Determination of proximate composition, amino acids, minerals and phytochemical profile of Cassava (*Manihot esculenta*) peel from sweet cassava variety grown in Yobe State of North Eastern Nigeria

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Abstract

The proximate composition, amino acid, mineral, and Phytochemical content of Cassava peel was determined. The peels were found to contain 8.70 % moisture, 4.89 % crude protein, 8.75 % crude fiber, 2.15 % crude fat, 8.93 % ash. Nitrogen free extract and metabolizable energy values were 66.56 % and 2717.96kcal, respectively. The results of amino acid content revealed that the histidine and tyrosine are the most limiting amino acid with values of 0.005% each. Essential amino acids such as lysine, leucine, methionine and Isoleucine with values of 0.032, 0.067, 0.076 and 0.070% were low. Mineral profile revealed that magnesium (913.74mg/kg) and iron (111.50mg/kg) as the most abundant mineral. Concentrations of phytochemicals were 26.06, 699.8, 0.063, 24.81,8.37,1457mg/100g and 2.84 for saponin, tannin, hydrogen cyanide, phytate, trypsin inhibitors, alkaloid and oxalate respectively. Based on results of this study, cassava peel can be potential source of energy; however, protein and amino acids contents are very low. It is therefore, recommended that feeding of animal with cassava peel based diets be supplemented with good quality amino acids.

Keywords: Cassava peel, Proximate, Amino acid, Minerals, Phytochemical

La Détermination de la composition immédiate, des acides aminés, des minéraux et du profil phytochimique de la peau de manidis (Manihotesculenta) provenant de variétés de manioc sucrée cultivées dans l'État de Yobe, dans le nord-est du Nigeria

Résumé

La composition immédiate, l'acide aminé, la teneur minérale et phytochimique de la peau de manioc ont été déterminées. Les pelures contenaient 8,70 % d'humidité, 4,89 % de protéines brutes, 8,75 % de fibres brutes, 2,15 % de matières grasses brutes, 8,93 % de cendres. L'extrait sans azote et les valeurs énergétiques métabolisables étaient respectivement de 66,56 % et 2 717,96 kcal. Les résultats de la teneur en acides aminés ont révélé que l'histidine et la tyrosine sont l'acide aminé le plus limitant avec des valeurs de 0,005% chacune. Les acides aminés essentiels tels que la lysine, la leucine, la méthionine et l'isoleucine avec des valeurs de 0,032, 0,067, 0,076 et 0,070% étaient faibles. Le profil minéral a indiqué que le magnésium (913.74mg/kg) et le fer (111.50mg/kg) sont des minéraux les plus abondants. Les concentrations de produits phytochimiques étaient de 26,06, 699,8, 0,063, 24,81,8,37,1457mg/100g et 2,84 pour la saponine, le tanin, le cyanure d'hydrogène, le phytate, les inhibiteurs de la trypsine, l'alcaloïde et l'oxalate respectivement. D'après les résultats de cette étude, la peau de manioc peut être une source potentielle d'énergie ; cependant, la teneur en protéines et en acides aminés est très faible. Il est donc recommandé que l'alimentation des animaux avec des régimes à base de pelures de manioc soit complétée par des acides aminés de bonne qualité.

Mots-clés: Pelure de manioc, Proximate, Acides aminés, Minéraux, Phytochimie

Introduction

Climate change is one of the key drivers of the challenges confronting the North Eastern Nigeria; it has impacted negatively on economic and social fabrics of the population. According to Ambrose *et al.* (2017) climate change poses great danger as it leads to loss of plants and animals as well as depletion of biodiversity. Drought and soil fertility depletion are common phenomena in Yobe and regarded as the fundamental biophysical cause for declining per capita food production (FAO, ICRISAT.2019). According to the (NBS, 2010, UNDP, 2018), Nigeria's multifaceted poverty index reported, Yobe state was ranked as one of the poorest states in the North with multifaceted poverty index (MPI) scores of 0.635. Yobe state also has the highest number of malnutrition cases in Nigeria (WFP, 2017). As a mitigation strategy to the threats posed by climate change, farming communities in some parts of Yobe state have since switched to cultivation of cassava. Cassava, are more robust in the face of higher temperature and increased drought stress, making it a potentially valuable food source (ILRI, 2015). Enormous cassava peels are generated as by product from Cassava processing and holds enormous potential as feed resource for livestock if properly processed (ILRI, 2015). It was reported to be cost-effective in compounding poultry feeds (Etchu *et al.,* 2015). Thus, with emerging technologies of drying, grating and preserving cassava peels, it holds the key to providing a readily available and sustainable source of feeding for domestic animals (Ayomide, 2018). Nutrient analysis enables livestock producers to make optimum use of nutrient, help researchers relate feed to animals' performance and reduce production costs. Nutrient values of cassava peel are listed in ingredient composition tables and reported in the scientific literature. However, in many instances, these values have been reported to be influenced by so many factors such as variety, the age of the harvested crop, soil and climatic conditions (Apeh *et al.,* 2017). Information gap existed on nutrient and phytochemical profile of cassava peels from tubers grown in Yobe State of North Eastern Nigeria. This study was undertaken to bridge the information gap by providing baseline information for researcher, livestock farmers and policy formulators

Materials and methods

Source and preparation of cassava peel

Cassava tubers were collected from Garbi village in Nguru local government area of Yobe State Nigeria. The site was selected based on high production of cassava. Nguru town is the head quarter of Nguru local government area in Yobe state, North Eastern Nigeria. It is located near river Hadejia at 12º 52' 45" N to 10º 27' 09" E. It has population of 150, 632 and an area of 916 sq. km (NPC, 2006). The tubers were washed and peeled with sharp knife to ensure that only outer cover of the tuber was removed. The peels were sun dried for a period of 7 days, milled into fine particle sizes using Laboratory mill (Arthur Thomas, USA), sieved via 1 mm sieve and were packaged in airtight plastic bags prior to analyses.

Laboratory analysis

Triplicate homogeneous representative samples of sweet cassava peel which was kept in properly labeled and tightly sealed clean plastic containers were analyzed. Analyses were conducted at T & D Laboratories Elim Vision Plaza, opposite 2nd Gate University of Ibadan.

Chemical analysis

Determination of proximate composition

Samples of the cassava peel were subjected to proximate analyses according to the methods of AOAC (1990). The parameters determined included moisture content (MC), crude protein (CP), crude fiber (CF), ether extract (EE) and ash content (AC). The nitrogen free extracts (NFE) was determined by difference. NFE (%) = 100 - (% CP + %CF + % ash + % EE).

The metabolizable energy (ME) was calculated from Pauzenga, (1985) formula as follows: ME (kcal/kg DM) = (37 x % CP) + (81 x % fat) + (35.5 x % NFE).

Determination of amino acids

The amino acid content of cassava peel was determined using the method described by AOAC, (1990). Samples were dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and loaded into the Technicon Sequential Multi-sample (TSM) amino Acid analyzer (TSM) using ion-exchange chromatography (Technicon Instruments Corporation, Dublin, Ireland).

Determination of saponin

Saponin content of cassava peel was determined according to method described by Sim (2011). Saponin solution was prepared by dissolving 10 mg of diosgenin, 16 ml of methanol and 4 ml of distilled water. Aliquots were taken in tube and vanillin reagent 8% (0.25 ml) was added. Thereafter 72 % v/v, of sulphuric acid (2.5 ml) was added slowly on the inner wall of tube. The solutions were thoroughly mixed and the tubes were transferred to a water bath set at 60^{o}C. After 10 minutes of incubation, the tubes were cooled in ice cold water bath for 3-4 minutes. Thereafter 0.1 g of freeze dried sample was dissolved in aqueous methanol 80 % (0.1 ml). 0.25 ml of aliquot was taken for spectrophotometric determination for total saponin at 544 nm.

Determination of tannin content

Tannins were determined using the method of Paul *et al*. (1988). 0.2 g of each sample was weighed into a beaker and soaked with solvent mixture (80 ml of acetone and 20 ml of glacial acetic acid) for 5 hours to extract tannin. The filtrate was removed and the sample was filtered through a double layer filter paper to obtain the filtrate. A set of standard solution of tannic acid was prepared ranging from 0 to 10 ppm. The absorbencies of the standard solution as well as that of the filtrates were read at 720 nm on a spectronic 20.

Hydrogen cyanide determination

The hydrogen cyanide content was determined according to method described by FIIRO, (2004). Twenty (20) grams of sweet cassava was weighed and transferred into a 1000 cm^3 beaker containing 100 cm^3 of distilled water, 200 cm^3 of phosphate buffer (pH 6.0) and 10 cm^3 of 2% mercuric chloride solution and left overnight. The sample was then transferred to 500 cm^3 round bottom flask and 5.0 g of hydrated stannous chloride was added to the sample and steam distillation method was used to separate the hydrocyanic acid from the prepared sample. After the mixture was heated by steam distillation, the released hydrogen cyanide was collected in a conical flask containing 50 cm^3 of 1% alcoholic sodium hydroxyl (NaOH) solution until the volume of the distillate was 200 cm^3. The distillate was then titrated against 0.02 M AgNO3 using 1 cm^3 of freshly prepared 0.5% w/v dithizone in ethanol as indicator and the amount of cyanide in the sample was determined. The end point of the titration was accommodated with a color change of the indicator from red to purple.

Concentration of cyanide=

$$\frac{\text{Titre value x 0.52 x 1000}}{\text{Weight of the sample taken}}$$

Determination of phytate

Phytate was determined using the method of Maga (1983). 2 grams of each sample were weighed. 100 ml of 2% concentrated hydrochloric acid was used to soak each sample into conical flask for 3 hours and filtered through a double layer of hardened filter paper. 50 ml of each filtrate was placed in 250 ml beaker and 107 ml of distilled water was added in each case to give proper acidity. 10 ml of 0.3% ammonium thiocyanate solution was added into each solution as indicator. This was titrated with standard iron (III) chloride solution which contained 0.00495g iron per ml. The end point was slightly brownish-yellow which persisted for 5 minutes.

Alkaloid determination

0.5g of cassava peel was weighed with sensitive digital scale and 20ml of 20% Acetic acid was added to it in 100ml beaker. The beakers were covered and allowed to stand for 4 hours. it was later filtered and placed in water bath to reduce the weight to one quarter. Concentrated Ammonium hydroxide was added drop wise until precipitation was complete. It was then collected by filtration and weighed.

Oxalate determination

The total oxalate was determined according to the procedure of Fasset, (1996). The extraction was done by weighing 1 g of each sample and soaked with 100 ml of distilled water. It was allowed to stand for 3 hours and each was filtered through a double layer of filter paper. 10, 20, 30, 40 and 50 ppm standard solution of oxalic acid was prepared and read on the spectrophotometer at 420 nm for the absorbance. The absorbance of filtrate from each sample were also read on the Spectronic 20

Determination of trypsin inhibitor activity

Trypsin inhibitor of the samples was determined by the method of Liener, (1979). 0.2 gram of each sample was weighed into a screw-cap centrifuge tube. 10 ml of 0.1 M phosphate buffer was added and the contents were shaken at room temperature for 1 hour on a UDY shaker. The suspension obtained was centrifuged at 5000 rpm for 5 min and filtered through Whatman No.42 filter paper. The volume of each was adjusted to 2 ml with phosphate buffer. The test tubes were placed in water bath, maintained at 37°C and 6 ml of 5% tricarboxylic acid (TCA) solution was added to one of the tubes to serve as a blank. 2 ml of casein solution was added to all the tubes previously kept at 37°C and were incubated for 20 min. The reaction was stopped after 20 minutes by adding 6 ml of TCA solution to the experimental tubes and then shaken. The reaction was allowed to proceed for 1 hour at room temperature. The mixture was filtered through Whatman No.42 filter paper and the absorbance of filtrate from sample and trypsin standard solutions were read at 280 nm.

Mineral determination

The sodium and potassium content was determined using a flame photometer while calcium, manganese, magnesium, iron, copper, lead, aluminum, phosphorus and zinc were determined by ashing the samples with a mixture of hydrochloric acid and nitric acid, followed by flaming in Atomic Absorption Spectrophotometer (Philip Analytica PU 9100X) using different lamps according to AOAC (1990).

Computed protein efficiency ratio

The C-PER was calculated using the equation described by Alsmeyer *et al.* (1974.)

C-PER = - 0.684 + 0.456 (LEU) - 0.047 (PRO)

= - 0.684 + 0.456(0.067) - 0.047(0.072)

C-PER=0.711

Statistical analysis

All the results were expressed as mean ± standard deviation of triplicate samples.

Results and discussion

The proximate composition of cassava peel is presented in Table 1. The moisture (MC), crude protein (CP), crude fiber (CF), ether extract (EE), ash and nitrogen free extract (NFE) values were 8.70, 4.89, 8.75, 2.15, 8.93 and 66.56 % respectively, while the Metabolizable energy value of 2717.96 (kcal/kg) was recorded. These values are comparable to values of 8.73, 4.21 and 8.46% for moisture, crude protein and crude fiber reported by Ezekiel *et al.* (2010) but higher than the values reported by Monday *et al.* (2017) in a study conducted on three varieties of sweet cassava peels (TMS

98/0581, TMS98/0505 and TMS 98/0524 grown in Apa, Otupko and Ushongo area of Benue state, Nigeria. The NFE value recorded in this study (66.56%) showed that cassava peel contains appreciable level of carbohydrates and can serve as energy source. The ether extract, ash and crude fiber content were higher than the values reported by Christopher *et al.* (2016) in a study conducted on three cultivars of waste cassava peels (NR 07/0220, TMS/419, TMS/3055). However, the crude protein value of 4.89% and ether extract (2.15%) fell within the range values of 3.7 to 5.9 and 0.0 to 3.3% for crude protein and ether extract reported by INRA *et al*. (2012b). Olugbenga (2020) and Heuze (2012) however, reported higher values of crude protein (5.48%), crude fiber (10.50%) nitrogen free extract values (70.46%) and 5.2, 14.0 and 70.9 % when compared with values reported in this study. The variation observed may be attributed to cultivar, agronomic practices and environmental factors. Cadavid *et al.* (1998) reported that cultivar and agronomic practices influence the composition of cassava products. The high fiber, low energy and protein values recorded in this study are in agreement with earlier reports of (Smith 1992, Sogunle *et al*. 2009)). The low- fat and high fiber contents accounted for low energy in cassava peel meal. All cassava cultivars presently grown in Nigeria are low in essential minerals, vitamins, and protein content (Njoku *et al*., 2014).

Table 1: Proximate composition sweet Cassava peels (%)

Nutrients	Values in percent
Moisture	8.70 ± 0.081
Dry matter	91.30 ± 0.074
Crude protein	4.89 ± 0.041
Crude fibre	8.75 ± 0.040
Ether extract	2.15 ± 0.040
Ash	8.93 ± 0.047
Metabilizable energy(kcal/kg)	2717.96± 0.001
Nitrogen free extract	66.56 ±0.124

Values are mean± standard deviation.

The amino acid composition of sweet cassava peel is presented in Table 2. The results of the amino acids profile recorded in this study revealed that Glycine (0.425 %), serine (0.315%), Proline (0.218%), Glutamic acid (0.176%), Arginine (0.140%) and Aspartic acid (0.108%) had the highest values. This differs from earlier report of Paul *et al.* (2016) whose report indicated Leucine and Glutamic acid as the most concentrated amino acids in Cassava peel. Furthermore, the authors reported that cassava and yam tubers contain relatively low amounts of proteins. The minimum threshold index of computed protein efficiency ratio for good quality protein is 1.50 (Friedman, 1996). Thus, computed protein efficiency ratio value (0.711) recorded in this study is below the threshold level hence cassava peel investigated in this study cannot be classified as good quality protein. It is therefore important to enrich cassava peel based diets with quality protein (Afolabi *et al.,* 2012). The least amino acids recorded in this study are Histidine and Tyrosine with value of 0.005% each. The amino acids values recorded in this study were lower than the values reported by (Aro and Aletor, 2012, Paul *et al.,* (2016) for cassava peels. The variation as earlier stated may be attributed to varietal difference, agronomic practices, geographical location and processing methods. Ogunbode *et al.*

(2019) in a study conducted on nutrients and anti – nutrient content of sundried cassava starch extract pulp observed low protein value which was attributed to difference in soil composition and geographical location. The values of proline (0.072%), serine (0.315%) and methionine (0.076%) recorded in this study were higher than the values of 0.03, 0.04 and 0.03 reported by Julie *et al.* (2009) for cassava root. The contents of glycine (0.426), cysteine (0.01) and threonine (0.025) were similar to values of 0.40, 0.01 and 0.03 for glycine, cysteine and threonine reported by the authors.

Table 2: Amino acid profile of sweet cassava peels (%)

Amino acids	Values in percent
Arginine	0.140 ± 0.001
Alanine	0.031 ± 0.001
Aspartic acid	0.108 ± 0.0008
Cysteine	0.01 ± 0.0004
Glutamic acid	0.176 ± 0.0009
Glycine	0.426 ± 0.0008
Histidine	0.005 ± 0.0008
Isoleucine	0.070 ± 0.0004
Leucine	0.067 ± 0.008
Lysine	0.032 ± 0.0001
Methionine	0.076 ± 0.0001
Ornithine	0.103 ± 0.0008
Phenylalanine	0.047 ± 0.0008
Pyrolysine	0.218 ± 0.001
Proline	0.072 ± 0.0004
Serine	0.315 ± 0.001
Threonine	0.025 ± 0.0004
Tyrosine	0.005 ± 0.0008
Trytophan	0.008 ± 0.0004
Valine	0.096 ± 0.002

Values are mean ± standard deviation.

The results for mineral composition of Sweet cassava peels are summarized in Table 3. The concentration of Magnesium, iron, lead and zinc were 913.74, 111.50, 1.97 and 2.88mg/kg respectively. The magnesium (913.74mg/kg) and iron (111.50mg/kg) was the most abundant mineral present. These values are higher than 236 and 14.7 mg/kg reported by Aro *et al.* (2010). The least concentrated mineral obtained in the present study was copper (0.00031%). The iron content recorded in this study (111.50 mg/kg) was higher than 15 mg/kg reported by INRA *et al*. (2012c). The calcium (0.056%) and potassium (0.29%) values recorded in this study are within the range values of 0.01 to 3.3 and 0.3 to 12.5 reported by INRA *et al*. (2012c). The sodium (0.085%) and phosphorus (0.09%) are however lower than values of 0.31 and 2.1 g/kg DM reported by INRA *et al*. (2012c). The values of sodium (0.085%), zinc (2.88mg/kg) and potassium (0.29%) were lower than values of 14 mg/100g, 0.34mg/100g and 271mg/100g reported by Julie *et al*. (2009) for cassava root.

Table 3: Some mineral profile of sweet Cassava peels

Minerals	Values
Ca (%)	0.056 ± 0.004
Mg (mg/kg)	913.74 ± 0.008
Fe (mg/kg)	111.50 ± 0.004
Pb (mg/kg)	1.97 ± 0.004
Zn (mg/kg)	2.88 ± 0.004
Cu (%)	0.00031 ± 4.71
Mn (%)	0.00090 ± 1.084
Na (%)	0.085 ± 0.004
K (%)	0.29 ± 0.004
P (%)	0.09 ± 1.387
Al (mg/kg)	2.1 ± 0.047

Values are mean ± standard deviation.

The concentrations of phytochemicals were 26.06, 699.8, 0.063, 24.81, 8.37, 1457mg/100g and 2.84 for Saponin, Tannin, hydrogen cyanide, phytate, trypsin inhibitors, alkaloid and oxalate respectively. The phytate, HCN and oxalate contents reported in this study 24.81, 0.063 and 2.84 mg/100g were lower than 1.01mg/g, 38.62mg/kg and 82.18mg/kg, 32.9mg/kg and 330mg/kg, reported by (Lamidi and Ogunkule, 2015, Aro *et al.,* 2010). The alkaloid content 1457mg/100 g recorded in this study was above the upper limit of 60 mg/100 g recommended for a safe feed (MacDonald *et al*., 1995). The HCN content (0.063mg/100g) of cassava peel was lower than the values of 0.72mg/100g, 32.9mg/kg and 37.58mg/kg reported by Ezekiel *et al.* (2010), Aro *et al.* (2010) and Ogunbode *et al.* (2019) for unfermented cassava peel, cassava peel and sundried cassava starch extract pulp. Safety limit for cyanide in cassava food is 10 mg/kg dry weight and levels below 100 mg/kg dry weight are considered safe in cassava chips for feeding to different classes of livestock (FAO and IFAD, 2004). The oxalate content recorded in this study (2.84mg/100g) was lower than 27.8mg/100g reported for potatoes (Barbara *et al.,* 2009). The values of anti - nutrients recorded were all below the threshold of lethal levels and therefore safe for animal consumption. Well-processed cassava peels have generally acceptable levels of HCN below 50 mg/kg (Osei *et al*., 1989; Nwokoro *et al*., 2005).

Table 4: Phytochemicals composition of sweet cassava peels

Phytochemicals	Values
Saponin (mg/100g)	26.06 ±0.226
Tannin (mg/100g)	699.8 ±1.023
HCN (mg/100g)	0.063 ±0.009
Phytate (mg/100g)	24.81 ±0.035
Trypsin inhibitor (Tiu/mg/g)	8.37 ± 0.0169
Alkaloids (mg/100g)	1457 ± 2.268
Oxalate (mg/100g)	2.84 ± 0.035

Values are mean ± standard deviation

Conclusion

The results from this study revealed that cassava peel contain appreciable level of NFE (66.56%) and can serve as energy source. The mineral contents showed that magnesium (913.74mg/kg) and iron (111.50mg/kg) are the most highly concentrated minerals. Cassava peels can therefore serve as a valuable source of magnesium and iron in livestock feed. The values of anti -nutrients recorded were all below the threshold of lethal levels and therefore safe for animal consumption. The computed protein efficiency ratio value of 0.711 recorded in this study was below the minimum threshold index level of 1.5 for good quality protein. Similarly, its essential amino acids contents were low. It is therefore, recommended that feeding of animals with cassava diets be supplemented with good quality amino acids.

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