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Nutrient composition of whole grain and processed "Niri" (*Citrullus vulgaris*) seeds

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Abstract
Citrullus vulgaris, traditionally known as "Niri" is a traditional seed used for the preparation of stew, soup and other traditional foods especially by inhabitants of the northern sector of Ghana. Despite it usage for centuries, less attention has been paid to it nutrient composition in Ghana. Therefore, this study was carried out to determine the proximate and mineral compositions of *Citrullus vulgaris* ("Niri") seed and it processed materials (raw and roasted purees, raw and roasted chaffs). Proximate and mineral compositions were done according to procedures in the International Association of Official Analytical Chemist. There were statistical differences ($P<0.05$) in all the proximate components examined. The ash (2.27%), fat (42.27%) and protein (20.30%) contents of the whole "Niri" seed were significantly higher ($P<0.05$) than the processed seeds. Carbohydrate and moisture contents were significantly highest in raw chaff (69.85%) and roasted puree (53.60%), respectively compared to the whole "Niri" seed and other processed products. The calcium content of the whole "Niri" seed and its processed product did not differ significantly ($P>0.05$) from the processed products. However, the iron (4.08mg/g), potassium (32.96mg/g), magnesium (28.35mg/g) and zinc (0.56mg/g) contents of the whole "Niri" seeds were significantly higher than the processed products. This study indicated that protein, carbohydrate, fat, water, calcium, iron, potassium, magnesium and zinc are present in both whole "Niri" seeds and in it processed form. Therefore, they have the potential to be used as ingredient for further processing or for non-tradition food.

Keywords: *Citrullus vulgaris*, food, further processing, "Niri", nutrients

1. Introduction
The "Niri" (*Citrullus vulgaris*) belongs to the Cucurbitaceae family. It is generally referred to as the melon, gourd, pumpkin or cucumber [1]. It is also a trailing herbaceous plant with a succulent greenish stem [2]. Watts [3] reported that, *Citrullus vulgaris* requires heat, sunshine and a long summer to grow, but may be grown and produced successfully in the North when proper cultural conditions are provided. The growing of "Niri" is less cumbersome and it is usually intercropped with cereals in the three regions of Northern Ghana.

Nutritional analysis carried out on *Citrullus vulgaris* varieties in Nigeria indicated that they are good source of protein [1]. They are also a complete food source as they contain minerals, carbohydrates and lipids [4]. Penuel *et al*. [1] reported 5.05%, 49.00%, 36.58%, 4.83%, 4.00% and 0.59% of moisture, fat, crude protein, ash, crude fibre and carbohydrates, respectively in raw undefatted "guna" (*Citrullus vulgaris*) seeds in Nigeria. These results were similar to previous research report of a protein content of 32.96%, moisture content of 2.75%, ash content of 3.53% and a carbohydrate content of 9.17% by Ogundele *et al*. [5]. Akinyele and Oloruntoba [6] also reported a proximate composition of 37.76% (crude protein), 26.85% (fat), 4.44% (moisture) and 3.38% (ash) for unfermented *Citrullus vulgaris*.

Mineral composition of raw undefatted *Citrullus vulgaris* as reported by Penuel *et al*. [1] were 81.00mg/100g for magnesium, 136.00mg/100g for iron, 33.00mg/100g for calcium and 207mg/100g for sodium. These results indicate that *Citrullus vulgaris* is comparable to other plant food sources.

The seeds of "Niri" are commonly used to prepare stews and soups in Ghana. It is an important food resource in traditional Ghanaian homes especially those in the northern sector as it is used to prepare special meals for important personalities like in-laws and sick persons for quick recovery. A traditional Frafra funeral is also incomplete without "Niri" soup. Though the plant has played an important role in the nutrition of Ghanaians in most rural communities, it's proximate and mineral composition has been given less attention. This study seeks to ascertain the proximate and mineral composition of whole "Niri" seed and its processed materials.

2. Materials and Methods
2.1 Processing of "Niri" seeds
2.1.1 Whole "Nire" Seeds
Whole "Niri" seeds were purchased from Aboabo Market in Tamale and processed at University for Development Meats Unit. Whole "Niri" seeds (7kg) were thoroughly washed, immersed in clean water and allowed to stand for ten minutes. All floating materials and seeds were removed off and the remainder rewashed and sun dried. The sun dried whole "Niri" seeds were then winnowed and further hand sorted to remove all foreign materials.

2.1.2 Preparation of "Niri" Purees
For raw puree, the sun dried whole "Niri" seeds were milled using simple corn mill. For the roasted puree, the sun dried whole "Niri" seeds were roasted at a temperature of 220°C for 30 minutes with intermittent stirring at 10 minutes' intervals. Roasted seeds were cooled and also milled. A kilogram each of the milled "Niri" seed (raw and puree) was

first mashed in 1.5 litres of clean water, sieved using a cheese cloth and the filtrate collected in a bowl. The chaffs (raw and roasted) were mashed for the second and third times with 0.75 litre of clean water each. The filtrates were collected into transparent containers covered with lids and kept in a chiller for 24 hours to settle. The settled filtrates were then decanted and drained off to obtain the purees (raw and roasted). The purees were stored at - 18°C for nutrient composition analysis.

2.1.3 Preparation of "Niri" Chaffs
The chaffs (raw and roasted) obtained during the processing of purees were oven dried at 60°C for 8 hours in an electric oven (Turbofan Blue seal, UK), cooled over night at room temperature and blended using kitchen blender (Philips) for 8 minutes. Samples were then collected, cooled, sealed and stored at - 18°C for nutrient composition analysis.

2.2 Nutrient Analysis of Whole "Niri" Seeds, Purees and Chaffs
Proximate and mineral analyses were respectively carried out at the Food Analysis Laboratory of Food Science and Technology Department, and the Central Laboratory of Kwame Nkrumah University of Science and Technology, Kumasi. Proximate composition and mineral analysis were done according to the International Association of Official Analytical Chemist [7].

2.3 Data Analysis
Data was analyzed using General Analysis of Variance of Genstat Discovery 4th edition. Where there were significant differences, ($P < 0.5$) means were separated using Tukey at 5% significant level

3. Results and Discussion
3.1 Proximate composition of whole and processed "Niri" seeds
The proximate composition of the whole "Niri" and processed (raw/roasted puree and raw/roasted chaff) "Niri" seeds is shown in Table 1. The results indicated that the whole "Niri" seed had significant ($P<0.05$) amount of ash, fat and protein than the processed "Niri" seeds, but lower in carbohydrate and moisture. The chaffs had high carbohydrate contents than the purees, but lower in protein than the purees. The moisture contents of the purees were significantly ($P<0.001$) higher than the chaffs and whole "Niri" seed.

Table 1: Proximate composition of whole "Niri" and processed seeds

Parameter	Whole grain	Processed "Niri" Seeds					
		Raw Puree	Raw Chaff	Roasted Puree	Roasted Chaff	S.e.d.	P-value
Ash (%)	2.273[a]	0.90[c]	0.82[c]	0.97[c]	1.17[b]	0.1816	0.002
Carbohydrate	20.860[c]	11.10[d]	69.85[a]	4.73[e]	47.12[b]	0.8420	< 0.001
Fat (%)	42.270[a]	29.58[c]	16.98[e]	26.71[d]	38.18[b]	0.5020	< 0.001
Moisture (%)	14.290[c]	45.42[b]	4.02[d]	53.60[a]	3.78[d]	0.6360	< 0.001
Protein (%)	20.300[a]	13.00[c]	8.34[d]	13.79[b]	9.95[d]	0.3880	< 0.001

S. e. d. = standard error of difference, Rows with different superscripts are statistically different ($P < 0.05$).

Carbohydrate content of chaffs (raw and roasted) were significantly ($P<0.001$) higher than whole grain (seed) and purees (raw and roasted). This is attributed to the processing which removed almost all cell contents (flour) to produce the purees. The remaining cell wall or seed coat contents (chaffs) are structural in nature and are generally energy given. Extraction of purees increased the fraction of seed coat to flour content in chaffs hence the high carbohydrate content in chaffs. The carbohydrate content of 20.86% in whole "Niri" seed was higher than the 7.22% for *Citrullus lanatus* [8] and 5.1% *for Colocynthis citrullus* [4]. The carbohydrate content was however, below 65-75% for cereals [8], hence cannot be used as a major source of energy in human nutrition.

Ash content of whole "Niri" grain was 2.27% and that of raw and roasted purees were 0.90 and 0.82%, respectively. Raw and roasted chaffs recorded values of 0.97 and 1.17%, respectively. The high inorganic content of cell walls accounted for the high ash contents of chaffs. These results are lower than what was reported for *Citrullus vulgaris* ("guna") in Nigeria [1]. They reported 4.83, 4.85 and 3.30% for undefatted (raw), defatted and protein concentrate, respectively. Ash content of *Citrullus lanatus* was found to be 6.70% [8] while "egusi" was 3.70% [4] and 6.84 – 6.99% [9]. The low ash content of "Niri" means it will have low mineral values and should therefore not be used as a major mineral source in human nutrition.

The fat content of whole "Niri" seeds, raw puree, roasted puree, raw chaff and roasted chaff were 42.27, 29.58, 16.98, 26.71 and 38.18%, respectively. The fat content was similar to the 42.60, 43.21 and 40.60% for unprocessed, roasted and germinated groundnut respectively reported by Kavitha and Paramavalli [10]. The results indicated that the oil content of whole "Niri" seeds was lower than that of raw undefatted "guna" (49.00%) as reported by Penuel *et al*. [1]. The test materials however, had higher values than defatted "guna" (5.5%) and "guna" protein concentrate (2.73%). The results were also lower than *Citrullus lanatus* (49.05%) [8] and *Colocynthis citrullus* (53.85%) [9]. High oil content of "Niri" seed makes it a potential oil producing crop. This when exploited in commercial bases will create jobs for the youth and rural farmers to enhance economic growth. The high oil content of the test materials will improve eating quality and energy levels when eaten or incorporated into food and meat products.

Moisture values of purees were significantly ($P<0.001$) higher than chaffs and whole "Niri" seed. This means the water that was used to process the flour into purees were not significantly removed by the decantation method. These moisture values were higher than those reported for raw undefatted "guna" (5.05%), defatted "guna" (5.5%) and "guna" protein concentrate (4.50%) [1] and 7.10% for *Citrullus lanatus* [8]. High moisture content of test materials make products prepared from them juicier and tender. Therefore, products incorporated with "Niri" purees are likely to have better sensory qualities in terms of tenderness and juiciness than chaff products. The high moisture values of purees will however make them prone to microbial

spoilage. The moisture content of whole "Niri" seeds were similar to the 13.56% for unprocessed wheat flour reported by Kavitha and Paramalavalli [10]. The moisture values for the chaffs were however, lower than 10%. This means whole "Niri" seeds and chaffs can be stored for long as low moisture content increases shelf life of food products [11].

Protein content of whole "Niri" seeds (20.30%) was significantly (P<0.001) higher than the test materials (8.34-13.79%). This implies that the methods used for processing reduced much of the nutrient but higher than most cereals. The protein values in this study were lower than those reported by Penuel *et al.* [1]. They reported a protein content of 36.58, 50.93 and 83.56% for raw undefatted "guna", defatted "guna" and "guna" protein concentrate, respectively. The results for whole "Niri" seeds are in agreement to those obtained for lean beef (22.3%) and beef carcass (16.5%) [12]. The protein values of the whole "Niri" seeds are however, higher than the 8-17.5, 8.8-11.9 and 7-10%, respectively for wheat, maize and rice [13]. Supplementing the consumption of maize and rice with "Niri" will most contribute to reducing malnutrition among rural dwellers and the entire population as a whole.

3.2 Mineral composition of whole and processed "Niri" seeds

The mineral composition of the whole "Niri" and processed (raw/roasted puree and raw/roasted chaff) "Niri" seeds is shown in Table 2. There was no significant difference (P>0.05) between the whole and processed "Niri" seeds in terms of their calcium content. Whole "Niri" seed was significantly higher (P<0.05) in iron, potassium, magnesium and zinc than the processed "Niri" seeds. Roasted chaffs recorded significantly lower values in potassium, magnesium and zinc than the rest of the test materials.

Table 2: Mineral composition of whole "Niri" seeds and processed seeds

Parameter	Whole grain	Raw Puree	Raw Chaff	Roasted Puree	Roasted Chaff	S.e.d.	P-value
Calcium (mg)	14.80	8.40	10.20	34.70	7.30	16.82	0.493
Iron (mg)	4.08^{a}	0.66^{d}	2.51^{b}	0.66^{d}	1.17^{c}	0.033	< 0.001
Potassium (mg)	32.96^{a}	23.74^{c}	23.35^{d}	26.54^{b}	14.91^{e}	0.0823	< 0.001
Magnesium (mg)	28.35^{a}	27.50^{c}	26.78^{d}	27.74^{b}	24.97^{e}	0.0671	< 0.001
Zinc (mg)	0.56^{a}	0.40^{b}	0.24^{d}	0.37^{c}	0.18^{e}	0.00816	< 0.001

S. e. d. =standard error of difference, Rows with different superscripts are statistically different (P < 0.05).

There was no significance (P>0.05) in calcium content between whole "Niri" seeds and test materials. This means the methods of processing did not affect calcium content. Contrarily, Penuel *et al* [1], found significance differences (P<0.05) in calcium content between unprocessed and processed "guna". Their results showed that raw undefatted "guna" (33.00mg/100g), was significantly lower (P<0.05) than defatted "guna" (42.00mg/100g) and "guna" protein concentrate (36.50mg/100g). The calcium contents of whole "Niri" seeds in this study were higher than the 28.2mg/100g for "egusi" as reported by Ojieh *et al.* [4]. This work confirms that "Niri" is a good source of calcium which could promote bone formation and neurological performance of consumers especially children, nursing mothers and pregnant women.

The iron content of whole "Niri" seeds was significantly (P<0.001) higher than processed materials. Methods of processing used in this study greatly reduced iron content in test materials. The results are lower than those of Penuel *et al*. [1]. In that study, raw undefatted seeds recorded a value of 136mg/100g, defatted seeds had 180mg/100g and protein concentrate recorded 115.5mg/100g iron. The World Health Organisation recommended dietary iron requirement of 10 and 15mg/day for children and adults, respectively [14]. Consuming "Niri" on 100g bases will meet the dietary iron requirements. This will enhance haem formation and will reduce anaemia in the population.

Potassium is key in a healthy performance of the heart. It is also associated with contraction of smooth muscles [15]. A major source of potassium in human diet is from plants. The potassium content of whole "Niri" seed, raw and roasted purees, raw and roasted chaffs from this study were; 32.963, 23.743, 23.347, 26.543 and 14.913mg/g respectively. Processing significantly (P<0.001) reduced potassium content in test materials. The results are higher than the 4.94mg/100g reported by Jacob *et al.* [8] for *Citrullus lanatus*. An adequate concentration of potassium in a diet enhances the utilization of iron [15]. This suggests proper utilization of iron as there is high concentration of potassium in "Niri". The results of this study showed that potassium is the only mineral with the highest concentration in "Niri". Consuming "Niri" on 100g bases per day will meet the 3,500 mg/day minimum requirement [8] which is needed for healthy heart and muscle performance.

Magnesium content was 28.35, 27.503, 26.78, 27.74 and 24.973mg/g, respectively for whole "Niri" seed, raw and roasted purees, raw and roasted chaffs. These results are higher on 100g bases than the 81.00mg/100g for raw undefatted "guna", 82.00mg/100g for defatted "guna" and 71.00mg/100 g "guna" protein concentrate [1]. The results are also higher than "egusi" which recorded a mean value of 31.4 mg/100g [4]. With these results, consuming "Niri" will therefore meet the magnesium requirement of 80-420mg/day [16]. Magnesium is essential in bones metabolism, control of insulin secretion, blood pressure and the circulatory disease prevention [17, 18].

Ingestion of zinc promotes healthy growth of hair and function of senses like smell and taste [19, 20]. The zinc values as shown in this study were in the range of 0.176 - 0.5567 mg/g, with highest in whole "Niri" seeds. The purees recorded higher values than chaffs indicating that zinc is found more in cell content (flour) than cell wall materials (chaffs). Jacob *et al.* [4] reported zinc value of 21.05mg/100g in *Citrullus lanatus*. Penuel *et al.* [1] also reported 49.50, 62.50 and 35.5mg/100g for raw undefatted "guna", defatted "guna" and "guna" protein concentrate, respectively. These show that whole "Niri" seed also has high zinc content compared to those of the same family on 100g bases. Consuming "Niri" will meet the 15mg/day for adults and 10mg/day for children according to WHO standards [14]. Consumption of "Niri" or its incorporated food/meat products will undoubtedly improve the mineral requirements of consumers especially rural dwellers.

4. Conclusions

The proximate and mineral analysis revealed that "Niri" is good source of protein, lipids and minerals. There was significant difference ($P<0.05$) between whole "Niri" seeds and processed materials in most of the analysis conducted. This implies that the methods of processing used leached much of the nutrients. The values recorded are however, higher than those of cereals thus making processed materials suitable protein sources. This work shows that "Niri" could be used in any of the processed forms in the food industry.

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