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PROXIMATE, FUNCTIONAL AND PHYSICOCHEMICAL PROPERTIES OF BASELLA ALBA FLOUR AND BASELLA ALBA PROTEIN CONCENTRATE

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ABSTRACT

This study aimed at determining the proximate, functional, and physicochemical properties of Basella alba whole flour (BWF) and Basella alba protein concentrate (BPC) for use as food ingredients with a view to improve their utilization by producing concentrate from its protein content which will serve as a cheap but abundant source of protein. OAU farm provided fresh Basella alba leaves. The stalk was quickly cut off, and the leaves were cleaned under running water to get rid of any mud or dirt that had stuck to them. Following cleaning, the leaves were dried in an oven for 4-5 hours at 60 °C. The powdered leaves were then sieved through sieves with a mesh size of 60 to 80. (Basella alba whole flour). The whole flour was used to prepare the concentrate by combined process of insolubilisation, neutralization and lyophilisation. The resulting flour was subjected to proximate, functional, and physicochemical properties determination. The results of the functional properties revealed that Basella alba protein concentrate (BPC) exhibited higher bulk density, water absorption, Oil absorption capacity and emulsifying properties when compared with BWF. This implies that that BPC will find better application as food ingredient. The proximate composition's findings revealed that the BPC has higher protein content than the BWF. In conclusion, the study revealed that Basella alba protein concentrate can be used as protein fortification and enrichment owing to its favorable protein content.

Keywords: Bulk Density, Basella Alba, Water Absorption Capacity, Oil Absorption Capacity

1. INTRODUCTION

Vegetables are any edible plant components that can be consumed whole or in part, raw or cooked, as a side dish or salad ingredient. Vegetables can include leaves, stems, roots, flowers, seeds, fruits, bulbs, tubers, and fungi among other things Uzo 1989, Uwaegbute (1989). Depending on the type of vegetable consumed, vegetables are good providers of oil, carbs, minerals, and vitamins Ihekoronye and Ngoddy (1985). Vegetable fats and oils, according to Onunogbu (2002), lower blood lipid levels, which lowers the risk of developing diseases linked to coronary artery damage. In many Nigerian homes, leafy vegetables are a staple of the diet. They are substantial dietary sources, particularly in rural areas where they greatly contribute to protein. minerals, vitamins, fibers, and other nutrients that are typically in limited supply in daily diets Mepba et al. (2007). They also add diversity to the menu Muhamed and Sharif (2011). Various vegetables have different nutrient contents, and while they don't have as many carbohydrates as starchy foods, which make up the majority of the food consumed, they do contain vitamins, important amino acids, minerals, and antioxidants. Vegetables, according to Okafor (1983), the most easily accessible and inexpensive sources of essential proteins, minerals, and necessary amino acids. While some vegetables are saved for the sick and the convalescent because of their medicinal qualities, most vegetables are included in meals for their nutritional worth. Indigenous vegetables have long been a staple of traditional diets in many cultures, but their nutritional worth is unknown and many of these products are neglected Keatinge (2012). *Basella alba*, a perennial vine from the basellaceae family, can withstand extreme temperatures very well Grubben and Denton (2004). Rathee et al. (2010)There are several other names for it, including cyclone spinach, Chinese spinach, vine spinach, Indian spinach, ceylon spinach, climbing spinach, malabar spinach, and east indian spinach Roy et al. (2010). Malaysia, the Philippines, tropical Africa, the Caribbean, and tropical south America, southeast of Brazil are among the regions where *Basella alba* is most prevalent. Owing to their ease in adapting to different soil types and climates it is one of the untamed leafy veggies. *Basella* leaves are used to make soup because they are mucilaginous and succulent. They are incredibly nutritious, including vitamins, minerals, proteins, carbohydrates, and dietary fiber Adeboye (1996). Despite the nutritious value of both varieties, the green *Basella alba* is preferred over the purple *Basella rubra* Edema and Fakorede (1978). Protein is a crucial ingredient needed for the development, upkeep, and healing of bodily tissues. Children, teenagers, and expectant women all need protein for healthy growth and development. All bioprocesses require proteins, which are transformed into specific body proteins in the blood, muscles, enzymes, hormones, skin, and hair, among other body parts, antibody and hemoglobin in red blood cells. All of the essential amino acids needed by our bodies can be found in a range of cereals, legumes, and vegetables. Protein combines or protein complementing, often known as consuming a variety of plant meals at the same time to obtain their complete protein value, was long believed to be necessary. One of the main nutritional issues in the poor countries is a lack of protein. According to Parriser et al. (1978) and Sikka et al. (1979), Fish Protein Concentrate (FPC) is one of the new protein sources being developed. Specifically, Single Cell Protein (SCP) and Soybean Protein (SBP) have significantly helped to address the global protein shortage. Malnutrition and protein deficiencies still affect an estimated 1 billion people worldwide. Therefore, new strategies for feeding the undernourished global population must be created, especially in the less developed nations. Scientists generally concur that protein malnutrition increases the risk of sickness, increases vulnerability to illness, and results in irreparable brain damage in survivors. Protein malnutrition also adds to the high infant and child mortality rates in developing nations FAO (2008), WHO (2002b). The majority of people in most underdeveloped countries are vegetarians, and even if it is possible to purchase meat, the price is so high that most households only eat it once or fewer per week. Consequently, it is believed that extending existing agricultural practices to marginal lands will help to address the on-going global food issue. *Basella alba* is a nutritious indigenous vegetable which contains an appreciable amount of protein if taken in abundant but it is underutilized mainly because it is not usually cultivated conventionally but grows spontaneously in non-hygienic places this affects the demand of the vegetable negatively. Therefore, this study is designed to improve the utilization of *Basella* *alba* by producing concentrate from its protein content which will serve as a cheap but abundant source of protein.

2. MATERIALS AND METHODS

2.1. MATERIALS COLLECTION

OAU Farm supplied the fresh *Basella alba* leaves. The stalk was then cut off and the leaves were quickly washed under running water to eliminate any mud or adherent dirt. After being thoroughly washed, the leaves were dried for 4-5 hours in an oven set to 60 °C.

2.2. PREPARATION OF *BASELLA ALBA* WHOLE FLOUR

Figure 1 shows the production of *Basella alba whole flour.* The dried leaves were ground into a powder and put through sieves with a mesh size of 60 to 80. Packaged the powdered leaves in a high density polyethlene bag until needed.

2.3. PREPARATION OF *BASELLA ALBA* PROTEIN CONCENTRATES

In order to create protein, concentrate from entire *Basella alba* flour, Gbadamosi et al. (2012) modified method was used, as shown in Figure 2. The medium's pH was raised to 6 and mixed for 4 hours at a constant pH. A magnetic stirrer was used to mix whole flour in water at a 1:20 ratio for 10 minutes. The slurry was centrifuged at 3,500 g for 10 minutes while at room temperature. Following the supernatant collection, it was then centrifuged at 3,500 g for 10 minutes after being rinsed with distilled water, redissolved in it, neutralized, and had its pH corrected to 7.0. The Sample was dried for 8 hours at 45 °C in a hot air oven, and the resulting concentration was then placed in a polyethylene bag for additional examination.

Figure 1

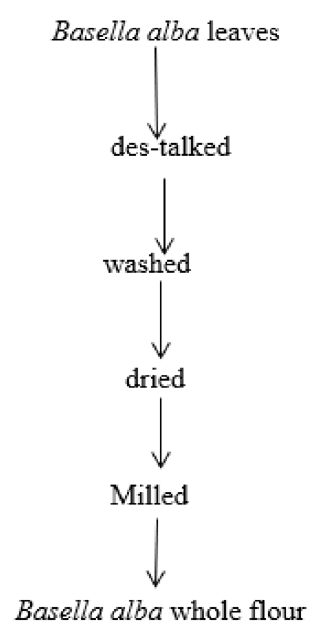

Figure 1 Production of *Basella Alba* Whole Flour

Figure 2

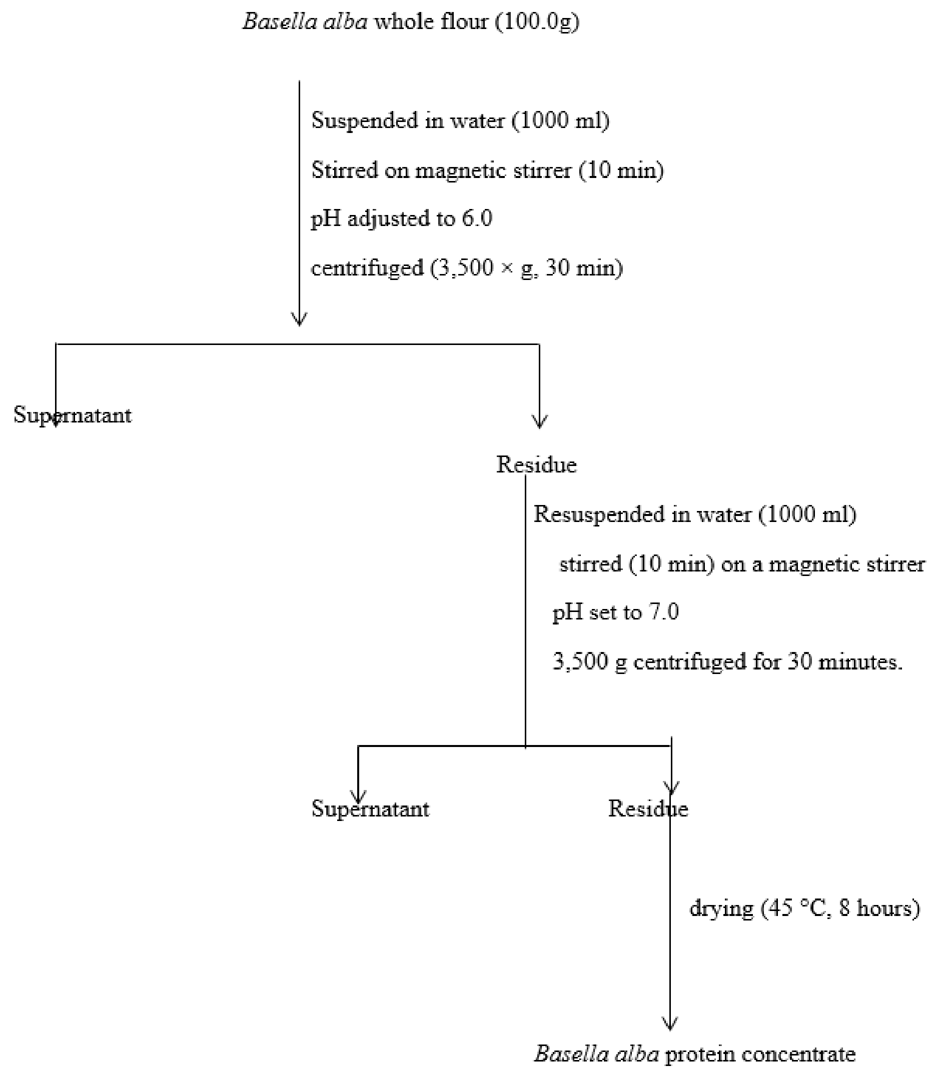

Figure 2 Production of *Basella Alba* Protein Concentrate Changed by Gbadamosi et al. (2011) from Cheftel et al. (1985)

2.4. PROXIMATE ANALYSIS

The approximate composition of *Basella alba* whole flour and *Basella alba* protein concentrate were determined using procedures recommended by the AOAC (2000).

2.5. FUNCTIONAL AND PHYSICOCHEMICAL PROPERTIES DETERMINATION

The Okezie and Bello method was used to calculate bulk density (1988). A modified version of Sathe and Salunkhe's approach was used to measure water absorption (1997). To assess oil absorption capacity, Lin and Zayas (1987) approach was utilized.

A modified version of Chavan et alapproach.'s was used to determine foam capacity and foam stability (2001). The material's pH was calculated using a 10% w/v suspension in distilled water. The mixture was well mixed after the Combo pH meter was calibrated using buffers with pH values of 4.0 and 10.0. Examining the least concentration of gelation was done using the Coffman and Garcia method (1977). The Pearce and Kinsella method was used to express the emulsifying activity index (EAI) and emulsion stability index (ES) (1978). The flour (200 mg) was dissolved in 30 ml of distilled water using a moderate swirl in order to disseminate the sample uniformly. The liquid was then mixed with 10 ml of pure Gino oil using a magnetic stirrer (AB Biotech, Sweden) at speed 10 for 60 seconds. After homogenization, a 500-microliter aliquot of the emulsion was taken from the bottom of the centrifuge tube and mixed with a sodium dodecyl sulphate (SDS) solution that had a 0.1% concentration. The absorbance of the diluted solution was measured at 500 nm using a spectrophotometer (UnicamHeios, UV-Visible Spectrophotometer, England). Equation 1 shows how to translate the Emulsifying Activity Index (EAI) into interfacial area per unit weight of protein (m2g-1).

$$\text{Emulsifying Activity Index (m2/g)} = \frac{2 \times 2.303 \times A}{0.25 \times \text{Protein weight (g)}} \qquad \text{Equation 1}$$

The Emulsion Stability Index (ESI) was calculated as previously described using the method outlined by Pearce and Kinsella after the emulsion was allowed to stand for 10 minutes at room temperature (1978). Emulsion Stability Index (minimum) = AA × Δt

A ₋ AA

Where,

A =Absorbance at 0 min after homogenization

AA = Absorbance at 10 min after homogenization.

3. RESULTS AND DISCUSSION

3.1. PROXIMATE PROPERTIES OF THE FLOUR

Table 1 displays the approximate composition of *Bassella alba* protein concentrate (BPC) and *Bassella alba* whole flour (BWF). BWF had a greater value as compared to BPC, and these values were 1.48 to 9.75% for the samples' moisture content.

Table 1

Table 1 Proximate Composition (%) of *Basella Alba* Whole Flour (BWF) and *Basella Alba* Proteins Concentrate (BPC)

Proximate Composition	Whole Flour	Protein Concentrate
Moisture	9.75±0.11[a]	1.48±0.21[b]
Ash	20.50±0.71[a]	16.64±0.51[b]
Protein	15.94±0.31[a]	68.26±0.11[b]
Crude fat	Not determined	Not determined
Crude fibre	3.03±0.23[a]	6.34±0.42[b]
Carbohydrates	50.78±0.51[a]	7.28±0.94[b]

The values given are the means and standard deviations of two independent assessments. Within the same row, mean values with various superscripts differ significantly ($P < 0.05$).

($P < 0.05$) Significantly different the whole flour's observed moisture content was higher than what Adeyeye and Omotayo (2011) recorded for Amaranthus hybridus and Telfaira accidetalis leaf (7.6% and 6.6%, respectively). Food's moisture content affects both the rate at which enzymatic activities occur on it and its ability to retain. The amount of food moisture has an impact on how quickly food is absorbed and digested. The crude fibre content ranged from (3.03%) for BWF to (6.34%) for BPC. The differences between them were significant ($P < 0.05$) and these values were higher than the values obtained for *Telfairia accidentalis* which was (1.7%) by Aletor and Fasuyi (1997). Consuming foods high in fiber lowers blood pressure and lowers the risk of cardiovascular disease development. Its inclusion in food inhibits trash from building up in the intestine. A sufficient intake of fiber is also necessary for healthy gut function and illness prevention. The ash content of BPC was 20.50%, greater than that of BWF, which was 16,64%; these values differed considerably ($P < 0.05$). The samples' ash content is a sign of their mineral composition, and the high values found imply that they may be used as sources of micro and macro elements. The values were greater than those listed by Saidy and Adunbarin (1998) for five vegetables, namely Telfaira occidentalis (0.68%), Roselle (0.46%), Cochuru solitonus (0.32%), and Talium triangulare (0.62%). The two samples' stated ash values showed that they are reliable sources of mineral elements. The results of carbohydrate contents of the samples as shown in Table 1 revealed that BPC contained 7.28% and this value was significantly lower than BWF with 50.78%. Food-based carbohydrates are the main source of energy. Although there are many sources of carbohydrates in a typical diet, cereals, and vegetables—which are high in fiber and other nutrients are the preferable options. There was a significant difference (P 0.05) in the samples' protein contents, with BPC having the greater value of 68.26% and BWF having a value of 15.94%. These values are higher than the 4.85% reported for sweet potato leaf protein concentrate by Akindahunsi, and Salawu (2005). This suggests that these leaf concentrates are a decent source of protein for the day. Food sources of protein contain the amino acids needed for the synthesis of hormones, enzymes, and the protein present in muscle, brain, blood, and other human tissues.

3.2. FUNCTIONAL PROPERTIES OF THE FLOUR

The results of the functional properties of *Basella alba* whole flour (BWF) and *Basella alba* protein concentrate (BPC) were presented in Table 2. The Bulk density of *Basella alba* whole flour (BPC) was found to be 0.65 g/ml and was less than that of *Basella alba* protein concentrate (BPC) of 0.80 g/ml and they were significantly different ($p < 0.05$) from each other. The combined impacts of related elements, such as the strength of attractive inter-particle forces, particle size, and number of contact points, are what determine bulk density, according to Peleg and Bagley (1983). Regarding packaging, the high volume per gram of protein material is crucial. An increase in bulk density is desirable because it provides better packaging benefits by allowing for the packing of larger quantities in the same amount of space Fagbemi (1999).

Table 2

Table 2 Physicochemical and Functional Properties of *Basella Alba* Whole Flour (BWF) *Basella Alba* and Protein Concentrate (BPC)

Functional properties	Whole flour	Protein concentrate
pH	6.06±0.03[a]	6.45±0.21[b]
Bulk density(g/ml)	0.66±0.01[a]	0.79±0.03[b]
Water absorption capacity (%)	255±0.07[a]	285±0.21[b]
Oil absorption capacity (%)	91.00±0.10[a]	110.00±0.01[b]
Emulsifying activity index (m^2/g)	15.04±0.23[a]	18.65±0.07[b]
Emulsifying stability index (%)	98.95±0.49[a]	115.6±1.56[b]
Foam capacity (%)	31.00±0.01[a]	20.00±0.03[b]
Foam capacity (%)	20.00±0.01[a]	2.06±0.03[b]
Least gelation (%)	15.00	20.00

The values given are the means and standard deviations of two independent assessments. Within the same row, mean values with various superscripts differ significantly ($P < 0.05$).

Table 2 displays the results of the water absorption capacity (WAC) tests of BWF and BPC. The findings revealed that BPC's WAC was 270% whereas BWF's WAC was 250%; these values differed considerably ($p < 0.05$) from one another. These values exceeded the WAC for pigeon pea flour, which was 138% (Oshodi and Ekperigin, 1999); soy flour, which was 130%; sunflower flour, which was 107.1%; and wheat flour, which was 60.2% Lin et al. (1974); and whole wheat flour, which was 140.63%. Adeyeye and Aye (2005). The high WAC may be due to the elimination of soluble carbohydrates (oligosaccharides) during manufacturing, which resulted in high polysaccharide content. Water absorption is the ability of flour to expand when exposed to water, improving the consistency of meals Osundahunsi and Aworh (2002). The High WAC of BPC could make it a potential ingredient in food systems. According to the results of the oil absorption capacity (OAC) tests conducted on *Basella alba* protein concentrate (BPC) and *Bassella alba* whole flour (BWF), BPC had a higher OAC of 110% compared to BWF's 90%, and these values were statistically different (p 0.05). This is in line with the study by Campbell et al. (1980), which found that OAC increased as protein content in products containing sunflower and soy protein increased. The samples' contents or levels of protein may be responsible for the variations in oil absorption ability between them

According to Table 2, the aqueous solutions of BPC and BWF had pH values that varied from 6.45 to 6.06, respectively. The results showed that some organic acids were present because the pH values were only mildly acidic. According to their pH values, BWF and BPC can be employed in meals that are acidic. Since it affects the functional attributes including solubility, emulsifying activity, and foaming properties, the pH of the flour suspension is essential Chavan et al. (2001), Odoemelam (2003), Khalid et al. (2003) and Gbadamosi et al. (2011).

The emulsifying activity index (EAI) of BPC was 18.60 m2/g, higher than that of BWF, which was 15.29 m2/g, at the natural pH of the samples. However, the emulsion stability index (ESI) followed a reverse order, with BWF exhibiting higher stability with a value of 114.5% higher than BPC, and these values were significantly different ($P < 0.05$). The outcomes corroborated Chavan et al. (2001) assertion that protein EAI tends to rise as protein concentration rises. The emulsion capacity observed in this investigation for the two flour samples is less than that reported by Fasuyi (2006) for Talium triangulare and Amaranthus cruenthus, which were both 28.7% and 32.7%, respectively. The manufacturing of croissants, coffee containers, and frozen desserts all require careful consideration of emulsion capacity. According to Ogunwolu et al. (2009), when peptide chains are sheared with lipid droplets, polypeptides unfurl to a higher extent as protein concentration falls. The availability of protein surface area increases noticeably as a result, as does the effectiveness of emulsifying. Because of the increase in protein concentration, this may explain why the EAI of the BPC obtained was higher than that of the BWF. As can be shown in Table 2, the foam capacity (FC) of BWF at natural pH was much higher than that of BPC, with values of 30.43% and 18.18%, respectively. The study's findings showed that BWF had a higher capacity for foaming than BPC; this could be because whole flour contains more foaming ingredients like saponin than concentrate does. Intermolecular polymers that surround the air bubbles are built by proteins to form stable foams Day and Underwood. (1986).

BWF (19.56%) had much higher foam stability (FS) than BPC (2.27%), which was likewise significant ($P < 0.05$) at Foam stability in food systems is significant because the ability of whipping agents to maintain the whip as long as possible is critical for their use in meals Boye et al. (2010a). The findings of this study outperformed those of Adeagbo *et al*. who found values of 4.20% in Allium Ceppa and 7.25% in Diplotaxis Tenuifolia (2013). BWF might function better as a foaming agent in food formulations since its foaming qualities were superior to those of BPC. As can be seen in Table 2, the two samples' gelation capacities greatly differed, with BWF having the lesser value of 15.00% and BPC having the greater value of 20.00%. Based on Lawal et al (2007), higher ionic strength and lower least gelation capacity result in greater gelation capacity and gelation characteristics, respectively. The ratios of the various components, including proteins, carbs, and lipids, that go into making the flours, as well as the interactions between these components, may be responsible for the difference in gelation concentration between the two samples. Higher amounts of BPC seem to gel in accordance with their globular shape, which may reduce the necessary protein-protein interactions for gel formation. For many foods, including vegetables and other items, protein gelation is essential for their preparation and acceptability (Lawal et al., 2007).

4. CONCLUSION

The study concluded that BPC has higher protein content than the BWF. The results of the functional properties also revealed that *Basella alba* protein concentrate (BPC) exhibited higher bulk density, water absorption, Oil absorption capacity and emulsifying properties when compared with BWF. This implies that BPC will find better application as food ingredient.

CONFLICT OF INTERESTS

None.

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