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Chemical composition of *Manihot esculentum crantz (*var. *umucass 36)*

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Abstract

Cassava (Manihot esculentum) is one of the most drought tolerant crops, adapted to varying agro-ecological zones and has a high potential for livestock and poultry production in Nigeria. Thus, proximate, macro and micro minerals, anti-nutrients, gross energy and amino acid profile of cassava (Manihot esculentum crantz var. UMUCASS 36) were carried out using freshly harvested cassava. The cassava root was washed, peeled and chopped into small pieces. This was oven dried and milled to form cassava root meal (CRM). The harvested leaf and petiole was chopped, oven dried and milled as cassava foliage meal (CFM). The tender, green apical part of the stem was equally harvested, chopped, oven dried and milled as cassava tender stem meal (CTSM) while the cassava composite meal(CCM) was a mixture of the root meal, foliage meal and the tender stem meal at the ratio of 10:4:1 respectively. The proximate, gross energy, macro (Na, P, K, Ca and Mg) and micro (Fe, Zn, Mn and Cu) minerals, anti nutritional factors (hydrocyanic acid, tannin and trypsin inhibitor) and the amino acids were determined in line with the internationally accepted standard. There were significant (P<0.05) differences among various parts of the UMUCASS 36 cassava for all the parameters considered. The crude protein was least in cassava root meal (2.29%) and best in cassava foliage meal (21.79%). CCM had the highest (P<0.05) gross energy of 3.77kcal/g. CFM had the best contents of sodium (0.27%), potassium (0.88%) and phosphorous (0.38%).CRM had the highest value of calcium (0.29%), CTSM (potassium, 0.88%) and CCM (magnesium, 0.34%). In micro mineral contents, significant(P<0.05) differences existed across the parts examined. CFM was superior in both iron and zinc contents while CTSM had best values of copper and manganese. Hydrocyanic acid value ranged from 1.26mg/kg in CFM to 6.57mg/kg in CCM while trypsin inhibitor had highest value of 9.62TIU/mg in CRM and CFM had tannin value to be 0.086% being the highest. All the anti-nutritional factors measured were at tolerable levels to broiler chicken. Percentages of amino acids like arginine, cysteine, histidine, phenylalanine and valine in leaf meal were high with these values 6.46, 3.09, 1.34, 3.14, and 8.27% respectively. The nutritive contents of UMUCASS 36 revealed that the root meal with gross energy of 3.66Kcal/g is a potential energy source and therefore can be used as an energy source in poultry ration. The high content of crude protein and its attendant amino acids in the UMUCASS 36 foliage meal placed it at a better level for consideration as replacement for the expensive soybean.

Keywords: UMUCASS 36, proximate composition, minerals, anti-nutrients, amino acid

Introduction

The scarcity of conventional raw materials for feed mill industry has caused a continuous rise in the cost of production, resulting to tremendous increase in the unit cost of livestock products such as eggs, meat and milk. Thus, these conventional raw materials, especially corn and soybean which are the main respective energy and protein sources in livestock feed have become uneconomical to the livestock farmers. This now necessitate a search for alternative feed materials that are readily available, cheap and less competitive with man.

Cassava is a potential energy source for animal production in Nigeria. It is widely grown in Nigeria and can serve as an alternative feed stuff especially as energy and protein sources.Cassava is one of the most drought tolerant crops and can be successfully grown on marginal soils, giving reasonable yields where other crops cannot do well (Cassava Master Plan, 2006). Out of more than 228 million tons of cassava produced worldwide, Nigeria produces 50 million tons of it yearly (Iwere, 2013). Nigerian cassava production is by far the largest in the world; producing a third more than Brazil and almost double the production of Indonesia and Thailand (FAO, 2004).

It has been projected that total world cassava utilization would hit 275 million tons by 2020 while some researchers estimate this figure close to 291 million tones (IFPRI, 2008; Iwere, 2013). Currently, there is increase in campaign for enlarging the cassava production scale in Nigeria. Therefore, cassava varieties such as **UMUCASS 36** offer tremendous potentials as a cheap alternative feed resource for animals.

The UMUCASS 36 cassava variety was bred by International Institute for Tropical Agriculture (IITA), Nigeria. It is a species of *Manihot esculenta Crantz* with a variety name UMUCASS 36. It was developed by National Root Crops Research institute (NRCRI), Umudike, Nigeria and has a breeder's code of IITA TMS 011368 (HarvestPlus, 2015).It is a pro-vitamin cassava with high β-carotene content which makes it more preferable to other existing varieties of cassava. The variety was released in the year 2011 and is widely adapted across the agro-ecologies from the humid forest in southern Nigeria to the semi- arid environment in the north. It could be harvested from 10-12 months of age with a root yield of 39.41 t/ha. UMUCASS 36 is moderately resistant to most pest and diseases of normal cassava (HarvestPlus, 2015).

The potential of UMUCASS 36 is yet to be fully explored for animal feed-stuff. Therefore, the aim of this research is to evaluate the chemical composition of this variety of cassava for eventual inclusion in livestock and poultry feed.

Materials and methods

Procurement and processing of experimental material

Preparation of cassava roots meal

The pro-vitamin variety of cassava roots (UMUCASS 36) was collected from cassava farm of the National Root Crops Research Institutes (NRCRI). The roots were washed and peeled and cut into small chips and oven dried at 70 °C for two days before milling. The milled flour was packed into polythene bags, until ready for use.

Cassava foliage meal

The leaves and tender stems of UMUCASS 36 cassava were collected at the point of harvest from cassava farm of National Root Crops Research Institute (NRCRI). They were then chopped into smaller sizes and then oven dried at 70°C before milling. The cassava foliage meal was packed into polythene bag ready for use.

Proximate compositions and gross energy of UMUCASS 36 cassava root meal, foliage meal, tender stem meal and composite meal

Samples of test ingredients (root meal, foliage meal, tender stem meal and composite meal) were analyzed for proximate constituents according to the methods of AOAC (2000). The gross energy was determined using adiabatic bomb calorimeter.

Mineral determination

Minerals were analyzed by dry ashing the samples at 550°C to constant weight and dissolving the ash in volumetric flask using distilled, de-ionized water with a few drops of concentrated hydrochloric acid. Sodium, calcium and potassium were determined using a flame photometer (Model, 405, Corning, UK) using NaCl and KCl to prepare the standards. Mg, Cu, Zn, and Fe were determined by atomic absorption spectrophotometry using buck 600 AAS. Phosphorus and manganese were determined using spectric 21D digital spectrometer. All determinations were done in triplicate.

Determination of amino acid profile

The amino acid profile was determined using the method described by AOAC (2006). The dried and pulverized samples were made to be free of water by ensuring constant weight for a period of time in the laboratory. 10g of the sample was weighed into the 250mL conical flask capacity. The sample was defatted by extracting the fat content with 30mL of petroleum spirit three times with soxhlet extractor that was equipped with thimble. The sample was hydrolysed by using 30mL of de-ionized water three times.

The amino acid content of the sample was recovered by extraction with 30mL of methylene chloride thrice before concentrated to 1mL for gas chromatography analysis.

Determination of anti-nutritional factors

Determination of hydrocyanic acid

Hydrocyanic acid was determined using Knowles *et al.* (1990) method. 5g of each sample was weighed into 250mL conical flask and soaked with 25mL of distilled water for 3hours. These were incubated for 16 hours at a temperature of 38°C, after the extraction.Filtration was done using double layer hardened filter paper. The distillation was carried out using Markham distillation apparatus. Each sample extracted was transferred into a two-necked 500mL flask connected to a steam generator. This was steam-distilled with saturated sodium bicarbornate solution contained in a 50mL flask for 60 minutes. About 1mL starch indicator was added to 20mL each of distillate and was titrated with 0.02N of iodine solution. The colour change was observed from colourless to blue which was the end point. The percentage hydro-cyanide was calculated with the formula:

$$\% \text{ hydrocyanic acid} = \frac{\text{titre} \times 100 \times 0.27 \times 100}{10 \times 1000 \times \text{weight of sample}}$$

Determination of trypsin inhibitor

Determination of trypsin inhibitor was carried out according to the procedure outlined by Kakade and Evans (1965). This involved weighing of 0.2g of the sample into a screw cap centrifuge tube. Also, 10mL of 0.1M phosphate buffer was added and the contents shaken at room temperature for 1 hour on a UDY shaker. The suspension obtained was centrifuged at 5000rpm for 5 minutes and filtered through Whatman No. 42 filter paper. The volume of was adjusted to 2mL with phosphate buffer. The test tube was placed in water bath, maintained at 37°C. Again, 6mL of 5% TCA solution was added to one of the tubes to serve as a blank. Then, 2mL of casein solution was added to all the tubes, which were previously kept at 37°C. The content was incubated for 20 minutes. The reaction was stopped after 20minutes by adding 6mL TCA solution to the tube and was shaken using UDY shaker. The reaction was allowed to proceed for 1 hour at room temperature. The mixture was filtered through Whatman No. 42 filter paper. Absorbance of filtered sample and trypsin standard solutions was read at 280nm. The trypsin inhibitor in mg/g was calculated using the formula:

$$T.I.\ mg/g = \frac{A\ standard - A\ sample}{0.1g \times sample\ wt\ in\ g} \times \frac{Dilution\ factor}{1000 \times sample\ size}$$

Determination of tannins

Tannin in the test feedstuff was determined according to the method of Maga (1982). 2g of sample was weighed into a beaker and soaked with solvent mixture (80mL of acetone and 20mL of glacial acetic acid) for 5 hours to extract tannin. Each filtrate was in the water-bath for 4 hours, after which the filtrates were removed. The samples were filtered through double layer filter paper to obtain the filtrate. A set of standard solution of tannic acid was prepared ranging from 10ppm to 50ppm. The absorbencies of the standard solution as well as that of the filtrates were read at 500nm on a spectronic 20. The percentage tannin was calculated using the formula:

$$\%\ tannin = \frac{absorbance \times average\ gradient \times dilution\ factor}{10,000}$$

Results and discussion

Table 1 presents the values of proximate composition and gross energy of UMUCASS 36 cassava root meal, foliage meal, tender stem and composite meal. There were significant (P<0.05) differences between the various parts of the UMUCASS 36 cassava for all the parameters considered. The crude protein ranged from 2.29% in cassava root meal to 21.79% in cassava foliage. The crude protein of the root meal of this variety of cassava fell within the values as reported by Oni *et al.* (2010) who reported 2.35% (MS 6), 2.08% (TMS 30572), 2.40% (TMS 30555) but cannot be compared with the crude protein of maize which ranged between 4.50 and 9.87% (Nuss and Tanumihardjo, 2014; Enyisi *et al.,* 2014). The crude protein of UMUCASS 36 foliage meal of 21.79% is in line with the report of Ravindran and Ravindran (1988) who established cassava leaf meal to have 21.00% crude protein. Other workers reported 18.00% (Akinfala *et al.,* 2002), 27.00% (Lukuyu *et al.,* 2014), 26.7% (Nigiki *et al.,* 2014)**,** 23.78% (Natalie and Mingan, 2016). This high percentage of crude protein in cassava leaf meal may make it suitable for partial replacement for highly competitive and costly soybean in livestock feed. The crude protein in cassava tender stem is next in value to the root meal with a value of 5.93%. Akinfala *et al.* (2002) submitted a value of 10.7% for tender stem which is higher than the value for this particular variety of cassava used in this experiment. This probably may be due to variety differences, the soil type and age of the cassava as at the time of harvest. The crude protein (19.83%) of the cassava composite meal was close to the cassava foliage meal (19.83%), though significantly (P<0.05) different from it. The value of the crude protein of UMUCASS 36 composite meal agree with the value of 18.9% crude protein reported by Nigiki *et al*. (2014) for cassava root leaf meal mixture. The composite meal can as well replace soybean in broiler feed but not totally because of the level of crude protein in it.

The ether extract percentages differed significantly (P<0.05) among the components of the cassava plant considered. The CCM had 7.67% as the highest followed by CRM having 4.10%, CTSM (2.71%) and CFM with 2.36%. Nigiki *et al*. (2014) reported 0.85%ether in CRM. The ether extract in UMUCASS 36 root meal was higher than what Nigiki *et al*. (2014) reported but similar to the value (3.92%) of Sarkiyayi and Agar (2010), who worked on sweet variety of cassava. This variability could be attributed to variety

Table 1:Proximate composition and gross energy of various parts of UMUCASS 36

Parameters (%)	CRM	CFM	CTSM	CCM	SEM
Dry matter	91.07^{b}	90.42^{d}	90.84^{c}	92.82^{a}	0.02
Crude protein	2.29^{d}	21.79^{a}	5.93^{c}	19.83^{b}	0.04
Ether extract	4.10^{b}	2.36^{d}	2.71^{c}	7.67^{a}	0.00
Crude fibre	6.45^{b}	19.77^{a}	19.74^{a}	5.87^{c}	0.00
Ash	7.56^{b}	8.70^{a}	6.33^{c}	4.74^{b}	0.02
NFE	70.67^{a}	37.80^{d}	56.13^{b}	54.71^{c}	0.05
Gross energy (Kcal/g)	3.66^{b}	3.42^{c}	2.89^{d}	3.77^{a}	0.00

CRM-cassava root meal, CFM -cassava foliage meal, CTSM - cassava tender stem meal, CCM - cassava composite meal, SEM- Standard Error of Mean. Means within the same row with different superscript ($^{a-d}$) are significantly (P< 0.05) different.

differences. The high ether extract value of UMUCASS 36 in its root meal and composite meal may make it to have a better feed efficiency. The root meal of UMUCASS 36 had a crude fibre level of 6.45%, foliage meal (19.77%), tender stem (19.74%) and composite meal (5.87%). The crude fibre of CFM value was similar to the value ofCTSM but differed significantly (P<0.05) from the values of CRM and CCM. Natalie and Mingan (2016) submitted a value of 3.70% crude fibre which is lower than what was observed in UMUCASS 36. The age at the time of harvest could influence the fibre content. The observed high level of crude fibre in UMUCASS 36 suggests that it is more fibrous than other varieties and the inclusion level in poultry diet should be low. Nigiki *et al.* (2014) submitted a value of 14.50%, while Akinfala *et al.* (2002) reported a value of 14.20% for crude fibre for cassava leaf meal which is quite low to the crude fibre in the UMUCASS 36 foliage meal probably because of the presence of the petioles in the UMUCASS 36 sample used in this experiment. They equally reported the root leaf mixture value of 12.6% which was higher than what was obtained in this work. This could be due to different ratio of mixture used. For tender stem, Akinfala *et al.* (2002) gave a value of 27.90% against 19.74% of UMUCASS 36. This could be attributed to variety difference. The 5.87% crude fibre in the composite meal of UMUCASS 36 compare favourably with 5.12% crude fibre of soya bean as reported by Ensimiger *et al.* (1990) which suggested that the composite meal could partially replace soya bean meal in broiler diet.

The ash differed significantly (P<0.05) across the various parts of the plant considered. The CRM (7.56), CFM (8.70), CTSM (6.33), CCM (4.74). Nigiki *et al.* (2014) submitted a value of 10.20% of ash in leaf meal while Lukuyu *et al.,* (2014) opined on 8.60% in foliage meal. For ash in tender stem, Akinfala *et al.* (2002) gave a value of 10.00%. These high values of ash imply that UMUCASS 36 is rich in mineral content than other varieties considered.

Nitrogen free extract (NFE) followed the same pattern of being significantly (P<0.05) different from each other like other parameters. The following percentages were recorded 70.67, 37.80, 56.13, and 54.71% for CRM, CFM, CTSM and CCM respectively. Lukuyu *et al.* (2014) and Nigiki *et al*. (2014) submitted the following percentages 59.2 and 79.10 respectively for cassava root meal. UMUCASS 36 root meal has lower value of NFE when compared with values of other researchers except 59.20% reported by Lukuyu *et al.* (2014). This lower value implied that the total digestible nutrient (TDN) in it is not as much as in the cassava varieties reported by other researchers because Eburuaja (2010) stated that the higher the value of NFE the more available the nutrients. Nigiki *et al*. (2014) reported 37% as the NFE in cassava leaf while Lukuyu *et al.* (2014) had a value of 42.9% in foliage meal which was similar to the result of UMUCASS 36 foliage meal. Cassava root meal mixture had a value of NFE as 61.6% as reported by Nigiki *et al*. (2014) which was higher than 54.71% of the UMUCASS 36 composite meal.

The gross energy of UMUCASS 36 ranged between 2.89 kcal/g in CTSM and 3.77kcal/g in CCM. There were significant (P<0.05) differences in gross energy of all the parts of the plant considered. Olugbemi *et al.* (2010) reported a value of 3.28 kcal/g which is similar to the gross energy of UMUCASS 36 root meal. Nuss and Tanumihardjo (2010) established maize had 3.65kcal/g as energy; the gross energy value of UMUCASS 36 root meal and CCM are comparable which implied that CRM and CCM of UMUCASS 36 can comfortably replace maize in broiler diet. On the average CRM can replace maize in broiler diet but will have to be fortified with other sources of crude protein while CCM can perfectly replace maize in broiler diet. CFM can as well partially replace soybean in diet formulation.

The macro and micro mineral composition of UMUCASS 36 is presented in Tables 2 and 3.

There were significant (P < 0.05) differences in all the parameters considered. The values of Sodium are 0.24, 0.27, 0.23 and 0.21% for CRM, CFM, CTSM and CCM respectively. Julie *et al.* (2009) said cassava root meal had 0.76% while the leaf had 0.51% of sodium which was higher than the values recorded of UMUCASS36. With these values of sodium in UMUCASS 36, it would reduce the amount of salt that will be added to the broiler diet since Olomu (2011) recommended 0.25% inclusion in broiler diet thereby reducing cost of production. Salt is important in broiler diet because the deficiency of it could result to reduced appetite and growth rate, decreased egg production and egg size, increased cannibalism and death in a prolonged cases of deficiency (Ewa, 2015).

Table 2: Macro minerals composition of UMUCASS 36

Parameters (%)	CRM	CFM	CTSM	CCM	SEM
Sodium	0.24b	0.27a	0.23c	0.21d	0.00
Potassium	0.70c	0.88a	0.88a	0.73b	0.00
Calcium	0.29a	0.28b	0.25c	0.23d	0.00
Phosphorous	0.36b	0.38a	0.32d	0.34c	0.00
Magnesium	0.28c	0.29b	0.25d	0.34a	0.00

CRM-cassava root meal, CFM-cassava foliage meal, CTSM- cassava tender stem meal, CCM- cassava composite meal, SEM- Standard Error of Mean. Means within the same row with different superscript (a-d) are significantly (P< 0.05) different.

CFM and CTSM have similar value of 0.88% of potassium but significantly (P<0.05)different from CRM (0.70%) and CCM (0.73%). Julie *et al.* (2009) recorded a similar value of 0.72% of potassium for the root meal while they had a range of 0.35 to 1.23% of potassium for cassava leaf meal which is in line with the discovery of this experiment. Potassium is involved in membrane function and carbohydrate metabolism; potassium in combination with sodium chloride functions is also involved in maintaining acid base and ionic balance of body fluid (Olomu, 1995; Roberts *et al.,* 2006).

UMUCASS 36 has calcium (Ca) contents of 0.29, 0.28, 0.25 and 0.23% for CRM, CFM, CTSM and CCM respectively which are significantly (P<0.05) different from one another. A range of 0.19 to 1.76% (cassava root meal) and 0.34 to 7.08% (cassava leaf meal) were submitted by Julie *et al.* (2009). Sarkiyayi and Agar (2010) reported sweet and bitter varieties of cassava to have 0.33% and 0.30% of calcium respectively. The value of calcium (0.29) in CRM of UMUCASS 36 fell within the range observed by Julie *et al.* (2009) but the leaf meal value was lower probably due to variety difference or soil conditions which normally affect the nutrient composition of cassava. Deficiency of Ca may cause deformity of bones (Rickets and Osteomalacia) and reduced growth rates (Roberts *et al.,* 2006).

Phosphorous of UMUCASS 36 differed significantly (P<0.05) across the various parts of the plant considered CRM (0.36%), CFM (0.38%), CTSM (0.32%) and CCM (0.34%). These values are in line with the range of values reported by Julie *et al.* (2009). They reported cassava root meal to have a range of 0.06 to 1.52% and cassava leaf meal to have 0.27 to 2.11%. There were significant differences (P<0.05) observed in the values of magnesium of UMUCASS 36. They ranged between 0.25 (CTSM) and 0.34% (CCM). Julie *et al.* (2009) opined on much lower value of 0.03 to 0.08% for cassava root meal but 0.12 to 0.42 for cassava leaf meal which is in line with what was observed in UMUCASS 36 foliage meal. The macro minerals in CFM is comparable to soybean with calcium of 0.26%, magnesium (0.28%), sodium (0.03%) with exception of phosphorous (0.57%) and potassium (1.59%) which were higher in soybean. Ca along with Phosphorus and Magnesium were important constituents of bone and are also involved in blood clotting (Roberts *et al.,* 2006).

Table 3: Micro minerals composition of UMUCASS 36

Parameters (mg/kg)	CRM	CFM	CTSM	CCM	SEM
Iron	193.55[b]	221.65[a]	189.40[c]	178.50[d]	0.37
Copper	6.95[b]	5.55[c]	22.25[a]	3.95[d]	0.10
Zinc	36.00[b]	41.55[a]	5.35[d]	14.05[c]	0.35
Manganese	15.10[d]	17.70[c]	28.50[a]	22.15[b]	0.10

CRM-cassava root meal, CFM-cassava foliage meal, CTSM- cassava tender stem meal, CCM- cassava composite meal, SEM- Standard Error of Mean. Means within the same row with different superscript ([a-d]) are significantly (P< 0.05) different.

Iron in UMUCASS 36 was quite high with CRM having (193.55), CFM (221.65), CTSM (189.40) and CCM (178.50) mg/kg. They differed significantly (P< 0.05). These values fell within the values (149 – 300mg/kg) reported by earlier researchers (Ravindran and Ravindran, 1988; Sarkiyayi and Agar, 2010). Iron is very important because of its occurrence in many hemoproteins such as hemoglobin, myoglobin and the cytochromes (Roberts *et al*., 2006). Its deficiency causes nutritional anaemia and decrease in haemoglobin content; however excess iron interferes with normal bone formation and hematopoiesis and lowers phosphorus and manganese availability (Olomu, 1995). Copper differed significantly (P<0.05) across the various parts of the plant considered CRM (6.95 mg/kg), CFM (5.55 mg/kg), CTSM (22.25 mg/kg) and CCM (3.95mg/kg). These values are in line with the discoveries of Ravindran and Ravindran (1988) and Julie *et al.* (2009). Copper is important in diets because it accepts and donates electrons and it is required for the utilization of iron in haemoglobin formation (Robert *et al*., 2003). However, excess of copper can cause problems because it can oxidize proteins and lipids, bind to nucleic acids and enhance production of free radicals (Roberts *et al.,* 2006; Olomu, 1995). Too high a level of copper has been reported to make feed unpalatable (Olomu, 1995).

There were significant differences (P<0.05) in the zinc contents of UMUCASS 36. The foliage meal recorded highest value of 41.55mg/kg of zinc and the least was found in CTSM with a value of 5.35mg/kg. These values observed in zinc content are in line with the range of values observed by Julie *et al.* (2009) with the exception of CTSM. Zinc regulates many processes of carbohydrate, lipid and protein metabolism because it is a component of over 70 enzymes (Olomu, 2011). It also plays a role in calcification of bones. The deficiency of zinc causes retarded growth and poor feather development, reduced egg production and hatchability in poultry (Olomu, 2011). Too much of zinc influences copper requirement (Olomu, 2011).

UMUCASS 36 has manganese contents of 15.10, 17.70, 28.50 and 22.15mg/kg for CRM, CFM, CTSM and CCM respectively which are significantly different (P<0.05) from one another. Ravindran (1992) reported a value of 52mg/kg cassava leaf meal which is higher than what was observed for UMUCASS 36 foliage meal. This variance may probably be due to some portion of petioles in the foliage meal and / or the variety difference. Meanwhile Julie *et al.* (2009) gave an average of 10mg/kg in root meal and a range of 72 to 252mg/kg in leaf meal. These could be attributed to the presence of petioles in the foliage meal as stated above. Manganese is important in the normal utilization of protein, carbohydrate and fat in the body because it is a cofactor of many enzymes e.g. esterase, kinase, peptidase, decarboxylase etc. (Olomu, 1995). It is also important in the prevention of bone malformation.

Generally, cassava foliage meal had a better share of the macro and micro nutrients in cassava plant followed by the root meal then cassava composite meal and lastly cassava tender stem meal though it showed high contents of potassium, copper and manganese. These parts could be used successfully in poultry diet depending on the ratio involved.

The levels of anti-nutrients in UMUCASS 36 are shown in Table 4. CCM contained higher hydro cyanic acid (HCN) with a value of 6.57mg/kg followed by CRM with 4.36 mg/kg then CTSM with 1.74mg/kg and lastly 1.26mg/kg in CFM. They all differed significantly (P<0.05). These values were lesser than the value (8.82mg/kg) Khang *et al.* (2000) observed in fresh cassava tubers. This could be due to variety difference. The level of HCN in UMUCASS 36 agreed with the discovery of Sarkiyayi and Agar (2010) of sweet cassava (4.60mg/kg) and (6.50mg/kg) for bitter cassava. These values were still within what broiler chicken could tolerate. Broiler chicken could tolerate as much as 100mg/kg above which could be toxic to their system. Apata and Babalola (2012) suggested a cyanide level that is <141mg/kg for broiler diet. Trypsin inhibitor (TI) level ranged between 2.25TIU/mg in CFM and 9.62 TIU/mg in CRM. They are all significantly (P<0.05) different. The 9.62 TIU/mg in CRM of UMUCASS 36 is in line with the 10.00 TIU/mg in the sweet cassava as reported by Sarkiyayi and Agar (2010).

Trypsin Inihbitor binds irreversibly to proteolytic enzyme thereby making them unavailable for the breakdown of protein which has been inactivated completely (Ewa, 2015). The TI is also known to cause pancreatic hypertrophy which depresses energy availability in animals (Akanji *et al.,* 2003).

Table 4: Anti-Nutritional Factors composition of UMUCASS 36

Parameters	CRM	CFM	CTSM	CCM	SEM
HCN (mg/kg)	4.36^{b}	1.26^{d}	1.74^{c}	6.57^{a}	0.00
Trypsin inhibitor (TIU/mg)	9.62^{a}	2.25^{d}	2.37^{c}	8.74^{b}	0.00
Tannin (%)	0.014^{b}	0.086^{a}	0.005^{c}	0.003^{d}	0.00

CRM-cassava root meal, CFM-cassava foliage meal, CTSM- cassava tender stem meal, CCM- cassava composite meal, SEM- Standard Error of Mean. Means within the same row with different superscript ($^{a-d}$) are significantly (P< 0.05) different.

The values Tannin in UMUCASS 36 was 0.014, 0.086, 0.005 and 0.003% for CRM, CFM, CTSM and CCM respectively. They are significantly different (P<0.05) from one another. Earlier researchers Khang *et al.* (2005); Sarkiyayi and Agar (2010) reported the values of Tannin in cassava foliage to be 3.81%, 0.40% for sweet cassava root and 0.60% for bitter cassava root which was higher than the tannin in UMUCASS 36 foliage meal. This difference may be due to variety and the soil type. The low level of tannin in UMUCASS 36 will make it more advantageous for farmers to use in broiler diet than other varieties of cassava because tannin forms a complex linkage with protein leading to loss of protein and consequent poor growth (Olomu, 1995).

The amino acid profile of UMUCASS 36 is presented in Table 4.5. Julie *et al.* (2009) who gave a full profile like represented in Table 4.5 had all their values lower than values observed in UMUCASS36 leaf meal with the exception of aspartic acid (2.44%) and serine (1.68%). This could be attributed to variety differences and also suggest that UMUCASS 36 leaf meal could serve better for poultry feed stuff in terms of amino acid level.

Table 5: Amino acid profile of UMUCASS 36 foliage meal

Parameters (%)	Value
Alanine	2.19
Arginine	6.46
Aspartic acid	2.16
Cysteine	3.09
Glutamic acid	8.67
Glycine	3.07
Histidine	1.34
Isoleucin	1.75
Leucine	3.44
Lysine	1.94
Methionine	0.54
Phenylalanine	3.14
Proline	2.64
Threonine	1.53
Tryptophan	1.26
Tyrosine	3.27
Ornithine	0.24
Serine	0.9
Valine	8.27

Soybean meal has the following range of amino acid content in percentage (%) dry matter arginne (2.45-3.1), cystine (0.45-0.67), histidine (1.0-1.22), isoleucine (1.76-1.98), leucine (2.2-4.0), lysine (2.5-2.66), methionine (0.5-0.67), phenylalanine (1.6-2.08), threonine (1.4-1.89), tryptophan (0.51-2.44) and valine (1.5-2.44) (ENV/JM/MONO, 2001). It is worthy to note that the percentages of arginine, cysteine, histidine, phenylalanine and valine in UMUCASS 36 leaf meal were higher than what ENV/JM/MONO (2001) observed for soybean meal. While isoleucine, leucine, methionine, threonine and tryptophan are within the same range, lysine in UMUCASS 36 leaf meal was lower than lysine in soybean meal (ENV/JM/MONO 2001). Comparing the amino acid in UMUCASS 36 and the work of early researchers (Wyllie and Chamanga, 1979) on cassava leaf and petiole, the amino acid contents of UMUCASS 36 were low. This may be due to variety difference (s), the soil conditions, the age and time of harvest of the leaf. The importance of amino acid in poultry feed cannot be overemphasized as they are the building blocks of protein which is used to build body tissues and repairs in the body.

Conclusion and recommendation

With the little exploration of this variety of cassava (UMUCASS 36), it could be said that this variety is better than existing ones in terms of colour, yield, low anti nutritional contents, high β carotene content (a precursor for vitamin A which is essential for sight) and the amino acid profile. These made it a good feeding stuff both for human consumption and for livestock especially poultry.

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