/100g) and saponin (0.08mg/100g; 0.05mg/100g) were higher in the purchased kunu-aya than in the prepared kunu-aya, while tannin (0.03mg/100g; 0.07mg/100g), and alkaloid (0.06mg/100g; 0.12mg/100g) were lower in purchased Kilishi than in prepared Kilishi. There was no statistically significant difference ($p<0.05$) in the saponin contents of purchased and prepared Kunu aya, but a statistically significant difference ($p>0.05$) exists between the tannin, alkaloid, and phytate content of both samples

Table 4. *Anti-nutrients and phytochemical compositions of purchased and laboratory-prepared commonly eaten snacks in Bida Nigeria (mg/100g).*

Snack samples	Tannin (mg/100g)	Alkaloids (mg/100g)	Phytate (mg/100g)	Saponin (mg/100g)
Kuli kuli purchased	$0.12^{a} \pm 0.00$	$0.39^{b} \pm 0.04$	$0.48^{b} \pm 0.00$	$0.41^{c} \pm 0.02$
Kuli kuli prepared	$0.08^{b} \pm 0.00$	$0.59^{a} \pm 0.00$	$0.57^{a} \pm 0.00$	$0.11^{a} \pm 0.02$
Kilishi purchased	$0.04^{cd} \pm 0.03$	$0.02^{e} \pm 0.00$	$0.13^{e} \pm 0.01$	$0.03^{f} \pm 0.01$
Kilishi prepared	$0.09^{ab} \pm 0.01$	$0.06^{e} \pm 0.00$	$0.16^{e} \pm 0.00$	$0.09^{cd} \pm 0.01$
Donkwa purchased	$0.10^{ab} \pm 0.00$	$0.30^{c} \pm 0.00$	$0.37^{d} \pm 0.04$	$0.09^{cd} \pm 0.01$
Donkwa prepared	$0.03^{d} \pm 0.01$	$0.06^{e} \pm 0.03$	$0.13^{f} \pm 0.01$	$0.08^{def} \pm 0.01$
Kunu aya purchased	$0.07^{bc} \pm 0.00$	$0.12^{d} \pm 0.00$	$0.09^{e} \pm 0.01$	$0.05^{cde} \pm 0.01$
Kunu aya prepared	$0.11^{ab} \pm 0.02$	$0.41^{b} \pm 0.04$	$0.42^{c} \pm 0.00$	$0.32^{b} \pm 0.01$
LS	***	***	***	***

*LS=Level of significance; ***=highly significant @ alpha= 0.05; Means with the same superscripts are not significantly different from each other (p>0.05)*

3.2. Discussion

3.2.1. Proximate Composition of Snacks

This study showed significant variations ($p<0.05$) in the proximate compositions of purchased and laboratory-prepared indigenous snacks commonly eaten in Bida, Nigeria. The difference could be attributed to variations in preparation skills, processing methods, and ingredients (like parts of meat used as in Kilishi). The protein contents of Kilishi prepared and purchased (65.68%; 72.55%) were significantly higher than the other snacks. This was because meat was the major ingredient for Kilishi. kilishi protein content implies that it can contribute significantly to the daily protein requirements, as meat is considered a good source of protein [18]. This study's protein values were lower when compared to the values reported [19] in the chemical evaluation of processed beef. The protein content of meat usually reduces when exposed to prolonged heat [20]. This study's kuli kuli

protein contents are comparable to the 17.30% – 18.61% protein value for local crackers [15], The low protein contents (1.20%-1.45%) of Kunu-Aya could be explained by the higher values of other proximate contents. Tiger nuts are rich in starch content, dietary fibre, and carbohydrates [21].

The differences in the fat contents of Donkwa and kilishi were expected because, even though both samples had ground nuts as one of the key ingredients, their processing methods vary. In this study fat values were 8.1% lower compared to those obtained by Ellis [14] on peanuts and cashew nuts but similar to 12.70% reported for local crackers as in [15]. Kuli Kuli's high-fat content tends to support the assertion by Akinyele and Oloruntoba [22] that heating enhances the availability of oil content in food products of nuts, and the oil is naturally present in groundnuts. The Recommended Dietary Allowance (RDA) for fat is between 20-35% of daily calories [23]. All the indigenous snacks analyzed did not meet up to the RDA of fat, but could contribute to daily fat intake.

The RDA for fibre is between 10-35% of daily calories [23]. The crude fibre content of Kuli Kuli prepared and purchased aligned with the report of Happiness [9] and is comparable to 2.18% – 2.23% fibre in local crackers [15]. Kuli kuli, Kilishi, and donkwa had appreciable fibre contents (Table 1) and can contribute to dietary intake. Kunu-Aya prepared and purchased had the least (0.03%-0.06%) fibre contents because their fibre contents were extensively removed during preparation. The snacks need to be consumed together with other foods to meet the recommended allowance.

Ash content of food indicates the mineral contents of a food sample [24]. The ash content of kilishi (purchased) could significantly aid in the metabolism of other organic compounds. Kunu-Aya's low ash contents (0.40%-0.50%) could be attributed to the high water content of the beverage. The observed ash content of kuli kuli purchased (2.50%) and prepared (2.30%) was lower compared to 3.3% and 3.45% reported in the effect of frying and roasting on the proximate properties of nuts [25]. This could be due to the variety of groundnut used, processing methods, and the soil conditions at different geographic locations.

The moisture content of a food product determines its keeping quality [25; 26]. The moisture contents of Kuli kuli, Kilishi, and Donkwa were less than 14% recommended for better shelf life and implies that these snacks can be stored for a relatively long period. In this study Kuli kuli's moisture contents could be compared to 4.08% – 6.52% reported for local crackers [15]. Kilishi moisture values were lower than 11.1% reported for beef jerky [27]. Kunu-Aya prepared and purchased had the highest moisture content (88.68%; 90.68%) because they are beverages/drinks. The moisture contents of all the purchased indigenous snacks were lower than the laboratory-prepared samples except for Kunu aya. This could be because the vendors would like to maximize profits by adding additional water to the beverage. High moisture content is known to favor bacterial growth. Carbohydrate content indicates the amount of useful energy in food [28]. There was a statistically significant difference ($p<0.05$) in the carbohydrate contents of purchased and laboratory-prepared Kuli Kuli, Kilishi, Donkwa, and Kunu-Aya respectively. The high carbohydrate content of purchased and laboratory-prepared Donkwa and Kuli kuli could be attributed to the basic ingredients (cornmeal and groundnuts) of these snacks that are known to have high carbohydrate contents. Purchased kilishi had lower carbohydrate content compared to 4.26% [29]. The Recommended Dietary Allowance for carbohydrates is between 45 and 65% of daily calories [23].

The riboflavin and niacin contents of the indigenous snacks analyzed were lower when compared to the other indigenous snacks (Kokoro: fried maize paste, masa, and kunu zaki) as reported in some Cameroonian household foods [30; 31]. The RDA of riboflavin (men 1.3mg; women 1.1mg) and niacin (men 17g; women 13g) [32] were higher compared to the values obtained from the snacks analyzed. This indicates that the indigenous snacks need to be fortified or eaten in combination with other foods to increase their riboflavin, and niacin levels. The health benefits of vitamins include their ability to prevent and treat various diseases including heart problems, high cholesterol levels, and eye and skin disorders [33]. The low riboflavin content of kilishi was because meat muscles are not very rich sources of riboflavin. This finding supports the report that the most important sources of riboflavin are dairy products, brewer's yeast; liver, and oily fish [34]. The vitamins content was generally lower in the purchased sample of kilishi than in the prepared sample, except for vitamin B3 which had the same value for both the purchased and prepared samples. All the samples in this study are not significant ($p>0.05$) in mean ratings for retinol (Vitamin A), thiamine (B1), and niacin (B3). The differences in means are attributed to sampling oddity. Niacin, however, had higher values because red meat and nuts contain considerable amounts of niacin. Niacin is provided in the diet from a variety of whole and processed food, with the highest contents in fortified packaged foods and meat from various animal sources [35]. Kilishi is a better source of niacin than Donkwa but should be consumed moderately as it can also lead to heart problems due to the processing methods used in its preparation. Lower quantities (2.35%) of vitamin A compared to the present study was found in Donkwa samples made with millet [36]. This could be due to some variations in the type of ingredients used. In this study, Donkwa was prepared using corn flour, which has a higher concentration of vitamin A than millet. Furthermore, vitamin A was found to be higher in the purchased sample of kunu-aya than in the prepared sample. and vitamin B3 content of both prepared and purchased samples of Donkwa was the same (1.40mg/100g). The main functions of fat-soluble vitamins (Vitamin A) are in the metabolism of carbohydrates during energy production and in regulating the body's use of protein [37]. Thiamin, riboflavin, and niacin usually occur together in foods, but in different proportions depending on the food source [38]. The RDA for thiamin for men and women is 1mg and 0.8mg respectively [32]. These study thiamin values could contribute to daily intake.

Table 3 shows the mineral contents of purchased kuli kuli and prepared kuli kuli. there was a statistically significant difference ($p<0.05$) in calcium, magnesium, zinc, iron, potassium, and sodium respectively. Eating nuts supplies protein, fiber, and healthy fats, and also helps to meet daily needs for magnesium and potassium [39]. Slightly higher quantities of zinc (1.01mg/100g) and much greater amounts of iron (1.12mg/100g) were obtained in beef jerky made from oven-dried goat meat [40]. The difference in iron and zinc contents may be due to the slight differences in processing method, or type of meat muscle used in the preparation of the different samples. The iron contents of the study snacks were comparable to 2.25mg/100g in cookies made from groundnut and cornflour [41], which are core ingredients in the preparation of Donkwa. The indigenous snacks (Kuli-kuli, Kilishi, Donkwa, Kunu-aya) contained appreciable mineral contents and can contribute to the recommended daily allowance.

There was a statistically significant difference ($p<0.05$) in all the anti-nutrients analyzed for the prepared and purchased indigenous snacks. The higher phytate values obtained from Kuli kuli could be attributed to the high legumes' high phytic acid

contents seeds, grains, legumes, and nuts contain phytate in varying quantities. Prolonged intake of high phytate foods can lead to mineral deficiencies in an individual [42]. The chemical composition of Kokoro (fried maize paste) and Donkwa had lower phytic acid content than the present study [43]. The differences may be attributed to disparity in soil composition, the climate where the nuts were cultivated, crop type, and ingredients used. Since phytate is mostly found within the hull of nuts, seeds, and grains; proper cooking, soaking in an acid medium, and lactic acid fermentation to reduce the phytic acid contents were recommended [42]. James [1] showed higher values (0.12mg) of tannin content in roasted meat muscles. The difference in values obtained may be related to a different method of preparation. The saponin content of the snacks in this study is comparable to 0.07mg reported for coconut milk physicochemical properties study [5], except for Kunu aya prepared (0.32mg), and Kuli kuli purchased (0.41mg) which had much higher values. Saponins and alkaloids have been shown to significantly augment the cytotoxicity of immunotoxins and other targeted toxins directed against human cancer cells. Alkaloids and saponins have been underscored to be beneficial to health [44]. The high level of saponin content in the kunu-aya goes to support the conclusion that saponin cannot be destroyed by processing or cooking [15].

All the samples in this study are not significant ($p > 0.05$) in mean ratings for alkaloid and saponin. The differences in means are attributed to sampling oddity. Anti-nutrients either bind to nutrients to prevent their absorption, react with nutrients to form indigestible compounds, or inhibit digestive proteins from breaking down a nutrient so it can be used by the body. Tannin, alkaloid, phytate, and saponin (antinutrients) were detected in the samples because these are foods of plant origin. Despite the health benefits accredited to these anti-nutrients, some of them can serve contrary functions above certain concentrations. Heat processing and fermentation are known to reduce anti-nutrients from anti-nutritional concentration levels often present in raw food to acceptable nutritional levels in products ready for consumption [44]. In general, the anti-nutrients present in the indigenous snacks analyzed are low to significantly interfere with nutrients utilization. They are below the established toxic level [45].

4. Conclusions

The study on evaluation of the chemical composition of indigenous snacks consumed in Bida local government Area of Niger State, Nigeria, found that kuli kuli (local crackers), kilishi (beef jerky), donkwa, and kunu-aya (tiger nut drink), were the major indigenous snacks consumed. There was a statistically significant difference between most of the nutrients present in both the purchased and prepared samples. Overall, the snacks were rich in nutrient contents, with the prepared samples having more nutritional value than the purchased ones. These indigenous food sources are a useful snacking alternative for a missed meal and can be further exploited and promoted for greater consumption nationwide.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Author Contributions

H.N. articulated the title, directed the review, experimentation, manuscript, and final write-up, U.N. conducted the review and participated in the experimentation. Both authors endorsed the work.

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