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AMINO ACID UTILIZATION OF WEANING AND GROWING PIGS FED COMPOSITE CASSAVA PLANT MEAL BASED DIET AND MAIZE

BY

Ogundeji S.T.[1],*, Adegbaju S.W[2], Akinfala E.O.[3]

[1]Lecturer I, Department of Agricultural Technology, Osun State College of Technology Esa-Oke
[2]Nutritionist, Department of Technology, Innovation, and Quality Control, Premier Feed Mill Co. Ltd, Ibadan, Oyo State
[3]Professor, Department of Animal Sciences, Obafemi Awolowo University, Ile-Ife

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Abstract

The study assessed the amino acid composition of cassava plant meal products (CPMP) and maize to evaluate its amino acid utilization by weaning and growing pigs. Three CPMPs comprising a mixture of sun-dried unpeeled cassava root meal, cassava leaf and tender stem meal harvested at 5cm are mixed at ratios of 2:1, 2.5:1 and 3:1. The leaf meal to tender stem meal ratio was 5:1. Sixteen weaning pigs (10.00 ± 0.57 kg) and sixteen growing pigs (18.50 ± 1.30 kg) were assigned randomly to CPMPs and maize at weaning and growing. Pigs were kept in a locally fabricated metabolic cage for 7 days and fed 100% CPMPs and maize diets. Water was supplied unrestrictedly and animals were fed 4 % of their body weight on a daily basis. Faeces collected during the last four days of the trial were weighed and oven-dried. Subsequently, mixed, milled and representative samples were taken for amino acid assay using the spectrophotometric method of Ninhydrin chemical reaction. The experiment lasted for 42 days. The result of amino acid composition showed that tryptophan, proline, isoleucine and valine differed ($P < 0.05$) from each other. CPMP I, compared with maize. Lysine ($P > 0.05$) of maize (0.63 %) and CPMP I (0.61 %) are similar. The weaning pigs ($P < 0.05$) poorly utilized the amino acids. The amino acids are best ($P < 0.05$) utilized by growing pigs except for arginine (23.59-33.62 %). The study concluded that CPMP I compared favourably with maize for amino acid composition. The crude fibre content of the CPM products and maize increased excretion of faecal protein may be responsible for reduced apparent digestibility of the amino acid by weaning while CPMP I pigs best utilized amino acids compared to maize.

Keywords: *spectrophotometric, metabolic cage, tender stem meal, Lysine, amino acid, weaning pigs.*

1.0. Introduction

Maize has been the most reported and commonly used source of energy in livestock feed production, constituting about 40-60 % of a balanced monogastric ration. Despite the high price, availability and inability to keep pace with the ever-increasing livestock production (Chaunynarong *et al.*, 2009) there is still pressure from human population and livestock feed millers concerning its use. This necessitated the search for cheaper alternative nutritional energy sources, which can be assessed easily for livestock production (Akinfala, 1997).

Recently, a certain number of pig farmers in south-western Nigeria have decided to feed their animals solely with agro-industrial by-products such as wheat offal, palm kernel cake, rice bran and other alternative feedstuffs such as whole cassava plant meal and distillers by-products which are cheaper and less competitive despite their nutritional inferiority compared to other conventional feedstuffs (Amaefule *et al.*, 2009) has been put into use for monogastric feeding regimes.

The Cassava root meal is rich in energy but very little in vitamins, protein and essential amino acids, carotene and other vitamins. This necessitated the need of improving its nutrient composition through development of cassava plant meal, which comprises of unpeeled cassava roots, stems and leaves to replace maize in the diets (Akinfala and Tewe, 2001; Akinfala and Tewe, 2004; Akinfala *et al.*,2011; Akinfala *et al.*,2013).

*Corresponding Author: **Ogundeji S.T.**

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The cassava plant meal newly identified as an improvement over cassava root meal will decrease the quantity of flour by further addition of more peels, leaves and tender stems, which are less utilized or left on farms unrefined (Akinfala *et al.*,2011). Some researchers (Akinfala and Tewe, 2004; Akinfala *et al.*,2011; Akinfala *et al.*,2013; Amusan, 2016 and Aderemi *et al.*,2012) worked extensively on the use of cassava plant meal as feedstuff capable of replacing maize in the diets of animals, but there is a paucity of information on the amino acid composition and digestibility of the products by the different classes of animals.

1.1 Objectives

The objectives of the study are to evaluate:

a. amino acid content of cassava plant meal products;
b. amino acid digestibility of weaning and growing pigs fed cassava plant meal products.

2.0 Materials and Methods

2.1 Collection and Preparation of test ingredients

The study took place at Swine Unit of Obafemi Awolowo University, Teaching and Research Farm, Ile – Ife. The laboratory analysis aspect of the work took place at the laboratory of Department of Animal Science, University of Ibadan, Ibadan.

A 2-year-old cassava root of TMS 30572 varieties (low cyanide variety) was purchased and harvested from a commercial farm around Ile –Ife, Osun State, Nigeria. The cassava stems were harvested at the tender part of 5 cm from the top of the cassava plant making up to 5 – 6 nodes while the leaves were collected from the stem.

The freshly harvested unpeeled cassava roots were washed with water, chopped into small pieces using a clean knife and sun-dried on a concrete floor for 7 days. They were turned regularly using a turning stick to encourage even drying. They were crushed after drying using a locally fabricated hammer mill crusher using a sieve size of 0.04 mm at a commercial feed mill around Ile – Ife and packed in an enclosed container. The leaves and tender cassava stem were sun-dried for 3 and 5 days respectively. After drying, milled using a grinder and then, packed into airtight bags discretely.

2.2 Preparation of Cassava Plant Meal Products

Three cassava plant meal products (CPMP) were produced and mixed following the procedure of (Akinfala *et al.*,2002). CPMP 1 production involves integration of sundried unpeeled cassava root meal, sun-dried cassava leaf meal and tender stem meal at ratio 2:1. (66.67 % sun dried unpeeled Cassava root meal, 27.78 % - sun dried cassava leaf meal and 5.63 % tender stem meal). The CPMP 2: sundried unpeeled cassava root meal, cassava leaf meal and tender stem meal were milled and incorporated together at a ratio of 2.5:1. (71.43 % sun dried unpeeled Cassava root meal, 23.80 %, sundried cassava leaf meal and 4.77 % tender stem meal). The CPMP 3 is made up of sundried unpeeled cassava root meal, cassava leaf meal and tender stem meal milled and mixed together at a ratio 3:1. (75 % sun dried unpeeled Cassava root meal, 20.83 % sundried cassava leaf meal and 4.17 % tender stem meal). The leaf meal and tender stem meal of each CPMP were mixed at a ratio of 5:1

2.3 Amino Acid determination

Amino acid profile of the cassava plant meal products and maize samples alongside faecal samples was carried out using a spectrophotometric method of amino acid determination of Ninhydrin chemical reaction of (A.O. A.C. 2005) procedure.

% Amino acid (any one) = $\frac{\text{Absorbance of sample x Gradient factor x Dilution factor}}{10{,}000} \times \frac{100}{1}$

2.4 Apparent Amino Acid Bioavailability of Weaning and growing Pigs fed Different Cassava plant Meal Products.

Experimental Animals and Management:

Thirty–two (32) (Large white × Hampshire) breed of pigs were used for this study. Sixteen (16) weaning pigs with an average weight of 10.00 ± 0.57 kg were used for the first phase (weaning Phase) while Sixteen (16) growing pigs with an average weight of 18.50 ± 1.30 kg were used for the second phase (growing phase). The animals were allotted randomly to four (4) formulated diets.

The pigs were housed independently in a locally fabricated metallic metabolic cage with (107 cm x 60 cm x 50 cm) dimension for 7 days on a standard diet. The animals were starved for 12 hours before the commencement of the study to clear the gut from previous meals they might have consumed. The animals were fed 4 % of their body weight (Norachack *et al.*, 2004). Drinkable clean water was supplied *ad libitum* to the animals. On the fourth day of the experiment, total faeces were collected from the metabolic cages very early in the morning on daily basis till the seventh day. After collection of the feaces, they were weighed and oven dried. The oven-dried faeces collected on daily basis were mixed; milled and representative samples were taken for amino acid assay while the remaining samples were kept in a labelled plastic bag and stored in a deep freezer for further analysis. The duration of the experiment was 32 days.

2.4.2 Experimental Diet Composition

The diet composition is represented in Table 1. Four diets were formulated. Each of the diets contained 99.75 % of the test ingredient and 0.25 % of salt. Experimental diet 1 contained maize while 2, 3 and 4 contained CPMP 1, 2 and 3 respectively.

Table 1: Composition of Experimental Diet

Ingredients (%)	Diets			
	Maize	**CPM Product I**	**CPM Product II**	**CPM Product III**
Maize	99.75	-	-	-
Unpeeled	-	66.57	71.33	74.90
Cassava Root	-	27.68	23.70	20.73
meal	-	5.50	4.72	4.12
Cassava Leaf	0.25	0.25	0.25	0.25
meal	**100.00**	**100. 00**	**100.00**	**100.00**

*Corresponding Author: **Ogundeji S.T.**

Tender Cassava stem meal	
Salt	
Total	

CPM: Cassava Plant Meal

2.5.3 Chemical Analysis of Experimental diet and Faeces

The amino acid composition of the feedstuffs and faeces was determined using the chemical procedures described above while the apparent amino acid digestibility was determined; using the standard feed digestibility trial formula given below:

Apparent Amino acid digestibility = Amino acid in feed – Amino acid in feaces x 100
Amino Acid in feed 1

3.0 Results and Discussion

3.1 Amino Acid Composition of Maize and Cassava Plant Meal Products

The amino acid (AA) composition of Cassava plant meal products and maize is presented in Table 2 below. The methionine, lysine, arginine, cysteine, serine, phenylalanine and leucine of the CPMPs and maize are similar ($P > 0.05$) in value. This showed that the CPMPs could replace maize in livestock diet. The lower values obtained for sulphur-containing amino acids in CPMPs may be due to the excessive detoxification of cyanide especially methionine and cysteine (Yin *et al.*,2014).

Valine ($P < 0.05$) of CPMP I was 12.84 % higher than other CPMPs. The valine and proline composition of CPMPs decreased with an increase in the unpeeled cassava root meal (UCRM) of the products. Alternating maize with CPMPs in diets of pig may have an effect on muscle metabolism, tissue repair and maintenance of nitrogen balance in the animal body system. Higher value (0.45 %) was observed by (Olomu, 2011). for maize.

The proline ($P < 0.05$) of maize was 11.97 % greater than that of CPMPs while CPMP III was 10.07 % higher compared to other CPMPs. Alternating maize with CPMPs in diet of animal might improve osmotic regulation and anti-oxidative potential in the cell membrane. Yin *et al.* (2014) reported a lower ($P < 0.05$) maize proline (0.66 %).

The isoleucine of ($P < 0.05$) maize and CPM product I was highest (4.09 %). The high values of maize and CPMP I was 9.29 % higher than other CPM products. Replacement of maize with CPMPs may influence haemoglobin formation, blood sugar and energy level regulations.

The tryptophan ($P < 0.05$) obtained for maize was 3.24 % higher than CPMPs while CPMP III was 0.94 % higher than other CPMPs. This showed that feeding CPMP products in diets of pig may improve feed intake, protein synthesis and the immune system of the animal due to their high protein composition and palatability.

Table 2: Amino Acid Composition of Maize and Cassava Plant Meal Products

Amino Acids (%)		Cassava Plant Meal Products				
	Maize	1	2	3	SEM (±)	P value
Lysine	0.63	0.61	0.47	0.55	0.03	0.35
Methionine	0.35	0.29	0.23	0.29	0.03	0.58
Arginine	0.87	0.79	0.89	0.92	0.03	0.32
Alanine	1.29	1.31	1.28	1.42	0.03	0.32
Tryptophan	2.16[a]	2.09[ab]	1.92[c]	2.12[a]	0.37	0.02
Cysteine	1.93	1.81	1.82	2.06	0.05	0.25
Valine	3.20[a]	3.10[a]	2.96[ab]	2.72[b]	0.08	0.04
Serine	1.66	1.51	1.61	1.55	0.03	0.15
Phenylalanine	2.53	2.42	2.42	2.49	0.03	0.55
Proline	1.42[a]	1.25[c]	1.30[bc]	1.39[b]	0.03	0.03
Isoleucine	4.09[a]	4.09[a]	3.80[b]	3.71[b]	0.07	0.01
Leucine	4.88	5.22	5.05	5.01	0.06	0.23

Means bearing different superscript in a row differ significantly (P<0.05)

CPMP: consist of 66.67 % sun dried unpeeled Cassava root meal, 27.78 % sun dried cassava leaf meal and 5.63 % tender stem meal. CPMP 2: consist of 71.43 % sun dried unpeeled Cassava root meal, 23.80 %, sundried cassava leaf meal and 4.77 % tender stem meal. CPMP 3: Comprises of 75 % sun dried unpeeled Cassava root meal, 20.83 % sundried cassava leaf meal and 4.17 % tender stem meal..

3.2 Apparent Amino Acid Digestibility of Weaning Pigs fed Maize and Cassava Plant Meal Products

The Apparent Amino acid Digestibility of Weaning pigs fed maize and cassava plant meal products (CPMP) is presented in Table 3.

The CPMP II fed pigs best utilized ($P < 0.05$) lysine (62.98 %) and methionine (55.73 %) which will result in increased intake into their system for growth and muscle accretion. Lui *et al.*(2014) reported higher lysine value (84.94 %) for maize. The reduced apparent lysine digestibility ($P < 0.05$) may be due to reaction of E – amino group with other active groups to form linkages which are not stable to enzyme hydrolysis (Mc Donald *et al.*,2010). The lower digestibility of CPMPs may be due to presence of lignin and hydrocyanide contained in the

*Corresponding Author: **Ogundeji S.T.**

products, which form bonds with other compounds thereby making them unavailable (Rodwell, 1985).

The CPMP I fed pigs showed best utilization ($P < 0.05$) for tryptophan (83.11 %), leucine (88.31 %), isoleucine (90.61 %) and alanine (73.72 %). The improved digestibility may result in improved voluntary feed intake and protein synthesis, which are precondition for improved growth, elevated skeletal muscle protein synthesis, digestive enzymes production, higher blood glucose concentration and fatty acid oxidation (NRC, 1998). The digestibility ($P < 0.05$) decreased with increase addition of UCRM of the products. The differences in tryptophan and leucine digestibility may be due to variations in dietary fibre fractions, nature of the fiber and presence of digestive enzyme inhibitors (Mc Donald *et al.*,2010).

The differences in isoleucine digestibility may be due to presence of minimal dietary neutral detergent fiber (NDF) fraction which when at increased level may increase endogenous nitrogen and amino acid losses (20). The depressed alanine digestibility of maize may be due to excess of more than 50 % α – amino acid been released from the muscle tissue (Rodwell, 1985). Pigs fed CPMP I absorb more alanine into the gastrointestinal tract via active transport resulting in increased alanine digestion necessary for liver detoxication, nitrogen transfer and tryptophan metabolism (Mc Donald *et al.*,2010).

The CPMP II fed pigs ($P < 0.05$) best utilized valine (66.22 %), phenylalanine (73.85 %), arginine (56.58 %) and cysteine (86.09 %). The low digestibility may be due to variations in the cell wall fractions of the feedstuffs which may enclose the intracellular protein thereby rendering the amino acid non-available for digestion (Mc Donald *et al.*,2010). The high digestibility may improve the proper functioning of the nervous system, utilization of arginine for the metabolism of protein and energy and improve the growth of fur in the animal.

Pigs fed maize least ($P < 0.05$) utilized serine (49.98 %) and proline (38.33 %). The improved utilization of serine and proline by CPMP II pigs results in improved neurone transmitting factors, absorption and improved osmoregulation of the animal body.

The lower digestibility values of serine, arginine, proline, lysine, methionine, alanine and valine compared to other amino acids may be due to a relatively high level of these amino acids in endogenous gut protein (Barth *et al.*,1993), increased loss of endogenous and exogenous protein and amino acids (Wenk, 2001) and increased bacteria protein excretion in feaces (NRC, 1994).

Table 3: Apparent Amino Acid Digestibility of Weaning Pigs fed Maize and Cassava Plant Meal Products

		Cassava Plant Meal Products				
Parameters (%)	**Maize**	**1**	**2**	**3**	**SEM (±)**	**P value**
Lysine	31.28[c]	38.77[bc]	62.98[a]	50.50[b]	4.75	0.014
Methionine	32.72[b]	38.05[b]	55.73[a]	33.45[b]	3.76	0.027
Tryptophan	75.18[ab]	83.11[a]	77.71[ab]	72.30[b]	1.78	0.014
Leucine	83.78[ab]	88.31[a]	86.20[ab]	81.01[b]	1.21	0.013
Isoleucine	64.16[c]	90.61[a]	79.71[b]	63.53[c]	4.46	0.011
Alanine	44.18[c]	73.72[a]	66.06[b]	50.88[c]	4.94	0.037
Valine	59.32[b]	49.56[c]	66.22[a]	48.34[c]	3.54	0.024
Phenylalanine	61.09[b]	70.78[a]	73.85[a]	58.03[b]	2.76	0.006
Arginine	53.72[a]	43.30[b]	56.58[a]	42.84[b]	3.03	0.028
Cysteine	68.80[bc]	74.88[b]	86.09[a]	60.55[c]	3.63	0.006
Serine	49.98[c]	69.90[b]	75.98[a]	66.42[b]	3.86	0.022
Proline	38.33[c]	50.13[b]	65.11[a]	49.38[b]	4.27	0.014

Means bearing different superscripts in a row differ significantly (P<0.05)
CPMP: consist of 66.67 % sun dried unpeeled Cassava root meal, 27.78 % sun dried cassava leaf meal and 5.63 % tender stem meal. CPMP 2: consist of 71.43 % sun dried unpeeled Cassava root meal, 23.80 %, sundried cassava leaf meal and 4.77 % tender stem meal. CPMP 3: Comprises of 75 % sun dried unpeeled Cassava root meal, 20.83 % sundried cassava leaf meal and 4.17 % tender stem meal..

3.3 Apparent Amino Acid Digestibility of Growing Pigs fed Maize and Cassava Plant Meal Products

The result of apparent amino acid digestibility of growing pigs fed maize and cassava plant meal products (CPMP) is presented in Table 4.

Pigs fed maize best utilized ($P < 0.05$) lysine (88.09 %), tryptophan (84.54 %), leucine (91.08 %) and alanine (84.07 %). The improved lysine digestibility may result in better muscle building (NRC, 1994). Lui *et al*. (2014) reported lower maize lysine digestibility (84.94 %). The high digestion and utilization of tryptophan by pigs may result in higher feed intake and improved protein synthesis in the animal body. The high utilization of leucine by growing pigs may improve protein synthesis in the skeletal muscles and improve growth rate. The differences ($P < 0.05$) in digestibility may be due to variations in cellulose and hemicellulose fractions of the diets, presence of substances such as reducing sugars, inhibitors of digestive enzymes (Mc Donald *et al.*,2010). e.t.c. endogenous amino acid loss and adsorption of amino acid and peptides (Soffrant, 2001). The lysine ($P < 0.05$) and methionine digestibility ($P > 0.05$) of the CPM products increased with the increase addition of unpeeled cassava root meal (UCRM) of the products.

*Corresponding Author: **Ogundeji S.T.**

The apparent isoleucine digestibility (P < 0.05) was best utilized by Pigs fed CPMP I (83.40 %) The high digestibility observed may result in reduced fat oxidation and blood glucose regulation in an animal body. The apparent valine digestibility was not significantly (P > 0.05) different.

The apparent phenylalanine digestibility (P < 0.05) of Pigs fed CPMP II was highest (80.66 %) while CPM product III was least (76.47 %). Pigs fed maize best-utilized (P < 0.05) arginine (37.62 %) while CPMP II arginine was least utilized (23.59 %). The arginine digestibility was the least absorbed among all the amino acids evaluated. The (P < 0.05) poor digestion and absorption of arginine may result in reduced nutrient metabolism and muscle nutrient composition (NRC, 1994).

Pigs fed CPMP II best digested (P < 0.05) cysteine (88.39 %) and serine (79.93 %). The high digestibility of cysteine indicates increased protein deposition in the muscles. The low serine digestibility by animals may be due to lower protein synthesis in the animal body (NRC, 1994).

Table 4: Apparent Amino Acid Digestibility of Growing Pigs fed Maize and Cassava Plant Meal Products

		Cassava Plant Meal Products				
Parameters (%)	**Maize**	**1**	**2**	**3**	**SEM (±)**	**P value**
Lysine	88.09^a	72.06^b	75.88^b	76.85^b	2.44	0.04
Methionine	81.05	78.74	81.06	82.94	0.96	0.60
Tryptophan	84.54^a	82.59^a	83.76^a	77.84^b	1.03	0.01
Leucine	91.80^a	88.85^b	89.62^b	88.81^b	0.37	0.02
Isoleucine	81.71^a	83.40^a	68.86^b	68.39^b	2.67	0.001
Alanine	84.07^a	81.49^a	75.44^b	71.05^b	1.97	0.004
Valine	74.57	73.88	72.48	73.46	0.57	0.74
Phenylalanine	76.81^{ab}	80.51^a	80.66^a	76.47^b	0.73	0.09
Arginine	37.62^a	27.60^b	23.59^c	23.68^c	2.34	0.04
Cysteine	80.50^b	81.08^b	88.39^a	85.98^{ab}	1.33	0.05
Serine	66.94^{bc}	61.47^c	79.93^a	70.87^b	3.07	0.02

Means bearing different superscripts in a row differ significantly (P<0.05)
CPMP: consist of 66.67 % sun dried unpeeled Cassava root meal, 27.78 % sun dried cassava leaf meal and 5.63 % tender stem meal. CPMP 2: consist of 71.43 % sun dried unpeeled Cassava root meal, 23.80 %, sundried cassava leaf meal and 4.77 % tender stem meal. CPMP 3: Comprises of 75 % sun dried unpeeled Cassava root meal, 20.83 % sundried cassava leaf meal and 4.17 % tender stem meal..

Conclusion

The study concluded that CPMP I compared favourably with maize for amino acid composition. The CPMP II amino acid was best utilized by weaning pigs compared to maize and other CPMPs while growing pigs digested amino acids in maize most while digestibility of CPMP I amino acids compared to maize. The increased crude fibre content of the CPM products and maize increased the excretion of faecal protein thus resulting in reduced apparent digestibility of the amino acid by weaning and growing pigs.

Recommendation

It can therefore be recommended that CPMP II be fed to weaning pigs while CPMP I be fed to growing pigs in replacement of maize for better utilization of amino acid.

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*Corresponding Author: **Ogundeji S.T.**