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NUTRITIONAL VALUE OF BOTTLE GOURD (*LAGENARIA SICERARIA*) SEEDS

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ABSTRACT

Whole seeds, dehulled seeds and seed coats of bottle gourd seed (*Lagenaria siceraria*) were analysed for their proximate, amino acids and mineral compositions. The results of the analysis showed that, whole seed has highest content of moisture (17.5 ± 0.21%) and ash (5.80 ± 0.83%) while dehulled had highest amount of crude protein (35.0 ± 0.48%) and crude lipid (39.22 ± 1.48%) and seed coat contain highest amount of crude fiber (59.05 ± 0.98%). The study showed a profile of seventeen amino acids (isoleucine, leucine, lysine, methionine, cysteine, phenylalanine, tyrosine, threonine, valine, alanine, arginine, aspartic acid, glutamic acid, glycine, histidine, proline and serine) with glutamic acid, leucine and aspartic acid being the predominant amino acid. The percentages (%) of essential and non-essential amino acids in dehulled seeds, whole seeds and seed coats were 44 vs 56, 41 vs 59 and 51 vs 49 respectively. The dehulled seeds contained essential amino acids that were found to be higher than WHO/FAO/UNU requirement. In whole seeds, threonine, lysine and lysine were found to be the most limiting amino acids. Seed coats were deficient in all the essential amino acids except for valine. Generally, the mineral composition of the seed was found to be relatively high, indicating the seed to be a good source of dietary elements, except for Ca, Zn, Co and Cr where very low values were obtained. Finally, the results of the study indicate that, bottle gourd seed is a potential source of protein, lipid, micro and macronutrients, and if properly utilised, could contribute in solving the problem of malnutrition and also serve as raw material for agro-based industries.

KEYWORDS: Bottle gourd seeds, seed coat, proximate analysis, minerals and Amino acid composition.

INTRODUCTION

The insufficient availability of animal protein sources and high cost of the few available plant protein sources has prompted an intense research into harnessing the nutrient potentials of lesser known under utilized legumes and oil crops (Enujigha and Akanbi, 2005). Cucurbits (family *Cucurbitaceae*) seeds are sources of food particularly protein and oil. Their nutritional compositions have been reviewed where dehulled cucurbit seeds were reported to contain about 50% oil and up to 35 % protein (Madaan and Lal, 1984; Martin, 1984).

Bottle gourd (*Lagenaria siceraria*) plant is an under-utilized legume cosmopolitan in most of tropical and sub-tropical countries. The plant is believed to be a native of Africa and is commonly known as *Luddai* (Hausa). Its stem is prostrate, angular, ribbed, thick, brittle, hairy, up to 9m long and produces no sap when cut. Leaves are simple, soft and hairy, up to 40cm long and 40cm broad.

The fruit is normally indehiscent, large, variable up to 80 by 20cm, sub globose to cylindrical, flask shaped with a constriction above the middle, green maturing yellow or pale brown, pulp drying out completely on ripening leaving a thick hard hollow shell with almost nothing inside except seeds. The seed are embedded in a spongy pulp, which are about 7 – 20mm long, compressed with two facial riges in some variants rather irregular and rugrose (Osagie and Eka, 1998; Kochler, 1981). The plant can be grown from seeds on sandy or loamy soil. It can be treated as a prostrate ground cover or as climber; in which case, the maturing fruits might need some support.

In Nigeria, the plant is commonly grown in Sudan savanna, particularly in Zamfara State, where it is planted as cash crop. Its fruits are used as container and musical instruments while the seeds are used as soup thickener similar to “egusi” and also as a source of edible oil (Maigandi and Ngang, 2002).

The aim of this study is to evaluate the proximate composition, amino acids profile and mineral content of the whole seed, dehulled seed and seed coat of *Lagenaria siceraria* so as to provide information on its nutritional values.

MATERIALS AND METHODS

Sampling and Sample Treatment

Ripe fruits of *Lagenaria siceraria* were randomly sampled from ten (10) different farmlands located in Zauma village, Bukkuyum Local Government Area, Zamfara State. After identification as *Lagenaria siceraria* by a Taxonomist in Botany Unit, Usmanu Danfodiyo University, Sokoto, and the fruits were broken manually and seeds were separated from the spongy part of the fruits, thoroughly mixed, from which a representative sample was taken. The seeds were sun dried for four days and divided into two portions, to which, one part was dehulled. Both whole, dehulled seeds and the seed coat were ground separately into a fine powder, sieved through 20-mesh sieve. Stored in corked plastic bottles and kept in a refrigerator at temperature of -1^0C for four days, prior to the time for analysis.

Analytical Procedure

Proximate Analysis

The recommended methods of the Association of Official Analytical Chemists (AOAC, 1990) were used for the determination of moisture, ash, crude lipid, crude fibre and crude protein content.

Estimation of Total carbohydrate

Total carbohydrate was calculated by difference by subtracting total sum of crude protein, crude lipid, crude fibre and ash from 100% dry weight sample.

Estimation of Energy Value

The energy value was calculated by multiplying the mean values of crude protein, crude fat and total carbohydrate by the factors of 4, 9, 4 respectively, taking the sum of the products

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and expressing the result in kcal /100g sample as reported (Onyeike et al.; 1995; Onyeike and oguike, 2003).

Amino acids

Amino acid determination was carried out using ion-exchange chromatography with Technicon Sequential Multisample Amino Acid Analyser, TSM (Technicon Instruments Corporation, Dublin, Ireland) at Postgraduate Laboratory, Zoology Unit, University of Jos, Nigeria as outlined in Adeyeye and Afolabi (2004). 2g sample was defatted with petroleum ether using Soxhlet extraction methods. The defatted sample was re-dried and milled into fine powder using porcelain pestle and mortar. 30mg sample in duplicate were weighed into a glass ampoules to which $5cm^3$ of 6M HCl and 5μmoles norleucine were added. The ampoules were evacuated by passing nitrogen gas, sealed with Bunsen burner flame and hydrolysed in an oven at 110^oC for 24 hours. The ampoules were cooled, broken at the tip and the contents filtered. The filtrates were evaporated to dryness at 40^oC under vacuum in a rotary evaporator. The residues were dissolved to 5μL (for acid and neutral amino acids) or10 μL (for basic amino acids) with acetate buffer, pH 2.2 and the solutions were dispensed into the cartridge of TMS. The chromatograms obtained from automatic pen recorder correspond to the quantity of each amino acid present. Quantification was performed by comparing the peak area of each amino acid in the sample to the area of the corresponding amino acid standard of the protein hydrolysate.

Mineral Analysis

Mineral analyses were done after triple acid digestion according to the method described by Hassan and Umar (2004) using atomic absorption spectrophotometer (Alpha 4 Model). Phosphorus content was determined spectrophotometrically using phospho-vanadomolybdate method with spectrophotometer (6100 Model, Jenway, UK) at the wave length of 660nm, while flame photometer (Corning 400, UK) was used for sodium and potassium analysis. All determinations were carried out in triplicate and reported as mean mineral content (mg/100gDM).

Statistical analysis.

The data generated were statistically analysed using the general linear model of SPSS (1999). V.10 was used for the analysis of variance (ANOVA) using completely randomnised designed (CRD), where significant differences between the mean are indicated. Duncan multiple Range Test was used to separate the means (Duncan, 1955).

RESULTS AND DISCUSSION

Proximate analysis

The results of proximate analysis of *Lageneria siceraria* seeds are shown in Table1.

The moisture content of the whole seeds, dehulled seeds and seed coats were 17.5 ± 0.21%, 10 ± 0.15% and 6.50 ± 0.10% respectively. All the samples showed significant variation ($p < 0.05$). The relatively low moisture content of the sample is of advantage since high moisture content is associated with increase in bacterial action during storage (Akintayo, 2004). The value for dehulled seeds is comparable to the values 8 – 9 % reported in the dehulled seed of *Citrullus vulgaris*, *Citrullus lanatus* and *Cucumeropsis manni* (Badifu, 2001).

The ash content of whole seeds (5.8±0.83) and that of dehulled seeds (4.70±0.84) show no significant variation ($p > 0.05$) between each other, however, the seed coat (1.67±0.42) have significantly low value ($p < 0.05$) compared to whole seed and dehulled. Since ash content represents the index of mineral elements present in the sample, this indicates that, the whole seed may have highest mineral content while seed coat the least value. The ash content in whole and dehulled seeds is generally higher than 3.7% reported as the ash content of calabash seed (Osagie and Eka, 1998).

As shown in Table 1, crude protein varied significantly ($P < 0.05$) between the samples. The order of concentration is dehulled seed (35.0 ± 0.84 %DM) > whole seed (19.25 ±1.01 %DM) > seed coat (16.84 ± 0.99 %DM). Copeland (1976) reported that protein formed principal component of embryo, thus this could be the reason for the high amount of it in the dehulled seed. The value obtained in dehulled seed is higher than that of soybeans (29.90%), oil beans (22.32%) (Enujiugha and Akambi, 2005) and ground nut (30.4%) which are among the commonest protein sources for Nigerians (Kadiri, 1988). The plant seed can therefore be a potential food supplements.

The crude lipid content of the samples is in the order: dehulled seed > whole seed > seed coat. All the samples showed significant variations ($p < 0.05$) among them. The values are however lower than 41 – 46.8% reported in the same *Lageneria* species (Madaan and Lal, 1984; Osagie and Eka, 1998). From the result, it can be seen that *Lagenaria siceraria* seeds are good source oil for domestic and industrial purposes.

The results of the crude fibre analysis of the samples were found to vary significantly ($p < 0.05$) with seed coat having the highest value (59.05 ± 0.98%) followed by whole seed (31.2 ± 0.76%) while the dehulled seed fibre (3.23 ± 0.25%) was the least. The crude fibre content of the dehulled seed is comparable with that of calabash seed (3.50%) but higher than 2.50% for water melon (Badiffu and Ogunsua, 1991). Dietary fibre promotes the wave-like contraction that move food through the intestine, high fibre in food expand the inside wall of the colon, easing the passage of waste, thus making it an effective anti-constipation agent. Fibre also lowers cholesterol level in the blood, reduces the risk of various cancers, bowel diseases and improves general health and well being (Anhawange *et al*, 2004).

The carbohydrate content in the samples follows the trend: seed coat > dehulled seed > whole seeds. The observed difference between the dehulled seed and seed coat indicates that, the distribution of carbohydrate in the seed tend to concentrate much in the seed coat than the dehulled seed. The values for the dehulled seed and seed coat are however comparable to Africa oil bean seed (19.2%) (Osagie *et al*., 1986), African walnut (19.8%) (Odunsua and Adebona, 1983) and higher than that of water melon (10.96%) (Oyolu, 1977) and pumpkin seed (7.6%) (Farinu, 1986).

Generally, the samples have high energy value in the order: dehulled seed > whole seed > seed coat. The observed trend could be attributed to high amount of crude lipid and crude protein in the dehulled seed than seed coat.

Amino acid contents

The amino acid contents of the dehulled seed, whole seed and seed coat of bottle gourd seed are shown in Table 2. The total amino acid contents (84.40g/100g protein) are significantly ($p<0.05$) higher than that of whole seed (74.43g/100g protein) followed by seed coat (44 g/100g protein). Since amino acids are the building block of protein, this indicates that amino acid distributions in the seed tend to be higher in the dehulled seed than seed coat. The finding is in accordance with (Copeland 1976)

Amino acids are classified as essential and non-essential based on the ability of the human body to synthesize adequate amount in the body. An amino acid is essential if it is not synthesized by the body in sufficient quantity. Considering the individual amino acids of each sample, a non-essential amino acid glutamic acid (Tewari, *et al*, 1998), was the most abundant amino acid in all the samples. Dehulled seed gave significantly the highest ($p<0.05$) value (14.30g/100g protein), followed by whole seed (11.21g/100g protein) and least was in seed coat (5.22g/100g protein). Comparing the amino acids

content of the edible portion (dehulled) of the seed with melon seeds as shown in Figure 1, indicates that *Lagenaria siceraria* contained higher amount of essential amino acids leucine, lysine, cysteine and threonine, while isoleucine, methionine and phenylalanine are low. Tyrosine and valine are comparable to each other. For the non-essential amino acids, those of *Lagenaria siceraria* are low.

The nutritional quality of food material is usually accessed by comparing its individual amino acids with reference standard set by World Health Organization (FAO/WHO/UNU, 1991) as shown in Figure 1. From the result, it can be seen that all the essential amino acid in dehulled seeds are above the reference values while whole seeds are threonine, valine and lysine deficient. The seed coats are however poor sources of protein with valine as the only amino acid above the reference standard as shown in Figure1.

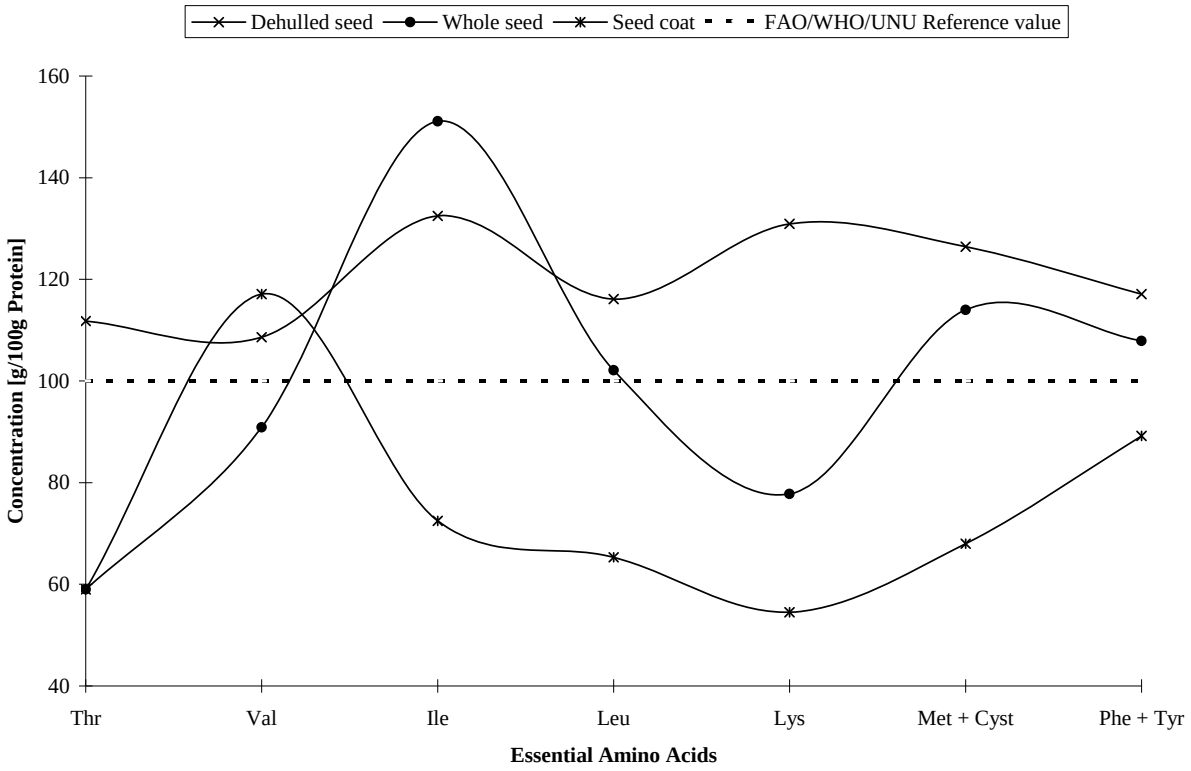

Figure 1: Comparison of essential amino acid content of Bottle gourd seed with FAO/WHO/UNU (1991) Reference value.

Minerals Analyses

The results of mineral contents present0 in *Lagenaria siceraria* seeds are shown in Table 3.

Potassium is the most abundant element in the samples in the order: whole seeds > dehulled seeds > seed coat. All the samples show significant variation ($p < 0.05$) in their potassium content with highest amount found in whole seeds. High amount of potassium is noted as a characteristic feature of most plant foods (Hassan and Umar, 2004). Sodium is an element associated with potassium responsible for the maintenance of body fluids (Omole, 2003). The concentration of this element also varies significantly ($p < 0.05$) within the samples with whole seed having the highest amount. High amount of potassium with respect to sodium is considered advantageous particularly to the hypertensive people (Olaofe *et al*., 2004). Furthermore, the recommended dietary allowance for these elements is 200 mg and 500 mg respectively (Thangadurai *et al.*, 2001); which is an indication that *Lagenaria siceraria* seeds could be regarded as a good source of these elements to the body.

Calcium and phosphorous are associated with each other for growth and maintenance of bones, teeth and muscles (Guthrie, 1989; Dosunmu, 1997; Turan *et al.,* 2003). The concentration of calcium in the sample is generally low and shows no significant difference ($p > 0.05$) among the samples analysed. On the other hand, phosphorous content was high but show no significant difference ($p > 0.05$). Generally, phosphorous content of bottle gourd seed was higher than the values reported for some conventional seeds and nuts (12.2 – 378 mg/100g) (Almustafa *et al*., 1995; Yusuf; 2003; Enujiugha and Akanbi, 2005). The recommended dietary allowance of calcium and phosphorous for adult is 800 mg per day (Thangadurai *et al.*, 2001). This shows that the seeds are good sources of phosphorous but not calcium.

The magnesium content shows a significant difference ($p < 0.05$) between the analysed samples with whole seed having the highest value followed by dehulled seed then seed coat. The values for whole and dehulled seed are however, higher than that of groundnut (228 ± 2.9mg/100g), shea nut (222 ± 3.1mg/100g) and cotton seed (228 ± 4.9mg/100g) (Almustafa, *et al,* 1995), while that of dehulled seed is comparable to (397.9mg/100g) in calabash seed (Dunu *et al.,* 1986). Considering the adult required daily allowance (RDA) of 350mg/day for Mg (Thangadurai *et al.*, 2001), bottle gourd seed can therefore, be a source of magnesium assuming a total absorption by the body and ignoring the effect of antinutritional factors.

Iron is the most abundant microelement in the plant seed. The iron content of whole seed (57.40 mg/100g) shows no significant difference ($p > 0.05$) when compared to dehulled seed (57.45mg/100g); however, seed coat has significant lower ($p < 0.05$) iron content. The values were found to be higher than oil bean seeds (5.628mg/100g) (Badifu and Ogunsua, 1991). This is an indication that the seeds could serve as a source of iron for both man and domestic animals.

Copper is an essential trace element in human body where it exists as an integral part of copper proteins ceruloplasmin, which is concerned with the release of iron from the cells into

the plasma; erythrocuprein, which occur in erythrocytes where it plays a role in oxygen metabolism and cytochrome, (an electron carrier) involved in energy metabolism (McDonald *et al.,* 1995; Adeyeye, 2002). Among the samples analysed, dehulled seeds have significantly ($p < 0.05$) the highest value (40.90 ± 1.02 mg/100g) compared to whole seeds (14.10 ± 0.25 mg/100g) and seed coat (12.95 ± 1.23 mg/100g), which show no significant variation ($p> 0.05$) between each other. However, these values seem to be high compared to reported values in calabash seeds (Dunu, *et al.,* 1986) and pride of barbados (Olaofe *et al*., 2004). They observed high concentration of copper in the seed could be as a result of bioaccumulation of the metal from the surrounding.

For manganese, the result indicates that, whole seed had the highest concentration (26.30mg/100g) when compared to whole seeds (25.95 ± 0.92 mg/100g) and seed coat (16.20 ± 0.73 mg/100g).The concentrations of manganese in the whole seed and dehulled seed are observed to be higher than the reported value of 12mg/100g for dehulled calabash seed (Badifu and Ogunsua, 1991). Manganese plays a structural role in the chloroplast membrane system and may be responsible for colour, test and smell and a cofactor for fatty acids, DNA and RNA synthesis (Ayaz, *et al.,* 2006). When compared with the recommended dietary allowance for an adult (i.e. 19-26mg/day) (NRC 1988), the samples can be regarded as good sources of manganese.

The dietary zinc is related to the needs for growth, tissue repair, normal function of immune system and obligatory excretion. Its deficiency leads to growth failure, sexual infantilism in teenage individuals and impaired wound healing (WHO. 1973). Zinc content of the whole seed, dehulled seed and seed coat are 0.15, 0.30 and 0.18 mg/100g respectively; which shows no significant difference ($p > 0.05$) between whole seed and dehulled seed. The values are generally low, when compared with the recommended daily allowance for an adult (15 mg/100g). This shows that, bottle gourd seeds are not good sources of zinc.

Among the samples analysed, chromium was detected only in dehulled seed (0.05mg/100g). Similarly both samples were found to contain low cobalt content ranging from 0.15 ± 0.00 65 mg/100g (in seed coat) to 0.65 ± 0.09 mg/100g (in dehulled seed). Even though, cobalt formed 4% by weight of vitamin B_{12}, it is presence in the food is not really useful, as vitamins B_{12} cannot be synthesized using the available cobalt by the body (Donsumu, 1979).

CONCLUSION

From the results it can be concluded that *Lagenaria siceraria* seeds are sources of high quality plant protein as evident from its essential amino acids content. The seeds could also be a good source of oil for commercial purposes. The seeds are also noted for its good source of dietary essential mineral elements such as K, Na. Mg, P, Fe, Cu and Mn. However further research is on the way to determine the level of anti-nutritional factors and nutrient bioavailability of the seeds so as to justify their usage either as animal feed or for human consumption.

Table 1: Proximate compositions of *Lagenaria Siceraria* seeds (%)*

Parameters	Whole seed	Seed coat	Dehulled seed
Moisture	17.5 ± 0.21[a]	6.50 ± 0.10[c]	10 ± 0.15[b]
Ash content	5.80 ± 0.83[a]	1.67 ± 0.42[b]	4.70 ± 0.83[a]
Crude protein	19.25 ± 1.01[b]	16.84 ± 0.99[b]	35.0±0.84[a]
Crude lipid	33.83 ± 1.26[b]	0.53 ± 0.05[c]	39.22±1.48[a]
Crude fibre	31.2 ± 0.76[b]	59.05 ± 0.98[a]	3.23 ±0.25[c]
Carbohydrate	9.92 ± 0.70	21.91 ± 1.10	17.85±0.8
Energy value (kcal/100g)	416.39	159.77	564.38

*All values are the mean of triplicate determination expressed on dry weight basis±standard deviation
abc means on the same row having different superscript are significantly different ($p< 0.05$)

Table 2**:** Protein and Amino acid Profile of *Lagenaria siceraria* seed (g/100g protein).

Amino acids	**Dehulled seeds**	**Whole seeds**	**Seed coats**
Essential Amino acids			
Iso leucine (Ile)	3.71[b]	4.23[a]	2.03[c]
Leucine (Leu)	7.66[a]	6.74[b]	4.31[c]
Lysine (Lys)	7.59[a]	4.51[b]	3.16[c]
Cysteine (Cys)	1.60[a]	1.56[a]	0.66[b]
Methionine (Met)	1.56[a]	1.29[b]	0.51[c]
Phenylalanine (Phe)	4.22[b]	4.50[a]	3.41[c]
Tyrosine (Tyr)	3.16[a]	2.30[b]	2.21[b]
Valine (Val)	3.80[b]	3.18[c]	4.10[a]
Threonine (Thr)	3.80[a]	2.01[b]	2.01[b]
Non Essential Amino acids			
Histidine (His)	2.09[a]	2.21[a]	1.79[b]

Arginine (Arg)	6.16^{b}	7.05^{a}	4.25^{c}
Aspartic acid (Asp)	9.11^{a}	8.85^{a}	4.01^{b}
Glutamic acid (Glu)	14.3^{a}	11.21^{b}	5.22^{c}
Glycine (Gly)	4.62^{b}	5.21^{a}	2.35^{c}
Proline (Pro)	4.00^{b}	2.80^{b}	0.79^{c}
Serine (Ser)	3.00^{b}	3.61^{a}	1.05^{c}
Total	**84.40^{a}**	**74.43^{b}**	**43.93^{c}**
Essential Amino acids %	**44**	**41**	**51**
Non Essential Amino acids **%**	**56**	**59**	**49**

Means on the same row having different superscript letters are significantly different ($p < 0.05$)

Table 3: Mineral composition of *Lagenaria siceraria* seed (mg/100g)

Element	Whole seed	Dehulled seed.	Seed coat
Potassium	3001 ± 1.58^{a}	2425 ± 4.83^{b}	2274 ±2.21^{c}
Sodium	1400 ± 2.34^{a}	1125 ± 0.92^{b}	1000 ± 1.12^{c}
Calcium	3.10 ± 0.36^{a}	3.70 ± 0.45^{a}	3.60 ± 0.36^{a}
Phosphorus	1250 ± 5.28^{a}	1313 ± 1.57^{a}	1213 ± 5.70^{a}
Magnesium	568 ± 1.51^{a}	376 ± 4.00^{b}	146 ± 4.83^{c}
Iron	57.4 ± 2.34^{a}	57.5 ± 1.38^{a}	20.5 ± 0.40^{b}
Zinc	0.15 ± 0.01^{a}	0.30 ± 0.03^{b}	0.18 ± 0.08^{a}
Copper	14.1 ± 0.25^{a}	40.9 ± 1.02^{b}	13.0 ± 1.23^{a}
Manganese	26.3 ± 0.30^{a}	26 ± 0.92^{a}	16.2 ± 0.73^{b}
Chromium	ND	0.50 ± 0.05	ND
Cobalt	0.20 ± 0.02^{a}	0.65 ± 0.09^{b}	0.15 ± 0.00^{c}

All values are the mean of triplicate determination expressed on dry weight basis±standard deviation
abc means on the same row having different superscript are significantly different ($p < 0.05$)
ND = Not detected

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