COMPARATIVE STUDY OF THE MINERAL, PROXIMATE AND AMINO ACID COMPOSITIONS OF RED SWEET POTATO (*IPOMOEA BATATAS*) AND ITS SYRUP

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Abstract: *The nutrient contents of raw Ipomoea batatas and its syrup were determined using standard methods. The proximate parameters determined were the ash, moisture, fat, crude fibre, crude protein, carbohydrate and the calorific values. At $p \leq 0.05$, the raw potato had a higher carbohydrate (69.41±0.71%) than the syrup (59.17±0.74%) but the latter had respective higher values of crude protein and ash (4.08±0.58% and 9.63±0.05%) than the former (3.03±0.23% and 3.55±0.57%). Both the 15.29±0.27 and 1.31±0.02%) crude fat and fibre contents of the raw potato were higher than the respective 10.09±0.13% and 0.53±0.00% of the syrup. The moisture content of the syrup (17.03±0.38%) was also higher than that of the raw sample but its calorific value of 343.82±1.03 kcal/100g was lower than that of raw Ipomoea batatas (427.43±3.61kcal/100g). The potassium, magnesium and zinc contents of the syrup were higher than those of the raw sample, the sodium, calcium, iron and phosphorus of the latter were higher. The amino acids profile of raw Ipomoea batatas and its syrup revealed that the raw sample had higher values than the syrup while the functional properties of the samples revealed that only the pH and oil absorption capacity of the raw sample were higher than those of the syrup. Therefore converting sweet potato to syrup was found to have enhanced most of its functional properties.*

Key words: *Amino acid, mineral, Nutrient, Sweet potato, proximate*

1. INTRODUCTION

Ipomoea batatas Lam (Sweet potato) which belongs to the plant family Convolvulaceae (Surayia *et al*. 2006)**.** Sweet potato is a vital food crop in most regions of the world, being cultivated in more than 100 countries (Eleazu and Ironua, 2013). It was reported that Nigeria is the number one producer of sweet potato in this continent (Africa) which produces about 3.56 million metric tonnes annually, with this, Nigeria becomes second world producer after China which is the first (FAO, 2003). In addition, it is an edible tropical tuber with white slightly sweet flesh (Oxford Dictionary, 2006). Sweet potato is one of the sixth greatest essential food crop in the universe as well as new way of using this crop have been acknowledged. The protein energy undernourishment which exist among children tents to be most important health challenges in advanced countries like Nigeria (FAO, 2001). Study have plays vital role in maintenance and assessment of food safety and quality which can be in industry as well as for application authorities at international and national levels. The nutritional value of sweet potato depends on varieties and growing conditions.

2. MATERIALS AND METHODS

2.1 Collection and treatment of samples

Raw red sweet potato root tubers were purchased from ten different farms in Bosso Local Government of Niger state North Central, Nigeria. The tubers were washed with water to control the attack of microorganisms. The skins were then peeled and the peeled tubers were placed in water for oxidation control. The tubers were then blended and juiced using a micro lab blender, $4cm^3/dm^3$ of lime juice was added to each sample to reduce the oxidation of the blended pulps which were filtered using white cloth sieves. These were evaporated and concentrated using water bath and finally filtered to obtain the syrup (Michael, 2005). The syrups obtained were eventually evaporated to dryness and kept for further use. For the raw samples, the root tubers were peeled and plastic graters were used to reduce the size, then sun-dried for two weeks for proper drying. These were then pounded manually into powder with ceramic mortar and pestle, sieved with 40-mesh sieve to obtain fine powder for the analysis.

2.2 Proximate Analysis

The standard analytical procedures for food analysis were used in carrying out the determination of fat, crude protein, crude fiber and moisture contents of these samples through the methods of AOAC (1990). Ash content was determined using the method of AOAC (2005). The carbohydrate values of the samples were determined by a difference (Mathew *et al.*, 2018).

2.3 Amino acid Analysis

The amino acid profile was analyzed through the methods of AOAC, (2005). Each of those sample were dried to obtained a constant weight, evaporated, hydrolyzed, defatted and loaded into the techno sequential multi-sample amino acid analyzer (TSM) that is premeditated to separate as well as analyze free neutral, basic and acidic amino acids of the hydrolysate.

2.4 Functional properties

Viscosity, water absorption capacity, oil absorption capacity, wettability and Bulk density were analysed using the method of Ndamitso *et al.*, (2015) while, the pH was measured through making a 10% (w/v) suspension of the sample in distilled water.

2.5 Mineral Analyses

The method described by AOAC (2005) was used to obtain the concentration of mineral contents. The ashed samples at 550 ^{0}C were boiled with 10 cm^3 of 20 % hydrochloric acid in a beaker which was filtered into a 100 cm^3 standard flasks in each case. Each of this was made up to the mark with deionized water. The minerals were determined from the resulting solutions. Potassium and sodium were determined using the standard flame emission photometery (FES) using KCl as well as NaCl as the standards. (AOAC, 2005). Calcium, zinc, and magnesium along withation the iron concentrwere determined using atomic absorption spectrophotometry.

3. RESULTS AND DISUCUSSION

Table 1: Proximate analysis (%) of raw *Ipomoea batatas* and its Syrup

Parameters	Syrup	Powder
Ash	7.63 ± 0.05^{a}	8.55 ± 0.57^{b}
Moisture	17.03 ± 0.38^{b}	8.71 ± 0.59^{a}
Fat	10.09 ± 0.13^{a}	15.29 ± 0.27^{b}
Crude fibre	0.53 ± 0.00^{b}	1.31 ± 0.02^{a}
Protein	4.08 ± 0.58^{b}	3.03 ± 0.23^{a}
Carbohydrate	59.17 ± 0.74^{a}	69.41 ± 0.71^{b}
Calorific value (kcal/100g)	343.82 ± 1.03^{a}	427.43 ± 3.61^{b}

Values are means of three separate parameters determined ± standard errors

Table 2: The mineral contents (mg/kg) of raw *Ipomoea batatas* and its Syrup

Parameters	Syrup	Powder
Sodium	250.33 ± 0.33^{a}	320.33 ± 0.33^{b}
Potassium	4600.00 ± 0.10^{b}	4300.00 ± 0.30^{a}
Calcium	20.67 ± 0.33^{a}	23.33 ± 0.16^{b}
Magnesium	2148.33 ± 0.67^{b}	1866.67 ± 0.33^{a}
Zinc	22.00 ± 0.58^{b}	14.33 ± 0.33^{a}
Iron	26.33 ± 0.66^{a}	32.67 ± 0.17^{b}
Phosphorus	230.33 ± 0.33^{a}	270.33 ± 0.33^{b}

Values are means of three separate parameters determined ± standard errors

Table 3 The amino acids profile of the raw *Ipomoea batatas* and its syrup (g/100g protein)

	Sample	
Amino acids	Syrup	Powder
Lysine	0.89±0.03[a]	3.32±0.01[b]
Histidine	0.50±0.11[a]	1.55±0.04[b]
Arginne	0.52±0.12[a]	5.27±0.05[b]
Aspartic acid	2.61±0.02 [a]	8.35±0.16[b]
Threonine	1.90±0.01 [a]	3.26±0.11[b]
Serine	1.11±0.05[a]	2.55±0.15[b]
Glutamic acid	4.39±0.04[a]	9.09±0.03[b]
Proline	0.71±0.01[a]	2.44±0.02[b]
Glycine	0.55±0.01[a]	3.08±0.03[b]
Alanine	1.18±0.03[a]	3.72±0.05[b]
Cysteine	0.33±0.01[a]	0.53±0.00[b]
Valine	2.49±0.12[a]	3.07±0.02[b]
Methioline	0.63±0.00[a]	1.02±0.02[b]
Isoleucine	1.65±0.02[a]	3.71±0.07[b]
Leucine	2.32±0.11[a]	6.59±0.03[b]
Tyrosine	1.27±0.11[a]	2.38±0.05[b]
Phenylalanine	1.43±0.12[a]	3.80±0.14[b]
Tryptophan	0.31±0.03[a]	0.57±0.03[b]

Values are means of ten separate parameters determined ± standard errors

Table 4 The functional properties of the raw *Ipomoea batatas* and its Syrup

Parameters	Syrup	Powder
pH	5.48±0.20[a]	6.14±0.09[b]
Viscosity (sec)	240.53±0.27[b]	193.19±0.17[a]
Bulk density (gcm^{-3})	0.69±0.00[b]	0.58±0.00[a]
Water absorption capacity (%)	2.53±0.06[b]	1.82±0.02[a]
Oil absorption capacity (%)	1.67±0.52[b]	0.51 ±0.17[a]
Wetability (sec)	116.67±0.33[b]	74.67±0.33[a]

Values are means of ten separate parameters determined ± standard errors

The nutritive, amino, mineral and functional properties of the locally available sweet potato species in Minna, Niger State were determined using standard procedures and the results were as given in Tables 1 to 4. The proximate composition and the energy values were presented in Table 1. The powder sample contained 69.41±0.71% carbohydrate while the syrup contained 59.17±0.74% and both of these values were lower than the 70.54±0.55% reported for boiled sweet potato but higher than the 60.77±0.33% reported for sweet potato porridge by Abubakar *et al*. (2010). However, the carbohydrate content of the raw sample was almost the same as the 68.78±0.01% reported for fried sweet potato by the same authors. This value for the powder sample is in confirmation with the report of Organisation for Economic Co-operation and Development in 2010, which reported the raw sweet potato to be 68.8%. These high carbohydrate values were indicative of the fact that both the powder sweet potato and its syrup are good sources of energy. From the result it shows that consumption of sweet potato can add to daily carbohydrate requirements of each individual. The carbohydrate value of powder sample as observed in this study confers on it the advantage as a rich source of energy. The result also revealed that the prepared syrup had high moisture (17.03±0.38) content compare to the powder sample with 8.71±0.59 moisture contents respectively. This result were lower than what was reported by Abubakar *et al*., (2010) as Sweet potato porridge (60.54±1.57), Sweet potato boiled (54.83±0.29) and Sweet potato fried (39.16±0.18). The result was also lower than potato flower (55.76±1.54) reported by Eleazu and Ironua, (2013).This high different may be due to differences treatment, and use of different species of the sample in analysis. So the syrup may have a short shelf life since microorganisms that cause spoilage grow in foods having high moisture content and also is indicative of low total solids (Adepoju *et al*., 2006). The percentage protein content obtained in this study was 4.08±0.58 and 3.03±0.23% for syrup and raw sample respectively. These values were however, in agreement with the recommendation by USDA, 2009 of 3.7-6.1 in potato and the result is higher than the analysis of Abubakar *et al*., (2010) who give the protein content of different sample as Sweet potato porridge (2.66±0.01)%, Sweet potato boiled (2.27±0.02)% and Sweet potato fried (2.25±0.08)%. The result was also higher than potato flower (2.67± 0.59)% reported by Eleazu and Ironua, (2013). The protein value was higher than 3.3% recorded by the USDA Nutrient Database for Standard Reference (Hall, 1998).

The result of the crude fat revealed that the syrup contained 10.09±0.13 and 15.29±0.27% of the raw sample respectively. These values were however, in disagreement with the recommendation by USDA, 2009 of 0.6 in potato and higher than the analysis of Abubakar *et al*., (2010) who give the fat content of different sample as Sweet potato porridge (0.51±0.02%), Sweet potato boiled (0.30±0.02%) and Sweet potato fried (2.65±0.11)%. Comparing this result with the 0.65±0.03% obtained from South Eastern Nigeria by Eleazu and Ironua, (2013) shows that the sample contains more fat. Dietary fats function in the increase of palatability of food by absorbing and retaining flavours. The percentage ash content of the sweet potato is in the range of 7.63±0.05 to 8.55±0.57% for syrup and powder respectively. However this range is a bit lower than 1.15±0.00% obtained by Eleazu and Ironua, (2013). Highest crude fibre content of 1.31±0.02 was recorded in the raw sample and the lowest value of 0.53±0.00 which is in similar with earlier results of 0.12±0.02

reported by Eleazu and Ironua, (2013). Abubakar *et al*., (2010) also give similar report of crude fibre content of different sample as sweet potato porridge (1.09±0.02%), sweet potato boiled (0.84±0.06%) and sweet potato fried (0.78±0.11%). The low content of fibre is not surprising due to the report by Agostoni *et al*., (1995) that starchy containing samples are not richest sources of dietary fibre. The low content of fibre is an indication that the species of potato may not be very useful to reduce high cholesterol levels, keeping blood sugar levels under control. The result of Calorific value (kcal/100g) was 343.82±1.03 and 427.43±3.61 for syrup and powder samples.

The concentrations of the minerals composition is shown in Table 2. The result revealed that the syrup had high Potassium content of 4600.00±0.00mg/kg when compare with powder sample with 4300.00±0.00mg/kg. The high concentration of potassium in the sample shows that potato can be useful in the normal P^H stability in organisms. That is the maintenance of acid base balance in the body. Potassium deficiency can also cause severe malnutrition, prolonged vomiting or chronic diarrhoea. Iron content of the syrup and powder (26.33±0.66mg/kg and 32.67±0.17mg/kg) was observed to be higher than the value (1.99±0.13mg/100g) for sweet potato porridge, (1.15±0.04mg/100g) for sweet potato boiled and (1.49±0.0mg5/100g) sweet for potato fried as reported by Abubakar *et al*., (2010)**.** This species of Potato has relatively high iron (Fe) contents and it can be recommended for people with iron deficiency. This potato when taking can play numerous biochemical roles in the body, including oxygen binding in haemoglobin and acting as an important catalytic in many enzymes. The results for calcium contents ranging from 20.67±0.33 to 23.33±0.16 in syrup and powder samples respectively. Abubakar *et al*., (2010) reported lower calcium levels for the entire sample analysed as sweet potato porridge (24.55±2.01mg/100g), sweet potato boiled (26.73±0.40mg/100g) and sweet potato fried (23.80±0.46mg/100g). This sample contained law value of calcium which is considered essential for bone and teeth formation and development in children. Calcium is also important to humans because of its contribution in blood clotting, muscle contraction, bone and teeth formation and in some enzymatic metabolic processes (NRC, 1989). The value of phosphorus from the syrup and powder 230.33±0.33mg/kg and 270.33±0.33mg/kg respectively. Since variety of potato studied here contain high value of Phosphorus which is a major structural component of bone in the form of a calcium phosphate salt called hydroxyapatite it can be useful for strengthen of the bones because of the high content of phosphorus. All energy production and storage are dependent on phosphorylated compounds, such as adenosine triphosphate (ATP) and creatine phosphate. Nucleic acids (DNA and RNA), which are responsible for the storage and transmission of genetic information, are long chains of phosphate-containing molecules. Inadequate phosphorus intake results in hypophosphatemia which include loss of appetite, anemia, muscle weakness, bone pain, rickets (in children), osteomalacia in adults (USDA, 2011). So eating of this species of potato can help to prevent death. The sodium content ranges from 320.33±0.33mg/kg to 250.33±0.33mg/kg where powder had the highest while syrup recorded lowest value. The concentration of magnesium was higher in the syrup (2148.33±1.67mg/kg) when compare to 1866.67±33.33mg/kg obtained from the powder sample. The high concentration of magnesium in the sample is an indication that this species of sweet potato may prevent the formation of oxalate kidney stones in body. The Powder recorded low value of zinc (14.33±0.33mg/kg) while syrup recorded higher value of 22.00±0.58mg/kg. These values are much higher than what was reported by Abubakar *et al*., (2010) as sweet potato porridge (0.22±0.01mg/100g), sweet potato boiled (0.26±0.01mg/100g) and sweet potato fried (0.25±0.02mg/100g). The value were within required daily allowance (RDA) of zinc for infants, children, adolescents and adult males and females ranges between 2.0 mg/100 g to 11 mg/100 g (Shils *et al*., 2006). This species of potato could as well be recommended for use as additives in animal feed production and a possibly replacement to serve as a source of Potassium, Magnesium, Sodium and Phosphorous. Table 3 shows the value of essential amino acid composition of the powder *Ipomoea batatas* and its syrup. Eighteen amino acids were found in varying proportions in the raw *Ipomoea batatas* and it syrup. Some essential amino acids (histidine, lysine, valine, leucine, arginine, methionine, arginine, methionine, phenylalanine and isoleucine) were present. However, the respective values for *Ipomoea batatas* syrup was (histidine0.50±0.11, lysine 0.89±0.03, valine 2.49±0.12, leucine 2.32±0.11, arginine 0. 52±0.12, methionine 0.63±0.00 and phenylalanine 1.43±0.12) and powder sample was (histidine1.55±0.04, lysine3.32±0.01, valine3.07±0.02, leucine 6.59±0.03, arginine5.27±0.05, me thioline1.02±0.02, phenylalanine3.80±0.14, and isoleucine3.71±0.07) respectively. Most of the protein values were lower in the raw sample compare to the syrup. The other amino acids are present in moderate amounts. Cysteine is the most limiting amino acid. Adequate methionine prevents disorder of nail, hair, and skin it also reduces liver fat and protect the kidney (Amino acid, 2005). Aspartic acid deficiency decreases cellular energy and may likely be a factor in long time fatigue (Amino acid, 2005).

The functional properties of the powder *Ipomoea batatas* and its Syrup is presented in table 4: The pH of the sample ranges from 5.48±0.20 -6.14±0.09 for syrup and powder respectively. This result is in agreement with 5.32±0.01 obtained by Eleazu and Ironua, (2013). The viscosity (sec) of syrup (240.53±0.27) was higher than powder sample (193.19±0.17), the bulk density (gcm^{-3}) for the syrup syrup was 0.69±0.00 and powder 0.58±0.00. This result is in confirmation with the 0.92±0.01 reported by Eleazu and Ironua, (2013). Higher bulk density is important because it offers greater packaging advantage (Fagbemi, 1999).Water absorption capacity (%) range from 2.53±0.06 to 1.82±0.02 for powder and syrup respectively. Oil absorption capacity (%) was 1.67±0.52% (syrup) and 51.66±1.17% (powder). This result indicates that the species of sweet potato analysed here had low level of oil absorption capacity. The Wetability (sec) of the syrup sample was 116.67±0.33 and that of powder was 74.67±0.33.

4. CONCLUSION

The red sweet potato variety that was studied was observed to possess good functional properties. The sample was found to be a rich source of protein and high minerals content. Red sweet potato variety that was studied can serve as good sources of food nutrients for man. The high moisture content in the syrup indicates that care must be taking to avoid microbial activities. The sample can also be important source of amino acid necessary for the body.

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