

Nutritional Comparison of Processed and Unprocessed *Citrullus lanatus* (Watermelon) Seeds for Possible Use in Feed Formulation

M.A. Milala¹, A. Luther², B. Burah^{1,*}

¹Department of Biochemistry, University of Maiduguri, Borno, Nigeria

²Department of Biochemistry, Bauchi State University, Gadau-Azare, Nigeria

*Corresponding author: bulama19@gmail.com

Abstract *Citrullus lanatus* (watermelon) seeds are often discarded, while its fruits are eaten. In this study, effects of processing either by roasting or drying of the seeds was assayed by analyzing proximate, mineral and vitamin A contents for possible boosting of animal feeds. The proximate analysis and vitamin A determination were performed using standard methods. Mineral elements content was determined by Atomic Absorptions Spectrophotometry (AAS). The results of the proximate composition of processed and unprocessed watermelon seeds had moisture content of 6.29% and 5.06%, ash content 2.59% and 2.98%, crude fat 47% and 32.9%, crude protein 68.04% and 49.7%, crude fibre 1.13% and 2.10% and carbohydrate 24.99% and 6.06% respectively. The elemental composition of both processed and unprocessed seeds showed that magnesium and sulphur contents were higher in unprocessed than processed seeds, while potassium, calcium, phosphorus, iron, copper, zinc and manganese contents of both processed and unprocessed seed were statistically similar. The crude fats, proteins and carbohydrates contents of the processed seeds were significantly higher ($p < 0.001$) compared with the unprocessed seeds. The vitamin A content of both processed and unprocessed seeds were found to be 0.033 $\mu\text{g/g}$ and 0.056 $\mu\text{g/g}$ respectively. However, vitamin A content of the unprocessed seeds was higher when compared with the processed seed. Therefore, the result of this study recommends that both processed and unprocessed *Citrullus lanatus* seeds may serve as suitable candidates in feed formulation.

Keywords: *Citrullus lanatus*, proximate composition, elemental composition, vitamin a and seeds

Cite This Article: M.A. Milala, A. Luther, and B. Burah, "Nutritional Comparison of Processed and Unprocessed *Citrullus lanatus* (Watermelon) Seeds for Possible Use in Feed Formulation." *American Journal of Food and Nutrition*, vol. 6, no. 2 (2018): 33-36. doi: 10.12691/ajfn-6-2-1.

1. Introduction

Watermelon (*Citrullus lanatus*) is a water-high fruit that constitute about 93% as the name implies "water" melon [1]. It is largely cultivated throughout India and in all warm countries, such as some Northern part of Nigeria, indigenous in tropical and South Africa. It is an annual herb (10m and 32.8ft) long stems lying or creeping on the ground, with curly tendrils. The *Citrullus lanatus* fruit has a smooth exterior rind (green, yellow and sometimes white and a juicy, sweet interior flesh). The rind is used in preserves, jellies and conserves and to make pickles [2]. The seeds are contained in the pulp; seeds of different varieties vary in size, thickness, texture of the seeds coat and the thickness of the seeds edges. There are small, moderate and large sized seeds. The seeds differ in colour, they may be black, brown, red, yellow or rarely white [3]. The seeds of brown-seeded melon are sometimes adulterated with the seeds of *C. moschata* by traders and sold as brown-seeded melon [4].

A well prepared and carefully formulated animal feed plays a significant role in livestock farming. The higher

cost and competition imposed on some feed ingredients, such as soybean, groundnut cake, maize and sorghum used by human population as food, have necessitated the use of unconventional materials such as watermelon seeds for animal feed formulation [5]. The chemical composition of watermelon seed, especially its richness in oil and protein quality, encourages its use in broilers to fulfill partially the energy and protein requirements of broiler chickens [6]. It is known that the unsaturated fatty acids especially linoleic, linolenic and arachidonic acids are essential in poultry nutrition. Menge and Richardson, [7] reported that hens fed ration deficient in linoleic acid laid fewer and smaller eggs and their hatchability and fertility were reduced. These findings advocated the benefits of using watermelon seed and its extract in chicken ration, because of its richness in unsaturated fatty acids especially linoleic acid.

Pal and Mahdevan, [8] examined the incorporation of watermelon seed cake in feed of kumoani bullocks. They found that the digestible crude protein content in watermelon seed cake is 20% and proved to be a good source of digestible crude protein and total digestible nutrient were found to be 20.42 and 52.73 kg/100 kg respectively and they concluded that, watermelon seed

cake can form a good cattle feed. In another research Singh *et al.*, [9] reported that watermelon seed cake can safely be fed to cattle up to 20% level. Though watermelon seed cake was not highly palatable, animal can be induced to eat the same with barely, also addition of common salt was found to increase the palatability of watermelon seed cake. It is on this background that this study is designed to evaluate the nutritive values of both processed and unprocessed watermelon seeds.

2. Materials and Methods

Citrullus lanatus (watermelon) seeds were procured from an open market in Gadau-Azare, Bauchi State, Nigeria. The seeds were washed and oven dried (at $50\pm 2^\circ\text{C}$) for 24 hours. The immature seeds and extraneous materials were removed; the remaining seeds were stored in plastic containers at room temperature. All chemicals used were of analytical grade.

2.1. Preparation of Seeds Flour

The watermelon seed was divided into two parts, one part was processed manually by roasting for 10 minutes while the other was dried. The processed and unprocessed seeds were milled into flour in an electronic blender. These were kept in air-tight plastic containers.

2.1.1. Determination of Proximate Composition

The proximate composition of the samples (processed and unprocessed watermelon seeds) was determined using the standard methods of AOAC [10]. The parameters were: crude fats, ash and crude fibre. The micro-Kjeldahl method was employed to determine the total nitrogen and the crude protein ($\text{N} \times 5.95$) AOAC [11]. Moisture content was determined by the method based on the principle of drying to constant weight. Total carbohydrate was calculated by the difference method (summing the values of moisture, crude protein, ash, and crude fat and subtracting the sum from 100).

2.1.2. Mineral Analysis

Potassium, calcium, magnesium, manganese, Sulphur, phosphorus, copper, zinc, and iron in the samples of both processed and unprocessed watermelon seeds were determined by the method described by AOAC [10] as reported by Otutu *et al.*, [12].

2.1.3. Determination of Vitamin A

Vitamin A content in the processed and unprocessed samples was determined using the methods of association of vitamin chemists (AOVC) [13].

2.1.4. Analysis of Data

The results of the proximate analysis, mineral analysis and vitamin A determination were analyzed for statistical significance by one way ANOVA [14] and student 't' test where applicable values at ($p < 0.001$) were regarded as significant in comparison with appropriate control. All data were expressed as means of \pm SEM.

Table 1. Proximate analysis of processed and unprocessed *Citrullus lanatus* (watermelon) seeds

Parameters (%)	Processed seed	Unprocessed seed
Moisture Content	6.29 \pm 0.12 ^a	5.06 \pm 0.12 ^a
Ash Content	2.59 \pm 0.19 ^a	2.98 \pm 0.18 ^a
Crude Fat	47.01 \pm 0.09 ^a	32.90 \pm 0.18 ^b
Crude Protein	68.03 \pm 0.37 ^a	49.70 \pm 0.61 ^b
Crude Fibre	1.13 \pm 0.62 ^a	2.10 \pm 0.21 ^a
Crude Carbohydrate	24.99 \pm 0.15 ^a	6.06 \pm 0.12 ^b

The values are Mean \pm SEM of three determinations. Note that: the values with different superscripts are significantly different ($P < 0.001$) confidence level, while the values with the same superscripts are the same.

Table 2. Elemental compositions of processed and unprocessed *Citrullus Lanatus* (watermelon) Seeds

Elements ($\mu\text{g/g}$)	Processed seed	Unprocessed seed
Potassium	1.81 \pm 0.02	1.92 \pm 0.04
Calcium	0.79 \pm 0.08	0.83 \pm 0.16
Phosphorus	36.83 \pm 0.21	37.90 \pm 0.15
Iron	0.61 \pm 0.02	0.51 \pm 0.01
Magnesium	1.21 \pm 0.02	2.66 \pm 0.02*
Sulphur	37.80 \pm 0.30	42.00 \pm 0.65*
Zinc	0.019 \pm 0.02	0.012 \pm 0.00
Manganese	0.006 \pm 0.21	0.008 \pm 0.00
Copper	0.011 \pm 0.01	0.013 \pm 0.00

The values are mean \pm SEM of three determinations ($P < 0.001$) Confidence level.

Note that: the values with superscripts are significantly different, while the values without the superscripts are significantly the same.

Table 3. Vitamin A composition of processed and unprocessed *Citrullus lanatus* (watermelon) seeds

Samples ($\mu\text{g/g}$)	Values
Processed seed	0.033 \pm 0.01*
Unprocessed seed	0.056 \pm 0.01**

The values are mean \pm SEM of three determinations ($P < 0.001$) confidence level. Note that: the values with double superscripts are significantly different from the one with single superscripts.

3. Results and Discussion

The proximate composition of processed and unprocessed *Citrullus lanatus* seeds is shown in Table 1. The level of moisture contents in both processed and unprocessed watermelon seeds were 6.29% and 5.06% respectively indicating no significant difference. This result also corresponds with other previous work reported by Otutu *et al.*, [12] and Rekha and Rose [15] with a moisture content of 6.40% and 6.41% but a significant difference in the report of Fila *et al.*, [16] having a moisture content of 48.75%. The difference may be due to the method used and the species of the watermelon. The moisture content of any food material is measure of the life span of food. It indicates how long a food material can be stored without becoming mouldy [17].

The ash content showed 2.59% and 2.98% respectively for processed and unprocessed watermelon seeds. There is no significant difference ($p < 0.001$), this result is in agreement with the publication of Rekha and Rose [15] which shows that the percentage ash content of watermelon seed to be 2.60% but varies with the report of

Mathew *et al.*, [18] whose percentage composition is 6.00%. The percentage composition of crude fat for processed and unprocessed watermelon seeds were of 47.01% and 32.90% respectively, showed significance difference between the processed and the unprocessed seeds; which may be due to the hydrolytic effect of heat on the fat deposit in the seeds. Fat consist of wide group of compounds that are generally soluble in an organic solvent and generally insoluble in water. Mabalaha *et al.*, [19] also reported oil yields of seeds ranging from 24.8 - 30.0% in *Citrullus lanatus* and *C. colocynthis* species respectively.

Crude protein contents in this study of 68.04% and 49.70% for processed and unprocessed seeds respectively, indicated a significant difference, having higher composition in the processed seeds. This result is also similar with that of Rekha and Rose, [15] which reported a percentage composition of 68.4% for processed seeds. Proteins are class of nitrogenous compound that consist of large molecules composed of one or more long chain of amino acids, around one third of watermelon seeds is proteins, mainly essential amino acids like lysine [15]. The crude fibre content was 1.13% for processed and 2.10% for unprocessed seeds, this result shows no significant difference and is similar to the result of Fila *et al.*, [16] who reported crude fibre content of 1.57%. Crude fibre of any seed indicates the presence of reasonable quantity of trapped water (bond) held by the hydrophilic polysaccharides of the fibre [20]. The carbohydrates contents of processed and unprocessed seeds were 24.99% and 6.06% respectively, which indicates high significance difference between the processed and unprocessed seeds. The processed sample recorded higher carbohydrates content, which support an earlier report by Agiang *et al.*, [21] that suggested that processing causes the granules to breakdown, softens the cellulose, and makes the starch more available.

The mineral compositions of processed and unprocessed seeds are presented in Table 2. Potassium concentrations were 1.81 µg/g and 1.92 µg/g which are statistically the same. Betty *et al.*, [22] reported a value of 5.7 µg/g for potassium in melon seed. The percentage composition of calcium in both processed and unprocessed seeds was 0.79 µg/g and 0.83 µg/g respectively. The report of Raji and Orelaja, [23] indicated that the calcium content of watermelon seeds is 0.02%. The level of phosphorus for the processed and unprocessed samples was 36.83 µg/g and 37.90 µg/g respectively, with no significant difference. Phosphorus is one of the most copious minerals in the body and it is essential for healthy development of bones and teeth. Phosphorous is estrogenic, immune stimulant and anti-osteoporotic [24]. The concentration of iron was 0.61 µg/g and 0.51 µg/g respectively for processed and unprocessed seeds, iron plays an important role in oxygen transport and storage [25].

The concentrations of magnesium in both treatments were found to be 1.21 µg/g and 2.67 µg/g respectively. The two values are significantly different. The value of the magnesium in processed seeds was lower than those previously reported by Acar *et al.*, [26]. Magnesium deficiency interferes with the transmission of nerve and muscle impulses, causing irritability and nervousness [24]. The concentration of copper in both processed and unprocessed seeds was 0.011 µg/g and 0.013 µg/g which is in variation with the report of Betty *et al.*, [22] who

reported values of 0.38 mg/100g of melon seeds. The concentration of sulphur was found to be 37.80 µg/g and 42.00 µg/g respectively for processed and unprocessed seeds. There is a statistical difference in the mean concentration for the processed and unprocessed seeds. A decrease in the concentrations of sulphur postulates the potentiality of heat to decrease its concentration in the processed watermelon seeds. Plenty of sulphur in the food products and excess of it gained by the body is excreted [27]. The concentrations of zinc in processed and unprocessed seeds were 0.019 µg/g and 0.012 µg/g respectively. Zinc may be regarded as a source for storage and secretion of insulin from the β-cell of pancreas; it is also required for wound healing [28]. The concentrations of manganese were 0.006 µg/g and 0.008 µg/g respectively for processed and unprocessed seeds. There is no significant difference among the two samples. These values are in comparison with the findings of Bor and Woodroof, [29].

The vitamin A content of the processed and unprocessed watermelon seeds as shown in Table 3 are statistically different with the processed seed having a concentration of 0.033 µg/g and the unprocessed seed has a concentration of 0.056 µg/g. A decreased in Vitamin A content of the processed watermelon seeds may be attributed to the destruction effect of heat on vitamins. Similarly, Anthony, [30] also reported that vitamin A content of watermelon rind and seed were 50.15 and 70.10 mg/100g respectively.

4. Conclusion

Results obtained from this study have shown that the crude protein levels in both processed and unprocessed watermelon seeds are high enough for its inclusion in feed formulation as source of protein. Furthermore, the carbohydrates and fats contents of the processed seeds are higher than the unprocessed seeds making it a considerable source of energy in animal feeds.

The mineral elements in watermelon seeds may serve as a good source of minerals in both the processed and unprocessed seeds. The vitamin A content also proves that watermelon seed is highly nutritive as this vitamin plays a vital role in maintenance of immune system, egg production and improves lactation in cows. It is noted that the unprocessed seeds has a high considerable amount of vitamin A as compared to the processed seeds. This may suggest the use of the unprocessed seeds in feed formulation for a better vitamin A supplement.

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