PERFORMANCE OF PREGNANT WEST AFRICAN DWARF GOATS FED GUINEA GRASS BASAL DIET AND CASSAVA PEEL AND LEAF MEAL BASED CONCENTRATE

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Abstract

The West African dwarf goat is a small ruminant that requires adequate and quality nutrition which usually is a basal forage diet (which is more often than not depleted during the dry season) and concentrate supplement to fully exploit her potential. The concentrate supplement is a combination of some expensive conventional feedstuff whose high cost in addition to competition for them between man and animals have resulted to the use of locally available and non-competitive / local feedstuff to compound concentrate rations. Cassava is planted mostly for its tuberous root leaving the leaves to wither after harvesting the root, in addition to heaps of peels derived from peeling the tubers. Thus, there is need to develop an adoptable system to properly handle this situation, in addition to problems such as environmental and health hazards resulting from the production of offensive odour. Cassava leaves and peels are cheap and easily assessable feed ingredients whose combinations can result in least costly but competitive and comparable rations that meet the nutritional requirements of animals at different physiological stages of life. This study evaluated the feeding value of cassava peel meal (CPM) and cassava leaf meal (CLM) as replacements for wheat offal (WO) and palm kernel cake (PKC), respectively in concentrate supplements. A basal diet of Guinea grass and the respective concentrate supplements were fed to sixteen pregnant West African dwarf (WAD) goats for 162 days. The goats (19.38 ± 2.30 kg) were brought on heat by synchronization through the daily administration of 10 mg medroxyl - progesterone acetate per animal for 14 days and serviced by a proven buck. Four does were allocated in a completely randomized design, to each of the four experimental concentrate supplements of T1 (standard concentrate/control), T2 (25% replacement of WO and PKC with CPM and CLM), T3 (50 % replacement of WO and PKC, with CLM and CPM) and T4 (75% replacement of WO and PKC, with CLM and CPM). Feeds were offered at 50 gDM/Kg BW, and feed intake, feed digestibility and weight gain were monitored. Total DM and OM intakes of the pregnant goats did not vary significantly (P>0.05) among the treatments. Crude protein intakes (g/d/kgW$^{0.75}$) was significantly highest in T4 (14.89) followed by T3 (11.74) and then T2 (9.80) and T1 (9.59) which did not differ significantly. The experimental diets significantly (P<0.05) influenced the EE, Ash, NDF, ADF, and HMC intakes of the pregnant goats in the respective treatments. Weight gain and feed conversion ratio (FCR) were significantly better in pregnant goats fed 50% replacement of WO and PKC with CPM and CLM, while a lower gain was in the 75% replacement with CPM and CLM. The digestibility (%) of dry matter (83.48 – 88.06), crude protein (74.13 – 83.20), ash (70.33 – 87.16), organic matter (82.15 – 85.67), ether extract (75.44 – 83.29), neutral detergent fibre (79.44 – 84.89), acid detergent fibre (78.69 – 87.30) and Hemicellulose (74.74 – 92.94) were high and also not significantly different (P > 0.05) in all the treatments except for ash digestibility (P < 0.05). Inclusion of CPM and CLM did not significantly (P < 0.05) influence the apparent digestibility (%) of DM, CP, OM, EE, NDF, ADF and HMC but Ash. All the animals had successful gestation and healthy kids on parturition. In conclusion, results have shown that WO and PKC can be replaced with cassava peel meal and cassava leaf meal respectively up to 50% level in the diet of pregnant goats without deleterious effect on the animals.

***Keywords**: Pregnant WAD does, Cassava peel meal, Cassava leaf meal, apparent digestibility, Weight gain*

Abstrait

La chèvre naine d'Afrique de l'Ouest est un petit ruminant qui a besoin d'une alimentation adéquate et de qualité qui est généralement une alimentation fourragère de base (qui est le plus souvent épuisée pendant la saison sèche) et un complément concentré pour exploiter pleinement son potentiel. Le supplément concentré est une combinaison de certains aliments conventionnels coûteux dont le coût élevé, en plus de la concurrence entre l'homme et les animaux, a entraîné l'utilisation d'aliments disponibles localement et non compétitifs / locaux pour composer des rations concentrées. Le manioc est planté principalement pour sa racine tubéreuse laissant les feuilles se flétrir après la récolte de la racine, en plus des tas de pelures provenant de l'épluchage des tubercules. Ainsi, il est nécessaire de développer un système adoptable pour gérer correctement cette situation, en plus des problèmes tels que les risques environnementaux et sanitaires résultant de la production d'odeurs désagréables. Les feuilles et les pelures de manioc sont des ingrédients bon marché et facilement évaluables dont les combinaisons peuvent donner des rations moins coûteuses mais compétitives et comparables qui répondent aux besoins nutritionnels des animaux à différents stades physiologiques de la vie. Cette étude a évalué la valeur alimentaire de la farine d'écorces de manioc (CPM) et de la farine de feuilles de manioc (CLM) en remplacement des abats de blé (WO) et du tourteau de palmiste (PKC), respectivement dans les suppléments concentrés. Un régime de base d'herbe de Guinée et les suppléments concentrés respectifs ont été administrés à seize chèvres naines d'Afrique de l'Ouest (WAD) gestantes pendant 162 jours. Les chèvres (19,38 ± 2,30 kg) ont été mises en chaleur par synchronisation grâce à l'administration quotidienne de 10 mg d'acétate de médroxyl - progestérone par animal pendant 14 jours et saillies par un bouc éprouvé. Quatre lapines ont été réparties de manière complètement aléatoire, à chacun des quatre suppléments de concentré expérimental de T1 (concentré standard/contrôle), T2 (remplacement de 25 % de WO et PKC par CPM et CLM), T3 (remplacement de 50 % de WO et PKC, avec CLM et CPM) et T4 (remplacement de 75 % de WO et PKC, avec CLM et CPM). Les aliments ont été offerts à 50 gMS/kg de poids corporel, et la consommation d'aliments, la digestibilité des aliments et le gain de poids ont été surveillés.

Les apports totaux de MS et de MO des chèvres gestantes n'ont pas varié significativement (P>0,05) entre les traitements. Les apports en protéines brutes (g/j/kgW0,75) étaient significativement plus élevés en T4 (14,89) suivi de T3 (11,74) puis de T2 (9,80) et T1 (9,59) qui ne différaient pas significativement. Les régimes expérimentaux ont influencé de manière significative (P <0,05) les apports en EE, cendres, NDF, ADF et HMC des chèvres gestantes dans les traitements respectifs. Le gain de poids et le taux de conversion alimentaire (FCR) étaient significativement meilleurs chez les chèvres gestantes nourries avec un remplacement de 50 % de WO et PKC par CPM et CLM, tandis qu'un gain plus faible était dans le remplacement de 75 % par CPM et CLM. La digestibilité (%) de la matière sèche (83,48 – 88,06), de la protéine brute (74,13 – 83,20), de la cendre (70,33 – 87,16), de la matière organique (82,15 – 85,67), de l'extrait éthéré (75,44 – 83,29), de la fibre détergente neutre (79,44 – 84,89), les fibres détergentes acides (78,69 – 87,30) et l'hémicellulose (74,74 – 92,94) étaient élevées et non significativement différentes (P > 0,05) dans tous les traitements sauf pour la digestibilité des cendres (P < 0,05). L'inclusion de CPM et CLM n'a pas influencé de manière significative (P < 0,05) la digestibilité apparente (%) de DM, CP, OM, EE, NDF, ADF et HMC mais Ash. Tous les animaux ont eu une gestation réussie et des chevreaux en bonne santé à la parturition. En conclusion, les résultats ont montré que le WO et le PKC peuvent être remplacés par la farine d'écorces de manioc et la farine de feuilles de manioc respectivement jusqu'à 50 % dans l'alimentation des chèvres gestantes sans effet délétère sur les animaux.

Mots clés : *WAD gravide fait, Farine d'écorces de manioc, Farine de feuilles de manioc, digestibilité apparente, Prise de poids.*

خلاصة

الماعز القزم في غرب إفريقيا هو حيوان مجترة صغير يتطلب تغذية كافية وعالية الجودة والتي عادة ما تكون نظامًا غذائيًا أساسيًا للأعلاف (والذي غالبًا ما ينضب خلال موسم الجفاف) ومكملات مركزة لاستغلال إمكاناتها بالكامل. مكمل التركيز هو مزيج من بعض الأعلاف التقليدية باهظة الثمن والتي أدت تكلفتها العالية بالإضافة إلى التنافس عليها بين الإنسان والحيوان إلى استخدام الأعلاف المحلية المتاحة وغير التنافسية / المحلية لحصص التركيز المركبة. يُزرع الكسافا في الغالب بسبب جذره الدرني مما يترك الأوراق تذبل بعد حصاد الجذر ، بالإضافة إلى أكوام من القشور المشتقة من تقشير الدرنات. وبالتالي ، هناك حاجة لتطوير نظام قابل للتبني للتعامل بشكل صحيح مع هذا الموقف ، بالإضافة إلى مشاكل مثل المخاطر البيئية والصحية الناتجة عن إنتاج الروائح الكريهة. أوراق الكسافا وقشورها رخيصة الثمن ويمكن تقييمها بسهولة من مكونات العلف التي يمكن أن تؤدي مجموعاتها إلى حصص غذائية أقل تكلفة ولكنها تنافسية وقابلة للمقارنة تلبي المتطلبات الغذائية للحيوانات في مراحل فسيولوجية مختلفة من الحياة. قيمت هذه الدراسة القيمة الغذائية لوجبة قشر الكسافا (CPM) ووجبة أوراق الكسافا (CLM) من خلال الإعطاء (WAD) لمدة 162 يومًا. تم إحضار الماعز (19.38 ± 2.30 كجم) للحرارة عن طريق المزامنة من خلال الإعطاء اليومي لـ 10 مجم ميدروكسيل - أسيتات البروجسترون للحيوان لمدة 14 يومًا ويتم صيانتها بواسطة باك مثبت. تم تخصيص أربعة من المكملات المركزة التجريبية الأربعة من تصميم عشوائي تمامًا ، T1 (التركيز القياسي / التحكم) ، T2 (25 ٪ استبدال WO و PKC بـ CLM و CPM) ، T3 (50 ٪ استبدال WO و PKC مع CLM و CPM) و T4 (75 ٪ استبدال WO و PKC مع CLM و CPM). تم تقديم العلف عند 50 جم / كجم من وزن الجسم ، وتمت مراقبة كمية العلف وهضم العلف CPM و CLM
لم يختلف إجمالي مأخذ DM و OM) بشكل كبير (P < 0.05) بين العلاجات. كان تناول البروتين الخام (جم / يوم / P للماعز الحوامل كجم W0.75) والتي لم تختلف معنوياً. أثرت الحميات التجريبية بشكل معنوي (P <0.05) على مأخذ HMC، ADF، NDF، Ash، EE للماعز الحوامل في المعاملات ذات الصلة. كانت T1 (9.59) و T2 (9.80) ثم T3 (11.74) يليه T4 (14.89) أعلى معنوياً في نسبة زيادة الوزن وتحويل العلف (FCR) أفضل بشكل ملحوظ في الماعز الحامل التي تم تغذيتها باستبدال 50٪ من PKC و WO) باستخدام CLM و CPM ، بينما كانت الزيادة الأقل في الاستبدال بنسبة 75٪ باستخدام CLM و CPM. قابلية الهضم (٪) للمادة الجافة (83.48 - 88.06) ، البروتين الخام (74.13 - 83.20) ، الرماد (70.33 - 87.16) ، المواد العضوية (82.15 - 85.67) ، مستخلص الأثير (75.44 - 83.29)Hemicellulose ، ألياف المنظفات المحايدة (79.44 - 84.89) وألياف المنظفات الحمضية (78.69 - 87.30) و (74.74 - 92.94) كانت مرتفعة ولم تختلف بشكل كبير (P <0.05) في جميع المعاملات باستثناء هضم الرماد (P). لم يؤثر P> 0.05) تضمين CPM و CLM) بشكل كبير P من (٪) على قابلية الهضم الظاهرة DM و CP و OM و EE و NDF و ADF و HMC ولكن الرماد. كل الحيوانات لديها حمل ناجح وأطفال أصحاء عند الولادة. في الختام ، أوضحت النتائج أنه يمكن استبدال WO و PKC بدقيق قشر الكسافا ووجبة أوراق الكسافا على التوالي بنسبة تصل إلى 50٪ في النظام الغذائي للماعز الحوامل دون WAD الحامل يفعل ، وجبة قشر الكسافا ، وجبة الكلمات الأساسية:
أوراق الكسافا ، قابلية الهضم الظاهرة ، زيادة الوزن

Introduction

Goats are small ruminants that have been domesticated for their meat and milk. They continue to offer food and revenue to many impoverished and marginal farmers, playing a significant socioeconomic role (Feleke *et al*., 2016). Many people eat goat meat, also known as chevon, despite the fact that it has a price that competes with beef on the market and can occasionally be even higher. This is due to the wide acceptance, flavor, tenderness, and palatability of the meat. The West African dwarf goat needs a sufficient amount of high-quality nutrition to reach its full potential, however during the dry season, the available feeds are frequently reduced. The high cost of concentrate supplementation, which is necessary to maintain goat productivity during the critical period of low pasture availability, is a barrier. There is a need to harness the potential of locally available and non-competitive local feedstuff to compound concentrate for goats instead of the expensive ones. Concentrate rations have the additional advantages of promoting rapid growth of ruminants, reduce methane production in the rumen and increase propionate production, thereby lowering energy losses and increasing efficiency of nutrient utilization (McDonald *et al.,* 1995).

The humid tropics' all-year crop cassava (*Manihot esculenta*) is one of the top 10 food crops in the world (Oyebipe et al., 2006). The byproducts, such as peels and residue, such as leaves, might fill the seasonal gap in the availability of feed for ruminant cattle in Nigeria because cassava is widely used as a staple crop there. The peels and leaves can be used in goat production after being processed using methods such ensiling and sun-drying, among others. As a result, the nutrition and health of the family will improve, and the sale of these animals and their products will stabilize and raise household income. Therefore, this study looked at the feed intake, weight gain, and nutrient digestibility of pregnant West African dwarf goats fed Guinea grass and cassava peel and leaf meal-based concentrate supplement.

Materials and Methods

Study Area

The experiment was carried out at the small ruminant unit of the University of Benin farm project, Benin City, Edo State, Nigeria. Benin City lies between latitude 6° and 30^{1}N of the Equator and longitude 5° 40^{1} and 6°E of the Greenwich meridian in the rain forest zone, with mean monthly temperature of 27.6°C. The area has an average annual rainfall and relative humidity of 2162 mm and 72.5% respectively (CNES/Airbus, 2016).

Preparation of Experimental Feeds

The cassava peels and leaves used during this study were collected from some cassava processing centers around Benin City. The fresh cassava peels and leaves were rinsed in water to remove contaminants, sun dried for 3 - 5 days depending on the intensity of the sun, with turnings at regular intervals to prevent fermentation. The sundried cassava peels and leaves were milled and bagged for feed formulation.

Experimental Animals and their Management

Sixteen (16) mature West African dwarf (WAD) does were purchased from villages around Benin City, weighed and housed in individual pens measuring 1 m x 1.5 m each and well bedded with wood shavings. The pens were cleaned thrice weekly with regular replacement of wet portions of the bedding material. The goats were quarantined, dewormed with Albendazole (KEPRO B.V. Holand, 1 mL per 20 kg body weight) and administered with long acting oxytetracycline 200 LA (invesa, Spain, 1 mL per 10 kg body weight). They were also vaccinated against PPR (Pestes des petit ruminante) using the PPR vaccine at 1 mL per 50 kg BW administered subcutaneously.

The animals were individually housed and induced into heat through synchronization by administration of 10 mg of medroxy - progesterone acetate tablets orally per animal daily for 14 days (Imasuen and Ikhimoya, 2008), after which the does were introduced to a chosen buck. This was repeated three times daily for four consecutive days in order to detect heat and does with confirmed heats were immediately serviced by the buck while those that failed to come on heat were induced and serviced again.

Experimental Treatments and Design

The experimental diets consisted of basal diet of Guinea grass (*Panicum maximum*) and graded levels of cassava peel and leaf meal based concentrate diets (Table 1) at 50 % supplementation fed *ad libitum*. The experimental diets are shown below:

Diet 1: Control diet (standard concentrate) + 50% Guinea grass (GG)

Diet 2: 25% partial replacement of energy source (wheat offal, WO) of the concentrate with cassava peel meal (CPM) + 25% replacement of protein source (palm kernel cake, PKC) of the concentrate with cassava leaf meal (CLM) + 50% GG

Diet 3: 50% replacement of WO of the concentrate with CPM + 50% replacement of PKC of the concentrate with CLM + 50 % GG

Diet 4: 75% replacement of WO of the concentrate with CPM + 75% replacement of PKC of the concentrate with CLM + 50% GG.

The pregnant animals were weighed, grouped into four and balanced for weight. They were randomly allocated into the four (4) dietary treatments in a completely randomized design (CRD).

Table 1: Ingredient compositions (%) of the concentrate supplements fed to the experimental goats

Ingredient	Diets			
	T1	T2	T3	T4
Maize	17.00	17.00	17.00	17.00
Wheat offal	40.00	30.00	20.00	10.00
Cassava peel meal	0.00	10.00	20.00	30.00
PKC	40.00	30.00	20.00	10.00
Cassava leaf meal	0.00	10.00	20.00	30.00
Bone meal	1.00	1.00	1.00	1.00
Salt	1.00	1.00	1.00	1.00
Premix *	1.00	1.00	1.00	1.00
Total	100.00	100.00	100.00	100.00
Calculated nutrient composition				
Metabolizable Energy (MJ/Kg)	11.13	10.84	10.54	10.24
Crude Protein (%)	15.54	15.58	15.62	15.67
Cost of feed/Kg (₦)	62.71	52.91	43.11	33.31

Feed Intake and Digestibility Study

Daily feeds were served to meet 5% of the experimental animal's body weight and this was frequently adjusted to ensure that each animal received about 20% of feed above its previous day's intake. The quantity of feed served and leftover was calculated and the difference recorded as the feed intake. The digestibility study lasted two (2) weeks during which the goats were allocated to metabolism cages for separate collection of daily urine and faeces. Faecal and urine outputs were determined for each doe. Total faeces and urine voided were collected each morning before feed and water were given ad libitum. The faeces were weighed fresh and 10% aliquot of each day's collection for each animal was taken and oven- dried at 100°C to constant weight, for dry matter (DM) determination. 5 g of the milled faeces was oven dried at 100°C for 48 hours to determine its residual moisture content. The seven (7) - day's faecal samples for each animal were pooled together, thoroughly mixed and milled. These were then stored at room temperature for subsequent chemical analysis. Urine collected per replicate was stored in plastic bottles and acidified with 2 mL of 20% tetraoxosulphate (VI) acid to arrest microbial activities as well as volatilization loss of nitrogen. For the pregnant animals, digestibility was done during the 16th week of gestation. The dry matter content of the concentrate feed and the Guinea grass was also determined by drying pre-weighed samples at 100°C until constant weight was obtained. Representative samples of the feeds and faeces collected were milled to pass through 1 mm mesh sieve and stored pending the laboratory analysis.

Chemical Analysis

Known weights of milled samples in triplicates were used for chemical analysis. The feed and faeces were analyzed for their respective components of crude protein (N × 6.25) and OM according to the procedure of AOAC (2000) while NDF and ADF components were determined by the detergent method (Van Soest *et al.,* 1991).

Statistical Analysis

Data were subjected to analysis of variance (ANOVA) using SAS (2014) and significant differences were declared at 5 % probability level and means were separated using Duncan Multiple Range Test.

Results

Chemical composition of experimental diets

Results for the chemical composition of diets tested are as presented on Table 2.

Table 2: Chemical composition (%) of the diets fed to the experimental goats

	Diets				
Parameter	T1	T2	T3	T4	SEM
Composition (%)					
DM	91.39[a]	87.54[c]	83.95[d]	89.16[b]	0.061
CP	15.75[a]	17.50[a]	19.25[a]	21.00[a]	3.200
EE	14.40[a]	12.60[ab]	11.55[ab]	10.15[b]	0.842
ASH	5.45[c]	10.85[b]	10.65[b]	16.80[a]	0.266
OM	85.94[a]	76.69[b]	73.10[c]	72.36[c]	0.243
NDF	33.20[b]	32.10[b]	29.10[c]	37.30[a]	0.532
ADF	31.90[a]	27.90[b]	24.10[c]	21.10[d]	0.640
HMC	1.30[b]	4.20[b]	5.00[b]	16.20[a]	1.053

SEM=Standard error of means;
[abcde]Means bearing different superscript letters within the same row differ significantly ($P < 0.05$)
Treatment 1: Control diet (0% CLM replacement of PKC + 0% CPM replacement of wheat offal
Treatment 2: 25% CLM replacement of PKC + 25% CPM replacement of wheat offal
Treatment 3: 50% CLM replacement of PKC + 50% CPM replacement of wheat offal
Treatment 4: 75% CLM replacement of PKC+ 75% CPM replacement of wheat offal
CPM = Cassava peel meal, CLM = Cassava leaf meal, PKC = Palm kernel cake,
DM = Dry matter, CP = Crude protein, EE = Ether extract, OM = Organic matter;
NDF = Neutral detergent fibre, ADF = Acid detergent fibre, Hemicelluloses = HMC

As shown in Table 3, daily intakes of dry matter and crude protein were highest in Treatment 4 with 75% replacement of wheat offal and palm kernel cake with CPM and CLM respectively
There was no significant ($P > 0.05$) effect of the dietary treatments on the average daily dry matter intake of concentrate and grass. The intake values ranged from 424.35 – 484.74 g/d and 130.77 - 137.55 g/d for concentrate and grass respectively. Also, average total feed intake (g/d) of the pregnant WAD does had respective values of 588.60, 555.12, 610.36 and 617.63 for T1, T2, T3 and T4 which were not significantly ($P > 0.05$) affected by the dietary treatments. Similarly, total dry matter intakes expressed per metabolic size ($g/kgW^{0.75}/d$) values were also not significant across the treatments. The average initial live weight (kg) of the pregnant goats did not vary significantly. Also, average final live weight (kg) the animals were not significantly influenced ($P > 0.05$) by the experimental diets. The total weight gain (g) was highest in treatment 3 but the value was significantly different ($P < 0.05$) from that of treatment 4 but not for treatments 1 and 2 ($P > 0.05$). The average daily weight gain followed the same trend as the total live weight gain. The Feed conversion ratio (FCR) of the pregnant West African dwarf goats increased with an increase in the level of dietary replacements with CLM and CPM except for treatment 3 (12.96), which had a lower FCR value than the first two treatments, that is, treatments 1 (15.39) and 2 (17.20). The dietary treatments did not significantly ($P > 0.05$) influence the FCR of the pregnant WAD goats in treatments 1, 2 and 3. However, treatment 4 (20.70) recorded the highest FCR value which varied significantly from the control and treatment 3.

Table 3: Performance of pregnant West African dwarf goats fed Guinea grass basal diet and cassava peel and leaf meal based supplement

	Diets				
Parameter	T1	T2	T3	T4	SEM
Initial body weight (Kg)	19.59^{a}	19.38^{a}	19.62^{a}	18.92^{a}	1.330
Final body weight (Kg)	24.26^{a}	25.44^{a}	26.99^{a}	23.44^{a}	1.950
Total Weight gain (Kg)	5.84^{ab}	4.88^{ab}	7.37^{a}	4.52^{b}	0.937
Average daily weight gain (g)	38.93^{ab}	32.62^{ab}	49.36^{a}	29.93^{b}	5.288
Dry matter intake (g/d)					
Concentrate	456.52^{a}	424.35^{a}	472.81^{a}	484.74^{a}	18.279
Grass	132.08^{a}	130.77^{a}	137.55^{a}	132.89^{a}	2.740
Total	588.60^{a}	555.12^{a}	610.36^{a}	617.63^{a}	9.560
Feed Conversion Ratio (FCR)	15.39^{b}	17.20^{ab}	12.96^{b}	20.70^{a}	1.250
Birth Weight (Kg)	1.35^{a}	1.24^{a}	1.41^{a}	1.11^{a}	0.098
Litter Size	1.33^{a}	1.33^{a}	1.00^{a}	1.67^{a}	0.272
Gestation Length	150^{a}	150^{a}	152^{a}	151^{a}	0.330

SEM=Standard error of means;
^{ab}Means bearing different superscript letters within the same row differ significantly ($P < 0.05$)
Treatment 1: Control diet 0% CLM replacement of PKC + 0% CPM replacement of wheat offal
Treatment 2: 25% CLM replacement of PKC + 25% CPM replacement of wheat offal
Treatment 3: 50% CLM replacement of PKC + 50% CPM replacement of wheat offal
Treatment 4: 75% CLM replacement of PKC + 75% CPM replacement of wheat offal
CPM= Cassava peel meal; CLM= Cassava leaf meal; PKC = Palm kernel cake

Total Nutrient intake (g/d and g/d/kgW$^{0.75}$) of pregnant West African dwarf goats

The results obtained for total nutrient intake (g/d and g/d/kgW$^{0.75}$) of pregnant WAD goats fed Guinea grass basal diet and cassava peel and leaf meal based concentrate supplement is presented in Table 4. Significant variations were observed in the mean crude protein intake (CPI) values both in g/d and g/d/kgW$^{0.75}$ obtained among the four (4) treatments studied. Treatment 4 was significantly highest and different from the other three treatments; T1 (99.17 and 9.59), T2 (98.88 and 9.80) and T3 (123.36 and 11.74). There was no significant difference between treatments 1 and 2. Total ether extract intake (EEI) in g/d and g/d/kgW$^{0.75}$ and was highest in the control (81.82 and 7.92) diet and lowest in treatment 4 (58.31 and 5.92) with presentation of significant variations between control and treatments 2, 3 and 4. No significant variation was found in the EEI of T2 and T3 as well as T2 and T4. Mean ash values (g/d) obtained during this digestibility study varied significantly and patterned the observation made with CPI. Treatment 4 was significantly highest and different from T1, T2 and T3. However T2 and T3 were not affected by treatment effect as no significant differences were observed between them. The mean organic matter intakes expressed in g/d and g/d/kgW$^{0.75}$ ranged between 489.25 and 546.14 as well as between 48.50 and 52.84 respectively. However, the dietary treatment did not have any significant ($P > 0.05$) effect on the OMI values. NDFI both in g/d and g/d/kgW$^{0.75}$ respectively, in T4 (289.46 and 29.40) was significantly highest and only different from those of T2 (247.55 and 24.54) and T3 (255.26 and 24.35), and not from NDFI of T1 (control). The lowest NDFI value was obtained in T2 (247.55 g/d and 24.54 g/d/kgW$^{0.75}$). ADFI values obtained for acid detergent fibre intake varied between 164.02 – 223.39 g/d as well as 16.79 – 21.83 g/d/kgW$^{0.75}$. Replacement levels significantly influenced the intakes of ADFI in all the four treatments, as the ADFI reduced significantly with increasing levels of CPM and CPL in the diets. There was an improvement in hemicelluloses intake as more of the CPM and CLM were added to the diets. The HMI was significantly lowest in the control diet (T1) and highest in T4.

Table 4: Total nutrient intake (g/d and g/d/kgW$^{0.75}$) of pregnant West African dwarf goats fed Guinea grass basal diet and cassava peel and leaf meal based concentrate supplement

	Diets				
Parameter	T1	T2	T3	T4	SEM
Nutrient intake (g/ day)					
Dry matter (DM)	588.60^{a}	555.12^{a}	610.36^{a}	617.63^{a}	9.560
Crude protein (CP)	99.17^{c}	98.88^{c}	123.36^{b}	146.58^{a}	4.125
Ether Extract (EE)	81.82^{a}	64.91^{bc}	69.03^{b}	58.31^{c}	2.642
Ash	42.46^{d}	65.87^{c}	75.09^{b}	104.29^{a}	2.364
Organic Matter (OM)	546.14^{a}	489.25^{a}	535.27^{a}	513.34^{a}	16.804
Neutral Detergent Fibre (NDF)	267.39^{ab}	247.55^{b}	255.26^{b}	289.46^{a}	6.594
Acid Detergent Fibre (ADF)	223.39^{a}	185.46^{b}	188.31^{b}	164.02^{c}	5.930
Hemicellulose (HMC)	37.97^{d}	57.21^{c}	84.54^{b}	97.26^{a}	1.810
Nutrient intake (g/d/kgW$^{0.75}$)					
Dry matter (DM)	63.20^{a}	55.82^{a}	56.70^{a}	62.98^{a}	3.300
Crude protein (CP)	9.59^{c}	9.80^{c}	11.74^{b}	14.89^{a}	0.340
Ether Extract (EE)	7.92^{a}	6.43^{bc}	6.56^{b}	5.92^{c}	0.169
Ash	4.11^{c}	6.65^{b}	7.15^{b}	10.59^{a}	0.230
Organic Matter (OM)	59.84^{a}	48.50^{a}	51.00^{a}	52.14^{a}	1.48
Neutral Detergent Fibre (NDF)	25.87^{ab}	24.54^{b}	24.35^{b}	29.40^{a}	0.80
Acid Detergent Fibre (ADF)	24.02^{a}	18.62^{b}	17.56^{b}	16.84^{b}	1.02
Hemicelluloses (HMC)	3.67^{d}	5.68^{c}	8.08^{b}	9.88^{a}	0.27

SEM=Standard error of mean;
[ab]Means bearing different superscript letters within the same row differ significantly ($P < 0.05$)
Treatment 1: Control diet 0% CLM replacement of PKC + 0% CPM replacement of wheat offal
Treatment 2: 25% CLM replacement of PKC + 25% CPM replacement of wheat offal
Treatment 3: 50% CLM replacement of PKC + 50% CPM replacement of wheat offal
Treatment 4: 75% CLM replacement of PKC + 75% CPM replacement of wheat offal
CPM= Cassava peel meal; CLM= Cassava leaf meal

Nutrient intake (g/d) of pregnant West African dwarf goats fed experimental diets during digestibility trial

The intake of dry matter (DMI) was similar ($P > 0.05$) in all the treatments. Also, CPI was not significantly influenced by the experimental treatments. The intake of EE was significantly highest in T1 and similar among T2, T3 and T4. Animals on T4 consumed the highest amount of ash ($P < 0.05$), while those on control diet consumed the least ($P < 0.05$). There was no significant ($P > 0.05$) difference in the ash intake of animals in T2 and T3. Organic matter and NDF intakes patterned that of DMI and were similar ($P > 0.05$) in all the treatments. Treatment 1 influenced highest intake of ADF ($P < 0.05$) while the values were similar in T2, T3 and T4. Hemicellulose was mostly consumed in T4 ($P < 0.05$) and least consumed in T1. The intake of T2 and T3 did not show any significant variation.

The result of apparent nutrient digestibility obtained as presented in Tables 5 and 6 below was high and did not show any significant difference in DMD, CPD among the four experimental treatments. Ash digestibility values were highest in the pregnant does fed dietary treatments replaced with CPM and CLM

Table 5: Dry matter and nutrient intake by the pregnant West African dwarf goats during the digestibility trial

Parameter	Diets				SEM
	T1	T2	T3	T4	
Intake (g/d)					
Dry matter (DM)	651.53^{a}	565.88^{a}	599.45^{a}	617.69^{a}	53.83
Crude protein (CP)	112.23^{a}	101.62^{a}	120.41^{a}	126.88^{a}	10.65
Ether Extract (EE)	94.60^{a}	67.12^{b}	67.09^{b}	57.81^{b}	6.78
Ash	46.21^{c}	67.40^{bc}	73.61^{b}	103.947^{a}	6.78
Organic Matter (OM)	612.32^{a}	507.38^{a}	537.68^{a}	525.56^{a}	24.05
Neutral Detergent Fibre (NDF)	289.36^{a}	250.48^{a}	253.08^{a}	292.27^{a}	22.89
Acid Detergent Fibre (ADF)	247.66^{a}	188.72^{b}	185.49^{b}	165.12^{b}	17.18
Hemicelluloses (HMC)	41.71^{c}	61.76^{bc}	67.60^{b}	127.15^{a}	6.32
Intake (g/d/kg kgW$^{0.75}$/d)					
Dry matter intake	63.20^{a}	62.98^{a}	56.70^{a}	55.82^{a}	3.30
Crude protein (CP)	10.89^{ab}	10.02^{b}	11.36^{ab}	12.93^{a}	0.66
Ether Extract (EE)	9.18^{a}	6.61^{b}	6.32^{b}	5.89^{b}	0.42
Ash	4.48^{c}	6.65^{b}	6.96^{b}	10.60^{a}	0.48
Organic Matter (OM)	59.39^{a}	50.05^{a}	50.87^{a}	53.59^{a}	2.91
Neutral Detergent Fibre (NDF)	28.07^{ab}	24.72^{ab}	24.00^{b}	29.81^{a}	1.45
Acid Detergent Fibre (ADF)	24.02^{a}	18.62^{b}	17.56^{b}	16.84^{b}	1.02
Hemicelluloses (HMC)	4.04^{c}	6.10^{b}	6.44^{b}	12.97^{a}	0.58

SEM=Standard error of mean;
^{ab}Means bearing different superscript letters within the same row differ significantly ($P < 0.05$)
Treatment 1: Control diet 0% CLM replacement of PKC + 0% CPM replacement of wheat offal
Treatment 2: 25% CLM replacement of PKC + 25% CPM replacement of wheat offal
Treatment 3: 50% CLM replacement of PKC + 50% CPM replacement of wheat offal
Treatment 4: 75% CLM replacement of PKC + 75% CPM replacement of wheat offal
CPM= Cassava peel meal; CLM= Cassava leaf meal; PKC = Palm kernel cake

Apparent Nutrient Digestibility of West African dwarf goats fed Guinea grass basal diet and cassava peel and leaf meal based supplement

The results obtained for nutrient digestibility coefficient of pregnant West African dwarf goats fed Guinea grass basal diet and cassava peel and leaf meal based concentrate supplement are presented in Table 6

Dry matter digestibility, (DMD) values (%) obtained for the pregnant goats did not vary significantly ($P > 0.05$) from 0.83 – 0.88. The values obtained for the other treatments, compared favorably with the control. Although the highest value (%) of crude protein digestibility (CPD) was obtained for the pregnant goats on treatment 4 (0.83), it was not significantly different from the CPD values of the pregnant animals on the other three treatments which were T1 (74.13), T2 (0.78) and T3 (0.79). Values obtained for ash digestibility (%), show that the treatment effects were not significant ($P > 0.05$) for pregnant animals fed dietary treatments 2, 3, and 4. However, significant variations existed between the control and the other three treatments.

Ether extract, organic matter, neutral detergent fibre, acid detergent fibre and hemicelluloses digestibilities (%) were not significantly ($P > 0.05$) affected by the experimental diets fed to the pregnant does.

Table 6: Dry matter and nutrient digestibility coefficient of pregnant West African dwarf goats fed the experimental diets

	Diets				
Parameter	T1	T2	T3	T4	SEM
Digestibility					
Dry matter	0.83[a]	0.88[a]	0.88[a]	0.87[a]	0.0178
Crude protein	0.74[a]	0.78[a]	0.79[a]	0.83[a]	0.0384
Ash	0.70[b]	0.87[a]	0.84[a]	0.86[a]	0.0286
Organic matter	0.85[a]	0.82[a]	0.84[a]	0.84[a]	0.0150
Ether Extract	0.81[a]	0.83[a]	0.82[a]	0.75[a]	0.0336
Neutral detergent fibre	0.79[a]	0.85[a]	0.81[a]	0.85[a]	0.0242
Acid detergent fibre	0.80[a]	0.87[a]	0.83[a]	0.79[a]	0.0266
Hemicelluloses	0.75[a]	077[a]	0.76[a]	0.93[a]	0.1224

SEM=Standard error of means;
[ab]Means bearing different superscript letters within the same row differ significantly ($P < 0.05$)
Treatment 1: Control diet 0% CLM replacement of PKC + 0% CPM replacement of wheat offal
Treatment 2: 25% CLM replacement of PKC + 25% CPM replacement of wheat offal
Treatment 3: 50% CLM replacement of PKC + 50% CPM replacement of wheat offal
Treatment 4: 75% CLM replacement of PKC + 75% CPM replacement of wheat offal
CPM= Cassava peel meal; CLM= Cassava leaf meal; PKC = Palm kernel cake

Discussion

Chemical composition of experimental diets

The result of the chemical composition of the concentrate supplement fed to pregnant does is presented in Table 2. It showed that the crude protein content of all the diets (T1-T4) varied between 15 and 18% which is within the recommended range of crude protein (CP) requirement for pregnant animals (NRC, 1981) but higher than the 8.70 – 14.0% given by NRC, (2007). Also, the metabolizable energy (ME) of 10.24-11.13 MJ/kg DM used during this study was similar to the recommended range of 2.1 – 2.7 kcal DE (NRC, 1981) for pregnant does. The CP content of the concentrate varied significantly and increased with an increase in cassava leaf meal (CLM) content in the diet, probably as a result of the high CP content of CLM used. This is in conformation with the reports of Oni *et al.* (2010) who fed different levels of dried cassava leaves (*Manihot esculenta*, *Crantz*) based concentrates as supplement to *Panicum maximum* to growing West African Dwarf goats. The dry matter (89.50%) obtained for cassava peel meal (CPM) is in agreement with the dry matter values of 80.95%, 87.60% and 87.59%, reported by Ravindran (1993), Ukankwo and Ibeawuchi (2014) and Morgan and Choct (2016), respectively. Also, the dry matter obtained for cassava leaf meal (92.25%) agreed with the reported values of 93.00, 92.06 and 93.00% DM by the aforementioned authors. The 28.00% crude protein obtained for cassava leaf meal was within the 16.7 to 39.90% range reported by Yousuf e*t al*. (2007) but higher than the crude protein of 20.80%, 21% and 25.10% reported by Adebayo *et al*. (2011), Ravindran (1993) and Ukankwo and Ibeawuchi (2014) respectively. This may be due to the variation in the fibre fractions of the cassava leaves during period of harvest, which influences the crude protein content of a feed material. The NDF and ADF content of 27.30 and 24.90 % respectively obtained for CPM during this study were higher than the values (10.44 and 13.34 %) for NDF and ADF respectively reported by Irekhore *et al*. (2015) who studied growth performance, haematological indices and cost benefits of growing pigs fed cassava peel meal diets supplemented with Allyme ®SSF. However, the values were lower than the 59.89 and 34.25 % reported by Kuforiji *et al*. (2016) for NDF and

ADF of cassava peel meal used in their study with growing rabbits.

The lower NDF and ADF of the CLM used in the study are related to its high CP content. This is in line with the views of Solomon *et al*. (2008) that high NDF and ADF contents can be related to lower crude protein content and subsequently low feed digestibility and vice versa. The DM (30.44%) and CP (8.75%) of the basal diet of Guinea grass in this study were similar to the values of 30.71 and 7.35% respectively reported for DM and CP by Bamigboye *et al*. (2014). However, Dele *et al*. (2013) reported lower DM value (21.03 %) and higher CP (9.48 %) than those obtained during this study.

Bamigboye *et al*. (2014) reported ash (7.12%) and ether extract (2.20%) values, which were similar to values obtained in this study. All the pregnant goats used during this study showed good growth performance and were able to carry their pregnancies to term, without abortion throughout the experimental period, a situation that is also described as a successful gestation. This is an indication that the respective experimental diets had sufficient nutrients required for a pregnant goat. Ahamefule *et al*. (2002) and Asaolu *et al*. (2012) reported that forages and feedstuffs containing less than 7% CP are poorly digested by ruminants due to insufficient nitrogen to stimulate rumen microbial functions and this resulted to poor performance by the animals. Hence the high CP of the experimental diets resulted in the good performance of the pregnant animals in this study.

The DM of the respective diets was high and CP content was observed to increase with increasing levels of CLM in the diets. This may be attributed to the high CP content of CLM (28.00%) in the different diets. Ether extract decreased with increase in the CPM and CLM in the diets which is probably as a result of the very low ether extract content of CPM (5.70%) and CLM (2.75%). Feed intake and body weight parameters of pregnant West African dwarf goats fed Guinea grass basal diet and cassava peel and leaf meal-based supplement.

Performance of pregnant WAD goats fed Guinea grass basal diet and cassava peel and leaf meal based supplement

The high dry matter intake recorded in the pregnant goats fed the respective concentrate supplement is in consonance with the reports of Oni *et al*. (2010) in a performance study on growing West African dwarf goats. The high crude protein in the diets is considered as an important factor in ruminants' diet because free choice intake of feed by animals increased by the increase in crude protein content of the diet. However, results obtained were at variance with those of Ngo *et al*. (2005) that dry matter intake reduced with increase in the levels of cassava in the diets of growing goats. In addition, the pregnant does had total voluntary dry matter intakes (DMI) of between 5 – 6% of their body weight which were higher than the 3% – 3.5% recommended by NRC (1981), but in consonance with the total voluntary DMI of 5% to 6% of body weight for goat's maintenance and production as recommended by ARC, (1995) and also as reported by Olomola *et al*. (2008) for pregnant West African dwarf goats fed groundnut cake, urea and rumen epithelial wastes in cassava flour and citrus pulp–based diets. However, this finding was at variance with that of Lapkini *et al*. (1997) that the highest DMI of 31.8 g /kg$W^{0.75}$ was from non – cassava based treatment, when the effects of graded levels of sun – dried cassava peels supplement diets fed to Red Sokoto goats in the first trimester of pregnancy was studied. The non - significantly different dry matter intakes (DMI) of the pregnant does on the respective dietary treatments is an indication that wheat offal and PKC can be successfully replaced with CPM and CLM at graded levels of 25%, 50% and 75% without deleterious effect on feed intake and weight gain of the pregnant does. This non – significant increase in dry matter intake is contrary to the reports of Lapkini *et al*. (1997) that DM intake by pregnant goats decreased with increase in CPM content of the diets. This may be due to relatively close and uniform particle sizes of CPM and wheat offal used during this study, thus resulting in rations that are highly degradable in the rumen even with increase in CPM content.

Also, the average daily grass DMI of the pregnant goats obtained during this study was non-significant. This is probably due to the palatability of the diets replaced with CPM and CLM which resulted in consumption of the different diets to ensure gut fill. This is in agreement with the findings of Ewuola *et al.* (2013) who opined during a study which evaluated growth response and nutrient digestibility of WAD goats fed micro doses of dietary afflatoxin, that daily dry forage DMI of goats fed 150 ppb afflatoxin was only numerically higher than the control diet. Similarly, dry matter intake for grass across the four treatments were non – significant, this may be due to the fact that an equal percentage of grass supplemented at 50 % was fed to all the animals whose weights have been balanced across the four experimental treatments. The Grass DMI is also in consonance with the results of Rahman *et al*. (2014) who reported only non – significant variations in the DM, CP and OM intake of grass, when feed intake and growth performance of goats offered Napier grass supplemented with concentrate pellet and soya waste was monitored. The gestation lengths of all the does were similar to the range of 150 – 152 days reported by Olomola *et al*. (2008). This further confirms the adequacy of the nutrients in the diets fed during the pregnancy period. Efficiency of feed utilization by the animals improved as indicated by decrease in the feed conversion ratio (FCR) with increase in the level of replacement of CPM and CLM. There was also a corresponding increase in weight gain. This could be explained from the result of significant degradation of the crude protein in the rumen and is in agreement with the results of Zinn *et al*. (1997) who fed an increasing level of CSM to cattle. Also, the works of Seng and Rodriguez (2001), Solomon *et al* (2008) and Oni *et al*. (2010) revealed that higher growth rates and lower feed conversion ratio indicate better goat performance in terms of weight gain with the high level of cassava foliage as supplement. Furthermore, the highest total weight gain and average daily weight gain was recorded in T4 though not significantly different from the T1 (control), T2 and T3. Pregnant does fed dietary treatments replaced with CPM and CLM at 50% (T3) also showed best FCR. This is at variance with the reports of Zinn *et al*. (1997) as well as Boyle - Renner *et al*. (2017) which indicated best feed conversion ratio and highest weight gain were observed in does fed the 0% replacement level of maize with cassava peel when compared to does on the 15 and 30% replacement levels.

Apparent Nutrient Digestibility of West African dwarf goats fed Guinea grass basal diet and cassava peel and leaf meal based supplement

Results were in conformity with the findings of Olomola *et al*. (2008), who reported non – significant differences in the DMD and CPD of pregnant WAD does fed groundnut cake, urea and rumen epithelial wastes in cassava flour and citrus pulp – based diets. This may be due to a high degree of utilization of the dietary treatments assigned to the pregnant does, irrespective of the replacement levels with CPM and CLM. In addition, the apparent crude protein (CPD) values obtained during this study are also comparable to the 77% - 86% crude protein digestibility values reported by McDonald *et al*. (2002), but higher than the 41% - 73% reported by Solomon *et al.* (2008) during a study conducted to evaluate the supplementation of cottonseed meal on feed intake, digestibility, live weight and carcass parameters of Sidama goats. The apparent CPD, though non – significant, observed in the pregnant does on the respective dietary treatments during this study agrees with the results of Solomon *et al*. (2008) that goats fed diets with high protein demonstrated better apparent CPD than goats fed diets of lower protein content. Furthermore, the non – significant variation observed in CPD across the four dietary treatments further infers that CLM can replace PKC in the pregnant goats' diets for the pregnant does on the various dietary treatments during this study. This is in consonance with the result of Solomon *et al.* (2008) who reported little or no effect of supplementation on digestibility of NDF and ADF. This can be attributed to possible reduction in rumen pH which has a depressing effect on the population of cell wall fermenting rumen microbes as a result of feeding more digestible supplement to the animals.

Conclusion

The study has shown that wheat offal and palm kernel cake can be replaced with cassava peel and cassava leaf meal respectively at 25, 50 and 75% in the diets of pregnant West African dwarf goats. Dry matter intake from pregnant goats fed diets compounded with CPM and CLM as energy and protein source feed ingredients compared positively with the control containing wheat offal and PKC, with crude protein and ash intakes that increased with an increase in cassava peel and leaf meal in the respective treatments studied. In addition, the average daily weight gain of pregnant West African dwarf goats fed concentrates replaced with CPM and CLM compared positively with that of the control. And does on treatment 3 (T3) had the best feed conversion ratio (FCR) which was also reflected in the weight of the animals. To this end, farmers can raise more West African dwarf goats by compounding proper rations to take care of the animals at their different physiological stages, with cheap feed resources found within the confines of their environment at minimal cost instead of reducing their herd size because of expensive and competitive feed resources.

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