NUTRIENT DETERMINATION OF CASSAVA PLANT MEAL

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ABSTRACT
The study assessed the nutrient profile in composite Cassava Plant Meal (CPM) with a view to enhancing its efficiency through bio-fortification. Three CPM products were developed from Tropical *Manihot* Species (TMS) 30572 harvested at 24 months. The sun-dried unpeeled cassava root meal, cassava leaf meal and tender cassava stem meal were mixed at ratios 2:1, 2.5:1 and 3:1 while the ratio of the leaves to tender stems was 5:1 across the three cassava plant meal products. The proximate composition, minerals, amino acids and vitamins contents of CPM and maize were determined. Results of proximate contents showed that CPM products had comparable crude protein and nitrogen free extract as maize. CPM products showed superiority (P <0.05) in calcium content over maize meal though maize meal was significantly higher (P <0.05) in phosphorus content compared to the three CPM products. All evaluated parameters of amino acids showed differences (P<0.05) although methionine contents were lower in all CPM products and maize. CPM products had significantly (P <0.05) higher values than maize in all evaluated vitamin contents. Based on the findings of this study, it can be concluded that CPM products had comparable nutrient profile as maize with CPM product 1 comparatively better in all evaluated nutrient profile.
Key words: Cassava plant meals, TMS 30572, maize, nutrients.

INTRODUCTION

Improving livestock productivity especially poultry and swine production require adequate supply of low-cost feeding ingredients. The cost of feeding has been reported to be 65 – 80 % of the total cost of production (Longe, 2006) with maize constituting 40 – 60 % of a balanced maize-soy based diet for poultry and swine. However, the seasonal feed deficit, ever rising cost of feeding ingredients and competition with human food consumption have consistently driven efforts towards the use of alternative dietary energy feed resources for monogastrics (Morgan and Choct, 2016). One of such alternative dietary energy feedstuff is cassava. Cassava and its components have enjoyed widespread patronage as potential energy source for animal production in Nigeria. It is cheap, widely grown with a yearly tuber production of 59.5 million tons and grows at an annual rate of + 4.0 %; the largest in the world (FAOSTAT, 2018). However, after harvesting the value-giving component, substantial proportion of the co-products (leaves and tender stems) are allowed to rot on farms and homesteads (Akinfala and Tewe, 2004). The incorporation of these cassava fractions to form composite cassava plant meal (unpeeled cassava tuber meal + cassava leaves and tender cassava stem meal) had been shown by previous studies to enhance performance of pigs (Adeyemi and Akinfala, 2018; Akinfala *et al.,* 2013) and poultry (Akinfala *et al.,* 2011; Akinfala *et al.,* 2002;). Similarly, studies have reported detailed information on the efficiency and nutrient profile of cassava flour (Ngiki *et al.*, 2014; Nagib and Sousa, 2007) or leaves (Iyayi and Losel, 2001) or peels (Iyayi and Losel, 2000) and its acceptability as energy source for livestock. Nevertheless, the detailed nutrient profile of CPM has not been widely documented. Detailed information on feed resource could support sustainable livestock production and offer wider feed options in livestock production system (FAO, 2018). The research was carried out to characterise the nutrients in cassava plant meal with a view to enhancing its efficiency through bio-fortification.

MATERIALS AND METHODS

Experimental location and preparation of test ingredients

The experiment was carried out at the Poultry Meat Laboratory of the Department of Animal Sciences Obafemi Awolowo University, Ile-Ife and the Laboratory of Animal Science, University of Ibadan,

Ibadan. The cassava variety of Tropical *Manihot* Species (TMS) 30572 aged 24 months were purchased from a commercial farm at Ile-Ife. The roots were lifted and soil was shaken off the roots while the cassava leaves were harvested from the plant stem and the tender stems were harvested at 5 cm, usually 6 to 7 nodes from the top of the plant. All the cassava components were harvested between June and November 2018. The fresh roots (unpeeled cassava root) were washed and chopped into small pieces, sun-dried on a concrete floor for an average of 5 – 6 days depending on the intensity of the sunlight, milled with 3 mm sieve mesh and packed into sacks. Also, the fresh cassava leaves and tender stems were sun-dried for about 3-4 days and about 5 days respectively after harvesting, milled and packed into separate sacks. The composite cassava plant meal products were mixed in line with the procedure of Akinfala *et al*. (2002) at three different ratios of 2:1, 2.5:1 and 3:1 represented as products 1, 2 and 3 respectively. The mixing ratio was in attempt to have comparable minimum crude protein content of 10 % as maize.

Nutrient determination

The nutrients determined in the cassava plant meal products include amino acids (essential and non-essential amino acids), vitamins (fat and water soluble vitamins) and minerals (calcium, phosphorus, zinc and copper). The fat soluble vitamins were determined following the procedure outlined by Adams and Moss (1995). The amino acid profile was carried out using the spectrophotometric determination of Ninhydrin chemical reaction. Mineral (Ca, P, Zn and Cu) contents and proximate composition were determined following the methods of AOAC (2005).

RESULTS AND DISCUSSION

The three cassava plant meal (CPM) products had comparable values with maize in the crude protein, ether and nitrogen free extracts (Table 1). Although, significant difference (P <0.05) exists in the values obtained for the crude fibre and ash with maize having the lowest values while CPM product 1 had the highest. The ash content of the CPM products decreased with increased inclusion of unpeeled cassava root meal in the mix.

Table 1: Proximate composition of maize and cassava plant meal products

Proximate Composition (%)	Maize	CPM1	CPM2	CPM3	SEM	*p*
Dry Matter (DM)	88.05	90.18	90.17	90.06	0.36	0.15
Crude Protein (CP)	10.38	12.62	12.25	12.51	0.56	0.24
Crude Fibre (CF)	2.57^{d}	8.05^{a}	4.69^{c}	6.81^{b}	0.79	0.01
Ash	2.82^{c}	6.69^{a}	6.53^{a}	6.15^{b}	0.60	0.01
Ether Extract (EE)	4.53	5.38	3.12	3.33	0.37	0.30
Nitrogen Free Extract	67.75	57.44	63.58	61.26	0.07	0.28

^{a,b,c,d} means in the same row having different superscripts differ at p <0.05; SEM: Standard Error of Means

Product 1 contained sun dried unpeeled cassava tuber meal + cassava leaf meal + tender cassava stem meal mixed at a ratio of 2:1 while the ratio of the leaves to tender cassava stems was 5:1 while Products 2 and 3 contained the same components but mixed at ratios 2.5:1 and 3:1 respectively.

The mineral contents of maize and cassava plant meal is shown in Table 2. The CPM products have significantly (P <0.05) higher values than maize for calcium but the values obtained for phosphorus content of CPM were lower than maize. The calcium and phosphorus contents of CPM increased significantly (P <0.05) across products 1 through 3. Lower calcium values (1.93 ppm and 0.28 ppm) were reported by Akinfala *et al.* (2011) who determined the mineral contents of CPM product 2 and maize. The minerals (zinc and copper) composition of CPM was comparable with maize. The variations observed in the mineral composition of CPM and maize may be due to variations in their ash and fibre contents.

Table 2: Mineral composition of cassava plant meal products

Minerals	Maize	CPM1	CPM2	CPM3	SEM	*P*
Calcium (%)	0.055^{b}	0.302^{a}	0.411^{a}	0.433^{a}	0.08	0.021
Copper (g/Kg)	0.018	0.025	0.022	0.024	0.03	1.00
Phosphorus (%)	0.512^{a}	0.104^{b}	0.120^{b}	0.121^{b}	0.079	0.001
Zinc (g/Kg)	0.120	0.122	0.117	0.122	0.003	0.16

means having different superscript in a row differ significantly (p <0.05)

Significant differences (*P* <0.05) exist in all evaluated amino acid contents of maize and CPM (Table 3) except tryptophan. There was a steady decrease in the amino acid contents of CPM products from CPM 1 through 3. This may be due to the increasing levels of unpeeled cassava root meal across CPM 1 through 3. Unsurprisingly, CPM products and maize had lower tryptophan, methionine and cystine contents, which followed a decreasing order from CPM 1 through 3. The lower contents observed for these corroborates the findings of earlier studies (Kong *et al.,* 2016) that plant-based diets are poor sources of methionine, cystine and tryptophan and should be adequately supplied in diets for poultry and pigs for feed efficiency and growth.

Table 3: Amino acid composition of cassava plant meal products

Parameters (g/100 g)	Maize	CPM 1	CPM2	CPM 3	SEM	*P*
Leucine	8.23^{a}	7.59^{ab}	7.18^{b}	6.59^{b}	0.22	0.03
Lysine	4.14^{b}	4.61^{a}	4.35^{ab}	4.08^{b}	0.07	0.01
Isoleucine	3.08^{b}	3.80^{a}	3.54^{a}	3.14^{b}	0.10	0.007
Phenylalanine	4.43^{b}	4.97^{a}	4.61^{b}	3.90^{c}	0.12	0.001
Tryptophan	0.89	1.00	0.89	0.73	0.34	0.56
Valine	3.80^{b}	4.21^{a}	3.97^{ab}	3.27^{c}	0.12	0.003
Methionine	1.23^{a}	1.28^{a}	1.20^{a}	0.96^{b}	0.04	0.08
Proline	4.47^{a}	4.87^{a}	4.06^{b}	3.65^{c}	0.15	0.001
Arginine	5.68^{b}	6.19^{a}	5.50^{b}	5.16^{b}	0.14	0.02
Tyrosine	3.44^{ab}	3.61^{a}	3.44^{ab}	3.10^{b}	0.07	0.04
Histidine	2.68^{b}	2.87^{a}	2.49^{c}	1.98^{d}	0.10	0.001
Cystine	1.33^{a}	1.45^{a}	1.39^{a}	0.97^{b}	0.06	0.01
Alanine	4.32^{b}	5.23^{a}	4.93^{a}	3.72^{c}	0.18	0.001
Glutamic acid	13.32^{c}	14.53^{a}	14.08^{b}	12.87^{d}	0.20	0.001
Glycine	3.37^{b}	3.70^{a}	3.61^{a}	3.04^{c}	0.08	0.001
Threonine	3.22^{c}	3.77^{a}	3.55^{b}	2.94^{d}	0.09	0.001
Serine	3.78^{c}	4.43^{a}	4.05^{b}	3.89^{bc}	0.08	0.001
Aspartic acid	7.38^{c}	8.56^{a}	7.94^{b}	7.07^{d}	0.17	0.001

means having different superscript in a row differ significantly (p <0.05)

The values obtained for CPM products 1 and 3 were higher (p<0.05) in all evaluated vitamin contents compared to CPM 2 and maize. The CPM 1 showed superiority over maize and other CPM products in all evaluated parameters. CPM products have the most significantly higher values of vitamins A (retinol) and niacin. The lower values of vitamin contents reported in this study could be due to the large proportion of cassava root contained in the composite mix. Similar findings were reported by Bayata (2019) and Salvador *et al.* (2014) who evaluated the contents of whole cassava root, unpeeled cassava root meal and cassava root meal respectively and obtained lower values.

Table 4: Vitamins composition of cassava plant meal products

Vitamins	Maize	CPM1	CPM2	CPM3	SEM	*p*
A (µg/100g)	11.40^{d}	15.17^{a}	13.28^{c}	14.40^{b}	0.53	<0.001
D (µg/100g)	0.17^{d}	0.29^{a}	0.25^{c}	0.26^{b}	0.016	<0.001
E (µg/100g)	0.13^{d}	0.19^{a}	0.15^{c}	0.16^{b}	0.007	<0.001
K (µg/100g)	0.09^{d}	0.12^{a}	0.10^{c}	0.11^{b}	0.003	<0.001
C (mg/100g)	0.10^{d}	0.18^{a}	0.15^{c}	0.17^{b}	0.012	<0.001
Thiamin (mg/100g)	0.21^{d}	0.24^{a}	0.22^{c}	0.23^{b}	0.003	0.01
Riboflavin (mg/100g)	0.07^{d}	0.10^{a}	0.08^{C}	0.09^{b}	0.003	0.01
Niacin (mg/100g)	2.06^{d}	2.28^{a}	2.10^{c}	2.17^{b}	0.03	0.011
Pyridoxine (mg/100g)	0.29^{c}	0.31^{a}	0.30^{b}	0.30^{b}	0.003	0.002
Folate (mg/100g)	0.10^{c}	0.12^{a}	0.10^{c}	0.11^{b}	0.002	0.038
Cobalamin (mg/100g)	0.012^{d}	0.028^{a}	0.017^{c}	0.022^{b}	0.002	0.027

means having different superscript in a row differ significantly (p <0.05)

CONCLUSION AND RECOMMENDATION

Based on the findings of this study, it can be concluded that cassava plant meal products had comparable nutrient profile as maize with CPM product 1 comparatively better in all evaluated nutrient profile. It is therefore recommended that CPM be supplemented with ample quantity of phosphorus and methionine to enhance desirable performance of livestock.

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