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Original Paper

Productive and physiological characteristics of West African dwarf goats fed cassava root sievate-cassava leaf meal based diet

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West African Dwarf (WAD) goat is an important livestock and its production is indispensable in the country's food chain. The WAD goat is a trypanotolerant breed reared mainly for meat. This breed can be bred all year-round, attains sexual maturity early and moderately prolific; thereby satisfying a part of the meat requirement. However, in Nigeria, scarcity, poor utilization of agro-waste and seasonality in feed availability undermines this goat breed in achieving better performance. Hence, the effect with of feeding cassava root sievate – cassava leaf meal (CRSCLM) diets on the productive and physiological characteristics of WAD goats were investigated for 97 days. Thirty six (36) WAD goats of about 8–10 months of age and averaging 7.19kg in weight were selected from the College flock for this experiment. The goats were randomly divided into four groups of nine animals each with three goats constituting a replicate. Feed intake and body weight changes were recorded accordingly. Blood samples were drawn from each goat on the last day of the trial and evaluated for haematological, biochemical and electrolyte profiles. Daily feed intke, daily weight gain and feed conversion ratio were not (P >0.05) influenced by the treatment diets. The haematological parameters indicated no significant difference (P >0.05) among the treatment groups. There was significant (P <0.05) difference for globulin (23.80–31.40), Creatinine (0.085–1.025) Cholesterol (97.125–120.46) and alanine aminotransferase (ALT) (13.96–18.22) across the treatment groups. Cholesterol and ALT were significantly (P <0.05) increased with increasing levels of CRSCLM. Globulin and creatinine however did not follow any specific trend with increasing or decreasing levels of CRSCLM. Sodium, potassium and chloride were significantly (P <0.05) different across the treatment groups with sodium being significantly (P <0.05) higher among the treatment groups than the control. The study revealed that CRSCLM in the diet of WAD goats had no deleterious effect on the growth performance and blood indices of WAD goats and could therefore be included in goat diets up to 60%.

Keywords: WAD goats, feed intake, growth performance, blood indices, serum electrolyte, cassava and agro waste

1 Introduction

Goats (Capra hircus) are unique ruminants owing to their ability to meet their nutritional requirements easily because of their moveable mandibles and ability to stand with their hind limbs which enables them to browse the most nutritious plant parts and even from thorn bushes and high tree branches. They easily adapt to different weather conditions which has helped their distribution and population in the world today. The West African dwarf (WAD) goat is believed to have originated from the south eastern Nigeria. This breed is one of the dominant breeds of goat in West Africa as a meat animal but however known as Nigerian dwarf goat in USA where it ranks fifth as a dairy breed; thus explaining its universal importance. They are trypanotolerant and widely distributed across the rainforest and derived Savannah zones of Nigeria (Ahamefule et al., 2005) where it makes significant contribution to the livelihoods of most families and the country at large. They are characteristically good mothers with high reputation for high meat and milk yield. The WAD goat is the dominant breed of small ruminants found in West Africa where they are raised under small holder management system (Jiwuba et al., 2017). Regardless of these advantages, the production of this indigenous breed of goat with great potentials is hampered due to high cost of feed and poor nutrient intake as a result of seasonal variations. This has necessitated the need to search for cheaper and readily available feed supplements to reduce feed cost for the ruminant farmers. Local and non-competitive

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feed supplement is the only means of reducing the production cost of WAD goats (Jiwuba et al., 2017), and this could be achieved through the use of cassava or cassava by products, since Nigeria is the highest world producer of cassava.

Cassava or its by products (Tijani et al., 2012; Anaeto et al., 2013; Jiwuba et al., 2016a; Jiwuba and Ezenwaka, 2016; Jiwuba et al., 2018) has been used as feeds for sheep and goats. The cassava leaf meal is very nutritious with nutrient compositions higher than that in the fresh leaves. Results on the chemical profile of cassava leaf meal revealed high protein content of 16.6% to 39.9% (Khieu et al., 2005; Jiwuba et al., 2018), high mineral content and also a major source of vitamin B_1, B_2 and C and carotenes (Adewusi and Bradbury, 1993). High amino acid profile and ME value (1,590 kcal/kg to 1,800 kcal/kg) (Ravindran, 1991; Khajarern and Khajarern, 2007) have been reported. Similarly, cassava root sievate proximate composition revealed 87.06% DM, 1.07% CP, 0.084% EE, 3.25% CF, 2.01% ash, 84.71% NFE and of 3330 Kcal/kg energy (Salami et al., 2003). Cassava and its byproducts however, have been implicated with anti-nutritional factors like cyanides (Morgan and Choct, 2016) which has been reported to affect nutrient availability, utilization and blood formation when not properly processed (Jiwuba et al., 2016b). Thus, the processing methods employed in this study would perhaps further reduce the anti-nutrients to tolerable values for WAD goats. To date, there is paucity of information on the effect of Cassava root sievate-cassava leaf meal supplements as feed component for WAD goats on productive and physiological characteristics.

2 Material and methods

2.1 Location of the experiment

The experiment was carried out at the sheep and goat Unit of Animal Production Technology, Federal College of Agriculture, Ishiagu, Ivo L.G.A., Ebonyi state, Nigeria. The College is located at about three kilometers (3 km) away from Ishiagu main town (Jiwuba et al. 2016b). The College is situated at latitude 5.56^0 N and longitude 7.31^0 E, with an average rainfall of 1,653 mm and a prevailing temperature condition of 28.500^c and relative humidity of about 80%.

2.2 Experimental feeds

The cassava root sievate (CRS) and cassava leaf were sourced and harvested within Ishiagu community. The cassava root sievate is a by product of cassava root processing which is acquired after the cassava roots meant for fufu (a popular food in Nigeria) production are peeled or not, washed clean and soaked in clean water for 3–5 days to ferment so as to reduce the hydrogen cyanide level and also to soften the roots to enable sieving (Jiwuba et al., 2018). Thereafter, the soaked cassava roots were sieved, the sievate (waste) collected and sundried for about 5 days to reduce the moisture contents and possible anti-nutrients that were not removed during the fermentation process. After which, the sundried cassava root sievate were coarsely milled and stored in batches. The cassava leaves were harvested from the College cassava farms after root harvesting. They were also coarsely milled using hammer mill to encourage chyme chewing. The cassava root sievate meal (CRSM) and cassava leaf meal (CLM) were mixed in the ratio of 3 : 1 and used in the formulation of the experimental diet. Four diets T_1, T_2, T_3, and T_4, were formulated. The cassava root sievate-cassava leaf meal (CRSCLM) was included at the levels of 0%, 20%, 40% and 60% for T_1, T_2, T_3, and T_4, respectively as presented in Table 1.

Table 1 Composition of the experimental diets for West African Dwarf Goats

	Dietary levels (%)			
Ingredients	T_1	T_2	T_3	T_4
CRSCLM	0.00	20.00	40.00	60.00
Palm kernel meal	48.00	38.00	30.00	20.50
Brewer's dried grain	47.50	37.50	25.50	15.00
Molasses	2.00	2.00	2.00	2.00
Bone meal	1.00	1.00	1.00	1.00
Salt	0.50	0.50	0.50	0.50
Limestone	1.00	1.00	1.00	1.00
Total	100	100	100	100

2.3 Animal management

Thirty six (36) WAD goats of about 8–10 months of age and averaging 7.19 kg in weight were selected from the College flock for this experiment. The goats were randomly divided into four groups of nine animals each with three goats constituting a replicate. The groups were randomly assigned the four experimental diets (T_1, T_2, T_3, and T_4) in a completely randomized design (CRD). The animals were housed individually in a well-ventilated cement floored pens equipped with feeders and drinkers. Each animal received a designated treatment diet in the morning (8 am) for 97 days. Feed offered was based on 3.5% body weight per day; the animals in addition were fed 1 kg wilted chopped *Panicum maximum* later in the day (5 pm). Regular access to fresh drinking water was made available. Initial live weights of the animals were taken at the beginning of the feeding trial and weekly thereafter. Final live weight was obtained by weighing the goats at the end of the experiment. Daily weight gain, daily feed intake and feed conversion ratio were calculated.

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2.4 Blood studies

Ten ml of blood samples were drawn from each animal on the last day of the study. The goats were bled through the jugular vein. The samples were separated into two lots and used for haematological and biochemical determinations. An initial 5ml was collected from each sample in labelled sterile universal bottle containing 1.0 mg/ml ethyldiamine tetracetic acid (EDTA) and used for haematological analysis. Another 5ml was collected over anti-coagulant free bottle and used for the serum biochemical studies. Serum biochemistry and haematological parameters were measured using Beckman Coulter Ac-T10 Laboratory Haematology Blood Analyzer and Bayer DCA 2000^{+} HbA1c analyzer, respectively. Mean corpuscular haemoglobin (MCH), mean corpuscular volume (MCV), mean corpuscular haemoglobin concentrations (MCHC), were calculated. However, the coagulated blood samples were subjected to standard method for evaluation of serum electrolyte levels using ELISA kit technique as described by Nowshari (1995). The standard flame photometry using Gallenkamp analysis were used to determine serum sodium (Na^{+}) ion, Potassium (K^{+}) ion. Chloride ion was determined according to the method of Baker and Silverton (1995).

2.5 Proximate analyses

All the sample of feed and test ingredients were analyzed for their proximate composition using the method of AOAC (2000). The following were determined and analyzed ; dry matter content (DM), crude protein (CP), crude fibre (CF), ether extract (EE), nitrogen free extract (NFE), ash, neutral detergent fibre (NDF) and acid detergent fibre (ADF), hemicellulose and metabolizable energy. Gross energy was calculated using the formula $T = 5.72Z_1 + 9.50Z_2 + 4.79Z_3 + 4.03Z_4 \pm 0.9\%$; where T = gross energy, Z_1 = crude protein, Z_2 = crude fat, Z_3 = crude fibre, Z_4 = nitrogen free extract (Nehring and Haelein 1973).

2.6 Data analyses

The results were analyzed using the Statistical Package for Social Sciences Window 17.0. One – way analysis of variance (ANOVA) was employed to determine the means and standard error. Treatment means were compared using Duncan's new multiple range test (Duncan, 1955).

3 Results and discussion

The proximate composition of the experimental diets, CRSM, CLM and *Panicum maximum* are presented in Table 2. The DM, CF and gross energy of the experimental diets tend to increase with increasing levels of CRSCLM while CP, NDF and ADF decreased with increasing levels of CRSCLM. Ash, EE, NFE and hemicellulose failed to follow a specific pattern across the treatment groups. The CLM is comparable with the DM, CP, ash and NFE values reported by Akinfala et al. (2002). The crude protein content of the CRSM is below the acceptable 7% CP for ruminant performance as recommended by ARC (1980) and 8% suggested by Norton (1994) for ruminal function. The fibre fractions (NDF, ADF and hemicellulose) have implication on the digestibility of plants. The NDF is a measure of the plant cell wall contents, used in determining the rate of digestion of feed. The NDF comprises mainly the cell wall fraction of forages and roughages and includes a complex matrix of lignin, small amounts of protein, and various polysaccharides. Odedire and Babayemi (2008) noted that the higher the NDF, the lower the plant's digestible

Table 2 Proximate composition of the experimental diets, cassava root sievate meal, cassava leaf meal and *Panicum maximum*

Nutrients (%)	Treatments				CRSM	CLM	*PM*
	T_1(0)	T_2(20)	T_3(40)	T_4(60)			
Dry matter	89.95	90.40	91.00	91.44	88.60	89.12	30.93
Crude protein	15.36	14.87	13.64	13.00	2.57	17.66	5.34
Crude fibre	18.96	18.96	19.65	20.11	18.96	5.38	12.64
Ash	5.44	5.59	4.91	4.50	1.80	9.87	4.01
Ether Extract	2.15	3.26	3.38	2.90	2.71	3.93	3.17
Nitrogen free extract	48.04	42.72	50.14	50.93	68.14	52.28	26.37
Gross energy (MJ/kg)	3.94	3.89	4.07	4.04	3.79	3.76	2.27
Neutral detergent fibre	62.44	42.08	35.75	33.93	25.34	39.90	58.31
Acid detergent fibre	58.35	38.30	25.11	23.69	6.68	33.25	28.60
Hemicellulose	4.09	3.78	10.64	10.24	8.66	6.65	19.17

CRSM – cassava root sievate meal; CLM – cassava leaf meal; *PM – Panicum maximum*

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energy. The values obtained for the CRSM may imply moderate cell wall content, moderate digestible energy and DM intake. The ADF consist mainly the lignin and cellulose. Hemicellulose has been reported to be more digestible than cellulose (Gillespie, 1998). The reportedly lower values of the fibre fractions is in agreement with the findings of Boonnop et al. (2009) for the same cassava by product. The high energy value reported for the CRSM is in agreement with Khampa et al. (2009) who noted that cassava roots contain high levels of energy and have been used as a source of readily fermentable energy in ruminant rations. The high dry matter value reported is favourably compared with the values of Boonnop et al. (2009). The proximate composition of the experimental diets revealed that the crude protein and the energy requirements are within the ranges reported for goats (ARC, 1980; NRC 1981; Norton, 1994). The DM, CP, ash NDF, ADF and hemicellulose were higher in the control, but however compared to the treatment groups. The proximate composition of *Panicum maximum* in this study is in comparison with the values reported by Odedire and Babayemi (2008), Onyeonagu and Eze (2013) and Jiwuba et al. (2016c) for the same forage.

The productive performance of West African Dwarf goats fed cassava root sievate-cassava leaf meal is presented in Table 3. There was no significant (P >0.05) difference for the parameters evaluated. There was (P >0.05) improvement on the feed intake among the treatment groups (T_2, T_3 and T_4) in comparison with the control diet. This may be attributed to high crude protein value of cassava leaf meal. Cassava leaves have been reported (Khieu et al., 2005) to have high crude protein, ranging from 16.6% to 39.9%; hence amino acid profiles of cassava leaves have been compared to be similar with alfalfa. Similarly, the improved intake observed among the treatment groups may also be attributed to high mineral, vitamin B_1, B_2, C and carotene levels, reported for CLM which tend to boost the appetite, vitality and general wellbeing of the goats. The quantity of feed consumed is largely dependent on the palatability of the diet and cassava or it by products has been generally observed to be highly palatable to goats.

There is also improvement (P >0.05) in the body weight changes from T_1 to T_4 with treatment groups having better performance than the control. The lower body weight gain of T_1 animals compared to other treatments maybe attributed to the lower feed intake recorded for the respective treatment. Jiwuba et al. (2016c) reported that dry matter intake is an important factor in the utilization of feed by goats. Feed conversion ratio was also better (P >0.05) for the treatment group.

Table 3 Growth performance of West African Dwarf Goats fed cassava root sievate-cassava leaf meal diets

Parameters	T_1	T_2	T_3	T_4	SEM
Total Feed intake (kg)	39.535	42.015	39.710	43.215	2.17
Daily Feed intake (kg/d)	0.408	0.423	0.409	0.446	0.07
Initial Body Weight (kg)	5.850	6.955	6.900	7.150	0.26
Final Body Weight (kg)	11.605	14.620	14.940	15.415	0.70
Total Weight Gain (kg)	5.755	7.665	8.040	8.265	0.32
Average Weight Gain (kg/d)	0.059	0.079	0.083	0.085	0.01
Feed Conversion Ratio	6.912	5.354	4.807	5.247	0.20

means in the row with no superscript are similar (P >0.05)

Table 4 Haematology of West African Dwarf Goats fed cassava root sievate-cassava leaf meal diets

Parameters	T_1	T_2	T_3	T_4	SEM
Packed cell volume (%)	31.23	31.66	29.90	30.36	3.2
Haemoglobin (g/dl)	9.97	9.59	9.04	10.00	0.18
Red blood cell (x106/mm^3)	13.89	14.70	14.56	14.99	3.96
White blood cell (mm^3)	10.96	11.80	11.15	11.71	2.19
Mean corpuscular volume (fl)	20.27	18.18	17.49	18.24	0.51
Mean corpuscular haemoglobin (pg)	5.57	7.11	6.83	7.00	0.69
mean corpuscular haemoglobin conc. (g/dl)	35.78	31.86	33.28	32.61	3.58

means in the row with no superscript are significantly similar (P >0.05)

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Table 5 Serum Biochemistry of West African Dwarf Goat fed cassava sievate-cassava leaf meal diets

Parameters	T_1	T_2	T_3	T_4	SEM
Total Protein (g/dl)	6.035	6.515	6.27	6.340	0.28
Globulin (g/dl)	2.845^{ab}	3.140^{a}	2.385^{b}	2.820^{ab}	0.12
Urea (mg/dl)	11.290	13.970	14.275	15.090	1.14
Creatinine (mg/dl)	0.085^{b}	0.900^{ab}	1.025^{a}	0.485^{ab}	0.16
Cholesterol (mg/dl)	99.270^{b}	97.125^{b}	110.735^{ab}	120.460^{a}	3.92
Bilirubin (mg/dl)	0.370	0.030	0.035	0.140	0.09
Aspartate aminotransferase (U/l)	178.5	195.505	179.05	194.765	7.29
Alanine aminotransferase (U/l)	13.960c	16.265^{b}	18.215^{a}	15.640^{b}	0.58
Alkaline phosphatase (U/l)	68.29	67.55	69.66	67.6	1.2

$^{a, b}$ – means in the row with different superscripts are significantly different (p <0.05)

Table 6 The serum electrolyte of West African dwarf (WAD) goats fed cassava root sievate-cassava leaf meal based diet

Parameters	Treatment				SEM
	T_1	T_2	T_3	T_4	
Sodium (mmol/L)	146.11^{d}	152.36^{b}	152.17^{c}	153.44^{a}	2.18
Potassium (mmol/L)	3.95^{c}	4.26^{b}	4.02^{b}	4.64^{a}	0.08
Chloride (mmol/L)	100.75^{c}	108.42^{a}	100.14^{c}	102.72^{b}	1.85

$^{a–d}$ – means value different superscript in a row differ significantly (P <0.05)

The haematology of West African dwarf (WAD) goat fed cassava root sievate-cassava leaf meal based diets is presented in Table 4. All the haematological indices examined in this study showed no significant difference (P >0.05) across the treatment groups. This indicated that the treatment diets were non toxic but nourishing and supported the haematological indices since all the parameters were within the normal physiological range for apparently healthy goats.

The blood biochemistry of the West African dwarf (WAD) goat fed cassava root sievate-cassava leaf meal based diet is presented in Table 5. Globulin, Creatinine, Cholesterol and ALT were significantly (P <0.05) influenced by the treatment diets and tended to increase with an increasing levels of the test ingredients. Total protein, urea, bilirubin, AST and ALP were not significantly (P >0.05) affected and failed to follow a specific pattern. The globulin values in this study compared with the reported values by Oni et al. (2012) for WAD goat fed dried cassava leaf based concentrate diets and fell within the reference range of 2.7–4.1 (g/dl) for healthy goats. This is an indication of proper functioning of the liver and high immunity response of the experimental animals; a view corroborated with Jiwuba et al. (2016a). This further suggested that the processing methods of cassava root sievate-cassava leaf meal reduced the antinutritional factor like tannin and HCN to tolerable values for goats. HCN and tannin have been reported (Mitjavila et al., 1977) to diminish nutrient permeability and increase excretion of endogenous protein. The creatinine value was highest (1.02 mg/dl) in T_3 goats and lowest (0.09 mg/dl) among the T_1 goats, but perhaps fell within the range 0.7–1.5 (mg/dl) for apparently healthy goats as reported by Fraser and Mays (1986); thus suggesting that the animal did not survive at the expense of body reserve. Privuloric et al. (2012) noted that creatinine level is directly correlated with muscle mass and kidney function in animals. This further indicated that CRSCLM did not hamper the physiological functioning of the organs (liver and kidney).

Zilva and Pannall (1984) stated that normal enzyme level in serum is a reflection of a balance between synthesis and their release, as a result of the different physiological process in the body. The activities of the enzyme alanine transminase (ALT) studied were influenced (P <0.05) significantly among the treatment groups but however are within the reported reference range of 15.3–52.3 (µ/l) for goats. ALT is an enzyme found in the highest amount in liver and typically used to detect liver injury (Pratt, 2010). The within normal physiological range reported in this study gave a clear indication of absence of liver malfunctioning or injury.

The serum electrolyte of West African dwarf (WAD) goats fed cassava root sievate-cassava leaf meal based diet is

presented in Table 6. The serum electrolytes showed significant (P <0.05) difference but however fell within the normal physiological range of 142–155 mmol/L, 3.5–6.7 mmol/L and 99–110.3 mmol/L respectively for sodium, potassium and chloride for apparently healthy goats. Serum electrolytes regulate plasma volume and acid-base balance, preserves normal irritability of muscles and cell permeability, activates nerve and muscle function and involve in the maintenance of body water. The within normal physiological reported for these electrolytes gave a clear indication that the diets supported the normal physiological functions of the goats since there was no liver or kidney damage. Similarly, nervousness, cardiac weakness, failure of the respiratory muscles, increased PCV above the normal range, and impairment of adrenal function which are common signs of chloride, potassium and sodium deficiency were not observed during the study.

Conclusions

It could be concluded that cassava root sievate-cassava leaf meal could be included in the diets of goats up to 60% in compounded ration without deleterious effect on the growth performance and blood characteristics of West African dwarf goats. The use of cassava root sievate-cassava leaf meal based diets is therefore recommended for enhanced goat production.

References

ADEWUSI S.R.A. and BRADBURY, J.H. (1993). Carotenoids in cassava: comparison of open- column and HPLC methods of analysis. In *J Sci Food Agric,* 62.

AHAMEFULE, F. O., IBEAWUCHI, J. A. and OKOYE, F. C. (2005). Blood biochemistry and haematology of West African dwarf (WAD) bucks fed pigeon pea-cassava peel based diets. In *Journal Anim Vet Adv.*, 4 (12): 1016–1020.

AKINFALA, E.O., ADERIBIGBE, A.O. and MATANMI, O. (2002). Evaluation of the nutritive value of whole cassava plant as replacement for maize in the starter diets for broiler chicken. In *LRRD,* 2002;14:1–6.

ANAETO, M., SAWYERR A.F., ALLI, T.R., TAYO, G.O., ADEYEYE, J.A. and OLARINMOYE, A.O. (2013).Cassava leaf silage and cassava peel as dry season feed for West African dwarf sheep. In *Global journal of science frontier research agriculture and veterinary sciences*.13 (2).

AOAC (2000). Association of Official Analytical Chemists: *Official Methods of Analysis*. 6th Edition. Washington DC, USA.

ARC (1980).*The nutrient requirement of ruminant livestock*. CABI., Farnham Royal, U.K.

BAKER, F.J. and SILVERTON, R.F. (1995). Introduction to medical laboratory technology: 6th Ed. Butterworth, England.

BOONNOP, K., WANAPAT, M., NONTASO, N. and WANAPAT, S. (2009). Enriching nutritive value of cassava root by yeast fermentation. In *Sci. Agric. (Piracicaba, Braz.),* 66(5): 629–633.

DUNCAN. D.B. (1955). Multiple range test and multiple *F*-test Biometrics, I, 1–42.

FRASER, C.M. and MAYS, A. (1986). The Merck veterinary manual. A hand book of diagnosis. Theropy and diseases prevention and control for the veterinarian 6th Edition, Merck & Co., Inc. Rahway, New Jersey, USA.

GILLESPIE, J.R. (1998). Animal science. Delmar publishers, International Thompson Publishing Company, 1204 pp.

JIWUBA, P.C., F.O. AHAMEFULE, I.P. OGBUEWU, and IKWUNZE, K. (2017). Blood chemistry and haematology of West African Dwarf goats fed *Moringa oleifera* leaf meal (MOLM) in their diets. In *Comparative Clinical Pathology*, 26: 621–624.

JIWUBA, P.C., EZENWAKA, L.C., IKWUNZE, K. and NSIDINANYA, N.O. (2016a). Blood profile of West African Dwarf goats fed pro-vitamin A cassava peel-centrosema leaf meal based diets. An*alele Stiintifice ale Universitatii, Alexandru Ioan Cuz", Sectiunea Geneticasi Biologie Moleculara* TOM XVII, Fascicula, 3: 27–134.

JIWUBA, P.C. and EZENWAKA, L.C. (2016). Growth performance and apparent nutrient digestibility of West African dwarf goats fed yellow root cassava peel-centrosema leaf meal based diets. In *Case Stud. J.*, 5: 204–210.

JIWUBA, P.C., DAUDA, E., EZENWAKA, L.C. and ELUAGU, C.J. (2016c). Replacement value of maize with sweet potato (*Ipomoea batata*) root meal on growth performance and haematogical characteristics of broiler starter birds. In *Archives of Current Research International,* 53:1–7.

JIWUBA, P.C., IKWUNZE, K., UME, S.I and NSIDINANYA, N.O. (2016b). Performance, apparent nutrient digestibility and cost benefit of West African dwarf goats fed dietary levels of *Moringa oleifera* leaf meal. In *Journal of Advances in Biology and Biotechnology*, 8: 1–9.

JIWUBA, P.C., ONUNKA, B.N. and NWEKE, J.C. (2018). Influence of supplemental cassava root sievate – cassava leaf meal based diets on carcass and economics of production of West African dwarf goats. In *Sustainability, Agri, Food and Environmental Research*, 40–54.

KHAJARERN, S. and KHAJARERN, J. (2007) Use of cassava products in poultry feeding: roots, tubers, plantains and bananas in animal feeding. http://www.fao.org/DOCREP/003/T0554E/T0554E10.htm [accessed 17.7.18].

KHAMPA, S., CHAOWARAT, P. SINGHALERT, R. and WANAPAT, M. (2009). Supplementation of yeast fermented cassava chip as a replacement concentrate on rumen fermentation efficiency and digestibility on nutrients in cattle. In *Asian Journal of Animal Science*, 3: 18–24.

KHIEU, B., CHHAY, T., OGLE, R.B. and PRESTON, T.R. (2005). Research on the use of cassava leaves for livestock feeding in Cambodia. In *Proceeding of the regional workshop on "The Use of Cassava Roots and Leaves for On- Farm Animal Feeding",* Hue, Vietnam; p. 17e9.

MITJAVILA, S., LACUMBE C., CARRERA, G. and DARECHE, R. (1977). Tannie acid and oxidized tanic acid on the functional state of the rat intestinal epithelium. In *Journal Nutrition*, 107, 2113–2121.

MORGAN, K.N. and CHOCT, M. (2016). Cassava: nutrient composition and nutritive value in poultry diets. In *Animal Nutrition*, 2: 253–261.

NEHRING, K. and HAELIEN, G.W.F. (1973). Feed evaluation and calculation based on net energy. In *J. Anim. Sci*., 36(5): 949–963.

NORTON, B.W.B., LOWRY, C. and SWEENEY, M.C. (1994).The nutritive value of Leucaena specie. Paper presented at Int'l. Workshop on Leucaena. R.D. Bogor, Indonesia. 20–29 January 1994.

NRC (1981). Nutrient Requirements for goats: Angora, dairy and meat goat in temperate and tropical countries. National Research Council; National Academy of Science Press, Washington DC.

NOWSHARI, M.A, BECKERS, J.F. and HOLTZ, W. (1995). Superovulation of goats with purifies FSH supplemented with Defined Amounts of PLH. In *Theriogenology*. 43; 802–808.

ODEDIRE, J.A. and BABAYEMI, O.J. (2008). Comparative studies on the yield and chemical composition of *Panicum maximum* and *Panicum maximum* as influenced by *Tephrosia candida* and *Leucaena leucocephala*. In *Livestock Research for Rural Development*, 20 (2).

ONYEONAGU, C.C. and EZE, S. M. (2013). Proximate compositions of some forage grasses and legumes as influenced by season of harvest. In *Afr. J. Agric. Res.*, 8: 4033–4037.

ONI, A. O., ARIGBEDE, O.M., SOWANDE, O.S., ANELE, U.Y., ONI, O.O. ONWUKA, C.F.I, ONIFADE, O.S., YUSUF,K.O., DELE, P.A. and ADERINBOYE, R.Y. (2012). Haematological and serum biochemical parameters of West African dwarf goats fed dried cassava leaves-based concentrate diets. In *Trop Anim Health Prod.*, 44: 483–490.

PRATH, D.S. (2010). Liver chemistry and function test In Feldman, M., Friedman, L.S., Brandt, L.J. (edition) *Sleiscenger anf fordran's gastronintestinal and liver diseases philade/*phia: Elseviers publishers, 118–124 pp.

PRIVULOVIC, D., KOSARCIC, S., POPOVIE, M., DIMITRIGERIC, D. and GRUBUR-LAJSIC, G. (2012). The influence of hydrated aluminosilicate on biochenmical and haematological blood parameters, growth performance and carcass traits of pigs. In *Journal Animal and veterinary Advance*, 11(1). 134–140.

RAVINDRAN, V. (1991). Preparation of cassava leaf products and their use as animal feeds. In *Roots, Tubers, plantain and bananas in animal feeding*, vol. 95. Rome, Italy: Food and Agriculture Organisation.

SALAMI, R.I. and ODUNSI, A.A. (2003). Evaluation of processed cassava peel meals as substitutes for maize in the diets of layers. In *International journal, poultry science*, 2(2): 112–116.

TIJANI, I. D. R., JAMAL, P., ALAM, M. Z. and MIRGHANI, M. E.S. (2012). Optimization of cassava peel medium to an enriched animal feed by the white rot fungi *Panus tigrinus* M609RQY. In *International Food Research Journal,* 19(2): 427–432.

ZALVA, J. F. and PANNAL P.R. (1984). *Clinical chemistry in diagnoses and treatment*. 4th Edition Eloyd luke Medical books Ltd. London.