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Annals of Food Processing and Preservation

Review Article

Effect of Processing on the Yield and Chemical Constituents of Protein Meals and Concentrate Produced from (Balanites *aeqyptiaca del*) Desert Date Seed Nut

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Submitted: 03 February 2023

Accepted: 21 February 2023

Published: 22 February 2023

ISSN: 2573-1033

OPEN ACCESS

Keywords

- Processing
- Yield
- Meals
- Concentrate
- Desert Date
- Nuts

Abstract

The processing, and chemical constituents of desert date protein meals and concentrate as bioactive recipe in foods are imperative. The direct use of seed nut as recipe especially for bakery and confectionary cottage industries are on the rise. The objective of this study was to evaluate the effect of processing and chemical contents of Aduwa seed nut as bioactive and safe active protein. Proteins and peptides are of great nutritional value and are directly involved in chemical processes essential for life such as in growth and maintenance of the body; proteins are good biochemical messengers and they could also help in cell structure integrity, maintain proper pH, and boost immune system. Aduwa concentrate yield decreased to 31.54% when resolved from Aduwa defatted nut meal 85.14%. Similarly, proximate contents decreased as samples were resolved from meal to concentrate except for protein content. The proximate content in deffated, concentrate is better than the meal. The amino acid profile revealed high HAA (41%) and EAA (38%) with APC sample that revealed high values above FOA/adult reference. Also, high trend values were observed in the mineral profile as samples were processed from meal to concentrate Ca (219-319 mg/ml), Na (825-1110 mg/ml), Cu (2-2 mg/ml), and Zn (6-9 mg/ml). The study revealed that toasting provides better yield and better nutrient profiles of the nut from desert seed nuts. The results obtained showed that Aduwa could yield more biomaterials and had more extractable protein and better mineral profile when processed using toasted approach.

Practical application: The use of extractable biomaterial from desert date seed is an important ingredient in food cottage industries. Heat annealing, defatting, and isolation into concentrate enhancing its protein folds and unfold properties are very important for food applications. The proximate and mineral content observed in the samples are good positive chemical indicators. Protein annealing and isoelectric precipitation of desert date seed could have positive effects when used as admix recipes. Hence, this study presents recipe to alleviate malnutrition.

ABBREVIATIONS

APM: Aduwa Protein Meal; DPM: Defatted Aduwa Protein Meal; APC: Aduwa Protein Concentrate; WHO: World Health Organization; FAO: Food and Agricultural Organization; AAA: Aromatic Amino Acid; BCC: Branched Chain Amino Acids; HAA: Hydrophobic Amino Acids; PCAA: Positively Charged Amino Acids; NCAA: Negatively Charged Amino Acids; SCAA: Sulphur Containing Amino Acids; EAA: Essential Amino Acids

INTRODUCTION

Seed nut processing is gaining recognition as potent source of bioactive nutrients around the world. The use of annual seasoned legumes and cereal crops which does depend on agronomic practices is seldom scarce, threatening their availability to upsurge the demand for plant protein sources. Nut proteins from cashew, fluted pumpkin, and host of other edible nuts are becoming relevant. The work on the use of cashew nut seed to reduce diabetes and hypertension because of their high antioxidant properties has been opined [1]. Seed nut proteins are rich in protein, mineral vitamins, polyphenols, and other phytochemicals which are super healthy. In addition to nut richness in several vitamins and minerals, unsaturated fatty acids, and fiber, tree nuts and peanuts contain numerous phytochemicals that may contribute to promoting health and reducing the risk of chronic disease [2]. While many of these bioactive constituents from Aduwa seed meal remain to be fully identified and characterized, it would be worthwhile to look at the potentials between the essential nutrients such as the proximate values, amino acid, and minerals profiles inherent and commonly present in desert date tree nuts. A lot of articles have been published describing the bio health benefits and related aspects of tree nuts [1]. However, desert date seed nut *Balanites aegptiaca* or *Aduwa* in Hausa language is a popular local medicinal tree for a lot of ailments because of their rich phytochemicals from its tree portions [3]. *B. aegyptiaca* seed when processed into powder and meal contain relatively high amount of protein and lipid, sugar, carbohydrate, and minerals such as potassium, calcium in significant amount [4]. This work focused on processing, percentage yield mineral and amino acid profile as well as proximate constituent of (*B. aegyptiaca*) Aduwa meal, Aduwa defatted meal and concentrate to project protein meals from Aduwa and the possible impact when used as an add mix or inclusion recipe in food processing.

MATERIALS AND METHODS

Source of Raw Materials

One kilogram (1 kg) of mature *B. aegyptiaca* fruits (Aduwa) used for this study was bought from Yobe State of Nigeria. They were conveyed immediately to the laboratory of the Federal University Gashua. The 0.5 kg of seed kernels was weighted using a weigh balance and moisture value reduced to 15% by solar cabinet drying using moisture prop (E20 USA Model 121). The final weighted samples were apportioned to toasting treatments under dry heat at 70°C for 30 minutes and then allowed to cool.

Aduwa Meal Making Process

The seed kernels were subjected to toasting pretreatment before milling, oil extraction, and meal caking. The toasting helps to reduce some anti-nutrients in the nuts and rupture the oil pocket within the seed cells making the bioactive protein readily extractable. The toasted seeds were made into flake cakes from the seed milled flours using mechanically expeller, semi-automated for making meals [3] (Figure 1).

The cakes produced were dried to 10% MC using the solar cabinet dryer packaged and transported to the Federal University of Agriculture, Makurdi, and Food Chemistry and Cereal laboratories for analysis.

Preparation of Defatted B. aegyptiaca seed meal (DPM)

The method of [5] was used to defat *Aduwa* meal. The meal sample was defatted with cold (4^0C) acetone using meal to solvent ratio of 2:10 w/v. The mixture was stirred over a magnetic stirred for 2 hrs. The slurry was then filtered through a Whatman No. 1 filter paper. The residue was re-extracted again in a similar fashion. The defatted meal was dried in a fume hood at room temperature and the dried meal was finally grounded in a blender to obtain homogeneous defatted *Aduwa* meal and stored in an air-tight plastic bottle for use.

Preparation of B. aegyptiaca Protein Concentrate (APC)

Aduwa protein concentrate was produced according to the [6], modified method. Briefly, the defatted meal was dispersed in distilled water at meal to water ratio of 2:10 (w/v); the pH was adjusted to pH 10 with 1 M NaOH and stirred for 2 hours at 30 °C. The mixture was separated by centrifugation at 3100 × g for 30 min at room temperature. The extracts were then precipitated by adjusting slurry pH to 4.0 with 1 M HCl before centrifugation at 3,000 × g for 30 min again. The protein concentrate was washed with distilled water and then the pH was adjusted to 7.0 with 1 M NaOH prior to freeze-drying. The dry protein concentrate was stored in airtight glass containers and kept in freezer for subsequent analyses.

Proximate analysis of the protein meal, defatted B. aegyptiaca meal and protein concentrate

The moisture content, protein content, crude fiber, ash, fat, and carbohydrate content of (*B. aegyptiaca*) were determined using the standard method by [7].

Mineral analysis of B. aegyptiaca meal, defatted meal and concentrate

The analyses for essential mineral elements on (*B. aegyptiaca*) were carried out by the atomic absorption spectrophotometric method described by [8]. The sample (0.5g) was weighed into 75 ml digestion flask and 5 ml digestion mixture (10ml HNO_3 and 10ml HCl) added and digested at 150°C until the solution becomes clear. The mixture was cool, and 30 ml of distilled water added. The tube was vigorously stirred. The blank was also prepared following the procedure describes earlier but with exception of the samples. The (*B. aegyptiaca*) Aduwa aliquot was then transferred to the Auto analyzer for total mineral analysis at 420 nm. The left-over digest was used to determine the other elements (calcium, magnesium, and iron) on the Atomic Absorption Spectrophotometer (Perkin Elmer, model 402). But sodium and potassium were determined by flame photometry.

Amino acid profile of B. aegyptiaca Concentrate.

The amino acid profiles of (*B. aegyptiaca*) samples were determined as described by [9] in duplicate using an HPLC system after samples were hydrolyzed with 6 M HCl [10]. The cysteine and methionine contents were determined after performic acid oxidation [11] and tryptophan content was determined after alkaline hydrolysis [12].

RESULTS AND DISCUSSION

Percentage Yield of B. aegyptiaca protein meal, defatted meal and protein concentrate.

The percentage yield for Aduwa meal APM (54.87%) and resolved samples DPM (85.47%), APC (31.25%) respectively are shown in Table 1. Result show that defatted meal (DPM) had a higher yield compared to Aduwa meal (APM) samples. This observation could be due to the removal of fatty molecule from the pockets of the material creating more room for bio active material to surface. The annealing processing observed during Aduwa protein meal making could have resulted in the 54.87% yield value. The defatted meal protein DPM had higher material

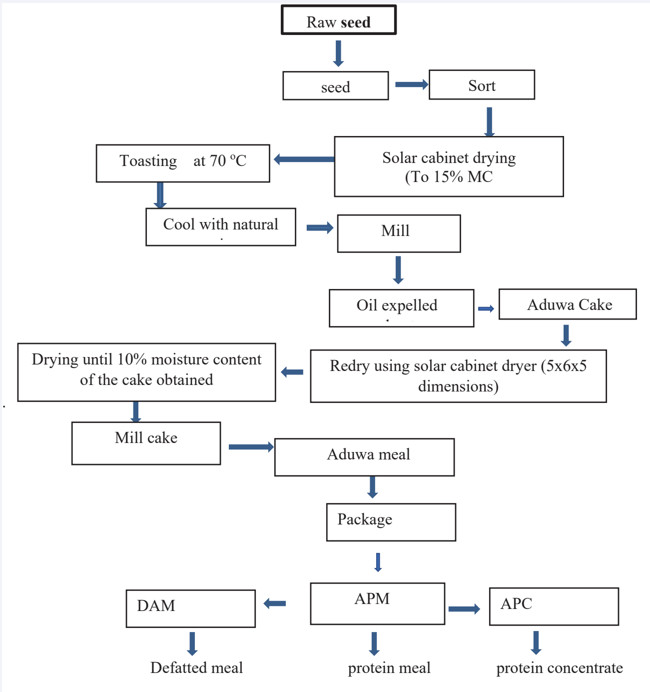

Figure 1 Balanites *aegptiaca del* Roasted Seed Meal making (modified) Source: [3].

Table 1: Percentage yield of *B. aegyptiaca* protein meal, Defatted meal and Average protein concentrate

Sample	yield (g)	Mean	Standard deviation	% Yield
APM	0.5277	0.5277	0.0296	52.77
DPM	0.8504	0.8504	0.022	85.04
APC	0.315	0.3153	0.0039	31.55

Abbreviations: APM: *Aduwa* Protein Meal; DPM: Defatted *Aduwa* Protein Meal; APC: *Aduwa* Protein Concentrate

yield and could be economically viable to processors than APC.

Proximate Composition of B. aegyptiaca Meals, Defatted Meal and Concentrate

Proximate Composition of Aduwa protein Meals and Concentrate are shown in Table 2. Moisture content in food matrix is one of the most important components of food processing and preservation. The amount of dry matter in a food is always inversely proportional to the amount of moisture it contains as such; moisture content is of direct economic importance to consumer, processor and transporters. It is very significance; however, moisture affects the stability and quality of foods. Food materials that contain much water are easily subjected to rapid deterioration from microbial attack, insect damage and sprouting [13]. The moisture content of the desert date *B. aegyptiaca* meal sample APM was found to be 6.87% significantly different (p>0.05) from protein samples DPM (4.96%) and APC (5.31%). The high value observed in (*B. aegyptiaca) Aduwa* protein concentrate APC compared to defatted (*B. aegyptiaca) Aduwa* protein meal DPM revealed processing changes on the macrostructures of the sample. This value reported are higher than the value reported on *B. aegyptiaca* seed, pulp and seed coat when oven dried at 55^{oC} for 24 hours [14], however lower than that reported in the pulps [15]. The variation in moisture content could be due to processing approach during meal, defatting and concentrate making processes. The values are however, below that reported by [16,17] who respectively reported moisture contents of (7.23%) and (7.16%). The findings of this study slightly agreed with reports by (Sara and Mahdi 2016) who reported a moisture content of (3.74%); [18] reported (3.13%), and [19] reported (4.08%). The differences could be attributed to kernel variety as well as processing treatments received [20] in this study, the percentage protein content of the (*B. aegyptiaca) Aduwa* meal sample differ significantly (p>0.05) as sample meal was isolated. Crude protein content of Aduwa protein meal APM was (26%), DPM (30%) and APC (62%) respectively. The value observed in DPM, and APC were significantly higher compared to APM. This variation could be attributed to processing method employed. The protein content observed in this study were above (33.75%) value report by [16,17,21]. In addition, the (*B. aegyptiaca)* Aduwa meals were found to have high crude protein content like that reported for its seed cake, pulp, Seed, and coat [14,22] and soybean meal [23]. The meals and concentrate from (*B. aegyptiaca)* Aduwa has higher protein content than the pulp as reported by [15]. Protein is an essential component of the diet required for the survival of humans and animals, *(B. aegyptiaca) Aduwa* meals and protein sample can serve as a source of bio nutrient. It could also serve as source of protein for animal feed [24] at meal state and concentrate form.

Fats are macronutrients, along with carbohydrates and protein. Fat is an important foodstuff for many forms of life and serves as both structural and metabolic functions. They are

Table 2: Proximate Composition of *B. aegyptiaca* protein Meals, Defatted meal, and protein Concentrate. (%)

Sample	Moisture Content	Fat	Crude Fiber	Protein	Ash content	Carbohydrate
APM	12.47ᵃ±0.038	14.67a±0.127	3.54a±0.031	25.81c±0.05	2.86a±0 0.03	40.66a±0.1
DPM	7.49ᵈ±0.040	4.86b±0.007	4.01a±0.726	29.59c±22.51	15.38a±023.8	27.11±22.1
APC	6.30ᵉ±0.117	0.46c±0.026	1.84b±0.010	62.30b±0.05	1.23a±00.02	27.88a±0.1
	0.00	0.00	0.00	0.418	0.62	0.06

Mean value is from three determinations. Means followed by the same alphabetic on the column are not significantly different at p>0.05. **Abbreviations:** APM: Aduwa Protein Meal; DPM: Defatted *Aduwa* Protein Meal; APC: *Aduwa* Protein Concentrate.

necessary part of the diet of both humans and animals and the most efficient form of energy storage [25]. The crude fat content of the meals and protein samples were significantly different at (p>0.05). The (*B. aegyptiaca) Aduwa* protein meal APM (28.91%) has significantly high fat content at (p>005) than APC (22.83%) and DPM (20.88%) According to [21], 39.63% fat content has been reported on desert date kernel and this result is supported by a similar report by [18,24]. The kernel oil is edible as Sesame and Groundnut oils which were most popular edible oils in Sudan [26]. The oil was reported to have a wide range of medicinal uses [27] and can be used as a biofuel. The (*B. aegyptiaca) Aduwa* samples results are however lower than that reported by who reported 50% fat content. Fat provides concentrated energy in the diet and enhanced palatability [28]. The high fat content of the meal of the (*B. aegyptiaca)* Aduwa meals is an indication that it is a good source of oil. Ash content refers to the inorganic residue remaining after either ignition or complete oxidation of organic matter in the food sample. The ash content is the measure of the total amount of minerals present within a food. The ash determination alongside that of the mineral contents of the foods important in nutritional label of the food, microbiological stability, and processing. It is also an important quality attribute for some food ingredients, as well as the first step in the preparation of certain samples for specific elemental analysis [29]. The ash content of the meal sample analyzed was found to be significantly different at (p>0.05) as sample meal are resolved; APC (6.64%), DPM (6.48%) and APM (6.45%) respectively. This result agreed with reports by [16-19]. The meal ash content was found to be lower than that found in its pulp as described by [15] but very similar with seed as value reported by [14]. Crude fiber is usually a measure of the quantity of indigestible lignin, cellulose, and other components. It consists largely of 60-80% cellulose and 4-6% lignin, in addition to other mineral matter. There is an increasing need to include food rich in fiber diet, as they help to prevent colon cancer. Fibers also are essential in treating or preventing diverticulosis, hemorrhoids, coronary heart diseases and constipation [30]. The (*B. aegyptiaca)* Aduwa meal seed protein analyzed in this study was found to contain an appreciable amount of crude fiber significantly (p>0.05) different as sample are been resolved to defatted meal and concentrate. The (*B. aegyptiaca)* Aduwa protein concentrate APC (7.09%) is significantly higher at (p>0.05) than APM (6.61%), DPM (4.89%) this values are lower than 13.0% reported by [21] and by [16,17,24]. The low values and variation in crude fiber content could be because of the different process treatments on the samples. Crude fiber in (*Balanites aegyptiaca) Aduwa kernel* meals is quite low as compared to that reported in its seed cake by [22]. Low crude fiber content in nuts could lead to constipation if excess of it is being consumed because crude fiber enhances bowel movements. Crude fiber is known to expand the inside walls of the colon, easing the passage of waste, and this make it quite effective against constipation.

Carbohydrates, alongside fats and proteins are one of the three macronutrients in our diet and their main function is to provide energy to the body. Carbohydrates molecules could come in different forms and sources. For example, sugars or dietary fibers, and in many different foods such as whole grains as well as fruit and vegetables. The carbohydrate content of the (*B. aegyptiaca)* Aduwa meal samples was significantly different. The (*B. aegyptiaca)* Aduwa protein concentrate APC (29.9%) has higher energy values significantly different (p>0.05) than DAPM (27.03%), These values are higher than 7.48% analyzed and reported by [17,19,21] but lower than values reported by [14] on coat pulp and seed of (*B. aegyptiaca)*Aduwa when oven dried. The high carbohydrate content in kernel of the (*B. aegyptiaca*) *Aduwa* meals and protein samples might be due to bond rupturing process that might have released carbohydrate biomolecules. This means that the kernel seed meals is an excellent source of modified carbohydrate.

Amino acid profile of B. aegyptiaca protein, Defatted meal and protein concentrate.

Amino acid has been defined as the building blocks of proteins and it is an important parameter to determine the quality of protein in food ingredient. Table 3 show the amino acid composition of (*B. aegyptiaca) Aduwa* protein concentrate. The essential amino acid (EAA) was (37.35 %), this suggests that (*B. aegyptiaca)* Aduwa protein meal resolved to concentrate could be a good quality source of protein. In a similar manner, the aromatic amino acids, hydrophobic amino acids, positively charged amino acid of the samples were high. The high concentrations of the hydrophobic amino acids in the API may have implications on the structural behaviors of the proteins.

The values obtained for the Sulphur containing amino acid at (3.67%) may dictate to antioxidant potentials of the APC sample. The tryptophan content of 1.16% value is higher when compared with (0.1 - 0.12%) reported for okra seeds flours similarly, the histidine content of (3.39%) are higher compared to WHO and FAO recommendations. The high amino acid profile of APC may be attributed to toasting processing.

Mineral composition of B. aegyptiaca protein meal, Defatted meal and protein concentrate

The mineral profile of protein materials from (*B. aegyptiaca)*

Table 3: Amino acid profile of B. *aegyptiaca* protein, Defatted meal, and protein concentrate.

Amino acid	APC	WHO	FAO/Adult
Leucine	8.47	1.80	1.90
Lysine	5.35	5.80	1.60
Isoleucine	4.55		
Phenylalanine	5.06	6.30	1.90
Tryptophan	1.16		
Valine	5.06	3.5	1.5
Methionine	1.62	2.7	1.7
Proline	4.10		
Arginine	8.26		
Tyrosine	4.12		
Histidine	3.39	1.90	1.60
Cystine	1.53		
Alanine	5.27		
Glutamic acid	18.08		
Glycine	4.26		
Threonine	3.86	3.4	0.90
Serine	4.93		
Aspartic acid	10.93		
AAA	10.34		
BCAA	18.08		
HAA	40.95		
PCAA	17.00		
NCAA	37.80		
SCAA	3.15		
EAA	37.35		

Abbreviations: APC: Aduwa Protein Concentrate; AAA: Aromatic Amino Acid = Phenylalanine, Tryptophan, and Tyrosine; BCAA: Branched Chain Amino Acids = Leucine, Isoleucine, Valine; HAA: Hydrophobic Amino Acids = Alanine, Valine, Isoleucine, Leucine, Tyrosine, Phenylalanine, Tryptophan, Proline, Methionine, and Cysteine; PCAA: Positively Charged Amino Acids = Arginine, Histidine, Lysine; NCAA: Negatively Charged Amino Acids = Aspartic, Glutamic, Threonine, Serine; SCAA: Sulphur Containing Amino Acids = Methionine, Cysteine; EAA: Essential Amino Acids = Histidine, Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Threonine, Tryptophan, And Valine.

Aduwa is shown in Table 4. Mineral calcium was significantly p>0.05 high in APC (509mg/L) and APM (3192mg/l) compared to DAPM (289mg/l)). These values however below the (800mg/l) recommended by [31] (FNB2001) for children adult and pregnant women. This change may be due to protein solubilization and precipitation process in these samples, eroding biomolecules such as lipid, fiber, and carbohydrates. Calcium is essential to maintaining total body health. Our body needs calcium every day not just to keep our bones and teeth strong but to ensure proper functioning of muscles and nerves and help our blood to clot. Calcium deficiency is usually due to an inadequate intake of the mineral when the blood calcium levels drop too low, as such, how much calcium we get is very important to our health [32].

The results showed that desert date meal protein and concentrate samples are rich in calcium potassium, sodium, and magnesium, however below recommended values [31]. Other minerals are also present in appreciable amounts.

Calcium content in meal AM (319mg/I), DPM (289mg/I) and APC (509mg/I) are high but significantly low compared to (800-1,200) of [31] recommended levels. Protein meal from APM and DPM were significantly rich in potassium (1550 mg/I) and (1355 mg/I) respectively compared to APC (430mg/I) sample. The potassium mineral content in the protein meal and defatted meal are however higher than 1600-200 recommended value by (FBN 2001). Sodium mineral is significantly p>0.05 higher in APC (1110 mg/I) compared to DPM (311mg/I) and APM (825mg/I) but the defatted meal was below 400 mg daily requirement by children [31]. This result revealed that APC could be a good material for electrolytic and ionic balances, hence a biomaterial ingredient. When there is an imbalance between the two minerals an individual may develop high blood pressure by consuming too much sodium and not enough potassium [33]. Potassium and sodium also help in regulating the water balance and the acid-base balance in the blood and tissues [34]. The findings in this study agreed with similar findings reported by [16,21,24]. Supplementing these protein materials could curb child and adult tetany oesteomalacia and related diseases due to lack of calcium. Potassium and sodium are electrolytes needed for the body to function normally and help in maintaining the fluid and blood volume of the body.

Magnesium content significantly decreased from APM (673mg/ml) to APC (303mg/I). The APM (673mg/l) and DPM (628mg/I) had high value of magnesium however higher than the value of (42mg/l) reported by [21] and recommended values (170-355mg) by [31]. These revealed that APM protein meal could be a potential vasodilator and neurotransmitter bioactive material. Magnesium, the fourth most common mineral in the human body after calcium, sodium, and potassium, is also the second most common intracellular cation after potassium. Magnesium is a cofactor in many enzyme systems and is also required for such fundamental processes as energy production and nucleic acid synthesis and plays an important role in the synthesis of ATP (adenosine triphosphate) from ADP (adenosine diphosphate) and inorganic phosphate [35].

Iron content significantly decreased as material meals were

Table 4: Mineral composition of *B. aegyptiaca* protein meal, Defatted meal and protein concentrate in (mg/I)

Sample	Ca	K	Na	Mg	Fe	Cu	Zn
APM	$319^{b}\pm 0.10$	$1150^{b}\pm 0.00$	$825^{b}\pm 0.10$	$673^{a}\pm 0.01$	$329^{a}\pm 0.10$	$2.0^{a}\pm 0.00$	9.0 a±0.02
DPM	$289^{c}\pm 0.00$	$1355^{a}\pm 0.01$	$311^{c}\pm 0.00$	$628^{b}\pm 0.01$	$26.0^{b}\pm 0.01$	$2.0^{a}\pm 0.00$	$7.0^{b}\pm 0.015$
APC	$509^{a}\pm 0.00$	$430^{c}\pm 0.00$	$1110^{a}\pm 0.00$	$303^{c}\pm 0.10$	$18.0^{c}\pm 0.10$	$2.0^{a}\pm 0.00$	$6.0^{c}\pm 0.01$
LSD	0.101	0.32	0.101	0.101	0.023	0.32	0.003

Mean values are readings from triplicate determinations; Means followed by the same alphabetic on the column are not significantly different at p>0.05
Abbreviations: APM: Aduwa Protein Meal; DPM: Defatted Aduwa Protein Meal, APC: Aduwa Protein Concentrate.

resolved to concentrates. APM (329mg/I), DPM (26.0mg/I) and APC (18.0mg/I) APM has high value of iron (329mg/l) than the value of APM and DPM respectively. Iron is a mineral that serves several important functions; its main function is to carry oxygen throughout our body and making red blood cells [36] as well as serves as a cofactor for many enzymes [37]. The cupper values in all the samples were not significantly different. They all had the same 2.0 mg/I value contents. Copper helps the body form collagen and absorbs iron and plays a role in energy production as well.

The zinc value in APM (9.0 mg/I) is significantly higher compared to DPM and APM protein meals. The zinc values from APM (0.009 mg/100g) and DPM (0.007 mg/100g protein meals revealed that these sample could be better preferred for child food fortification to aid in growth and sexual maturity in growing children compared to APC at (6.0 mg/l) zinc content. Zinc plays role in wound healing as well as manage incidence of diarrhea. Iron is a mineral that serves several important functions, its main function being to carry oxygen throughout our bodies and making red blood cells [36].

CONCLUSION

This study revealed that defatted (*B. aegyptiaca)* Aduwa protein meal and protein concentrate had a good range of proximate, amino acid and mineral profiles. The defatted and concentrate samples have high protein, ash, and crude fiber values higher than the meal sample. However, when defatted and resolved to concentrate, the chemical properties such as the essential amino acid (EAA), hydrophobic amino acid (HAA) and negatively charged amino acid (NCAA) content were increased as well as the calcium, sodium, and zinc contents. Indicating that concentrates from Aduwa seed could be useful, and potential admix recipe to enrich food.

ACKNOWLEDGEMENTS

Authors are grateful to the management of Federal university Gashua and support the Department of Food Science and Technology, Federal University of Agriculture, Makurdi gave during the study.

AUTHORS CONTRIBUTION

Ogori A.F performed the experiments, analyzed the results, and formats the first manuscript. Girgih A. T designed the experiment and analyzed the data, supervised, and wrote the third draft, Eke O.M wrote the first and Abu O.J wrote the second draft of the manuscript and read and edited the manuscript

FUNDING DECLARATION

The authors are grateful to Tet FUND through the management of Federal University Gashua and for the funds and time to undertake this research

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding authors upon reasonable request.

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