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Effects of formulated concentrate and palm kernel cake supplementation on performance characteristics of growing West African dwarf (WAD) goat kids

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***Target Audience:** Extension agents and Ruminant nutritionist*

Abstract

The escalating cost of commercial concentrate has worsened the irregular supply of high quality feeds for ruminants. Therefore feeding strategies to enhance the utilization of native pastures by ruminants is paramount. A 100-day study was conducted to investigate the effects of mixing palm kernel (PKC) cake with a formulated maize-based concentrate in varying proportions, for use as supplement to grass silage diet by the goat. Twenty-five male-WAD goat kids, aged between five and six months with initial body weights range of 6.0 – 8.2 were fed five different supplements (A, B, C, D and E) each prepared by mixing a maize-based concentrate with palm kernel cake in the proportions of 100:0, 75:25, 50:50, 25:75 and 0:100 respectively for 100 days. Results showed that the intake of silage, apparent nutrient digestibility, body weights gains, red blood cell (rbc) and hemoglobin (Hb) increased (P<0.5) with increase in PKC offered. Creatinine, aspartate aminotransferase (AST) and alkaline phosphatase (ALP) blood levels differed (P<0.05) while alanine aminotransferase (ALT) and triglycerides showed marginal differences (P>0.05) among treatments. It was concluded that maize-base concentrate mixed with PKC in the proportion of 50:50 can improved utilization of grass silage in WAD goat kids.

***Keywords**: Formulated concentrate, Palm kernel cake, supplement, silage, growth performance, Hematology*

Description of Problem

Inadequate supply of good quality native pastures to sustain ruminants during the dry season has been the major problem hindering the productivity. Also, the increasing cost of available feedstuffs has led to competition between man and livestock thereby worsening the irregular supply of high quality feed for ruminants and increase in the prices of their products. Feeding strategies are therefore necessary to improve animal performance when tropical grasses are fed (1).

To improve these resources, different treatment methods like biological, chemical, fungal, ensiling, supplementation with high quality protein source and urea have been reported (2;3). Similarly, ruminants in the tropical and sub-tropical countries mostly depends on pasture and agricultural by-products of relatively low quality. However, the unique ability of ruminant animal to utilize fibre owing to its rumen microbes is another alternative promising and economic way to rear them. Improvement in ruminant production will therefore require investigating the different possible sources and means of

upgrading the poor roughages by improving their digestibility and voluntary intake (4). The efficient utilization of local feed resources may reduce the cost of production and enhance the productivity of ruminant animals, however, growth rate or carcass quality must not be compromised to have a significant positive impact on production (5).

Recently, agro-industrial by-products and crop residues are being used as alternative cheap and less competitive sources of livestock feeds. Palm kernel cake (PKC) has been noted to contain moderate levels of protein and energy (6; 7), and is available all-year round in the tropics; its cheap price makes it valuable good source of supplement in the ration of growing goats. PKC will facilitate economic and profitable ruminant production by reducing the cost of feeding during rearing. According to. (6), few researches have evaluated PKC as a major component of high concentrate diet for goats. This experiment investigates the efficacy of PKC as a replacer of formulated concentrate (FC) supplement to boost the nutrient density of forage ration, nutrient digestibility of the ration and growth performance.

Materials and Methods

Experimental site

The study was conducted at Teaching and Research Farm of Landmark University, Omu-Aran. Omu-Aran is situated between Latitude 8.1333^0N and 5.1000^0S with altitude of 562 m above sea level in the marginal forest belt of Nigeria. The yearly rain season is between the end of March and early October, while the dry season falls between late October and mid-March. The mean temper*ature* is uniformly high, range between 28^oC and 29^oC and relatively humidity in the wet season is between 75 to 80% while in the dry season it is about 65%.

Experimental diets

Pennisetum purpureum (Elephant grass) was harvested at 8 week regrowth from pasture plant on the Teaching and Research Farm of Landmark University. The harvested grass was cut to average length of 2.5cm, mixed thoroughly with over-ripe banana (*Musa species*) slurry prepared by a grinder at ratio of 10% of the weight of chopped wilted *Pennisetum purpureum* and packed in the air-proof bags lined with 20 mm thick nylon. Sodium chloride was added as a sterilizer. Ensiling was carried out inside bags that were closely sealed, pressed with a 25 kg weight load and kept under laboratory conditions for 40 days. Maize-based concentrate [maize,-(33%); -soya bean cake – (15%); wheat offal – (50%); bone meal – (1%); Sodium chloride – (0.5) and vitamin premix – (0.5%)] was mixed in varied proportions with palm kernel cake (100:0, 75:25, 50:50, 25:75 and 0:100) to supplement *ad libtum* intakes of grass silage.

Assessment of physico-chemical parameters of grass silage

Physico-chemical parameters of grass silage were determined as described by (8). The appearance of the silage in terms of color was assessed using a color chart. The smell and texture of the silage were adjudged by a six-man panel while the pH of the silage was determined using a pH meter (JENWAY, Model Serial No 35547, Bobby Scientific Ltd. Stone, Staffs, UK, ST15 0SA).

Experimental animals and management

Twenty-five growing WAD bucks of 5-6 months old, with live body weights (BW) ranging between 6.0 and 8.2kg sourced from Teaching and Research Farms of Landmark University were treated for internal and external parasites with Ivermectin injectable at dose of 1 ml/50 kg body weight. The animals were randomly distributed into five groups of five animals each in a Completely Randomized Design (CRD). All animals were kept in well ventilated pens (3 x1.5 m^2) under a roofed

house. Each group was assigned to one of the five treatments alongside the silage offered in excess of 10% above the expected intake according to individual body weight. Feed was given at 9.00 hour of every day, after the daily cleaning of the pen. Clean drinking water and mineral lick block were made available for all the animals throughout the experiment. The feeding experiment lasted 90 days. Each concentrate plus palm kernel cake mixture (200g) was offered to goats alongside silage in one meal per day throughout the feeding regime. Leftovers were collected and weighed every morning to estimate the intake. The goats were individually weighed weekly before morning feeding. The average daily weight gains and feed conversion were calculated. At expiration of 90 days of the feeding trial, animals were transferred to metabolism crates and allowed 3 days adjustment to crates. Faeces voided per animal were collected for 7 days then weighed, mixed, 10% representative sample was taken and freezed at -4^{o}C. Same procedure was used for the feed offered and samples of ort collected. Composite samples of feed offered, ort and feaces were thawed to room temperature, mixed thoroughly and oven dried at 105^{o}C for 24 hours. Each dried sample collected was mixed and sieved through 1mm sieve then stored until analyzed. Nutrient digestibility (%) was calculated as a difference in nutrient intake and nutrient voided in the feaces divided by nutrient intake and the quotient multiplied by 100.

Blood collection

Blood sample (10 mL) was drawn from jugular vein of each of the 25 WAD bucks at days 1, 45 and 90 during the feeding trial using disposable syringes (10 ml) and needles (18 gauge size). The blood samples harvested on each day of collection were divided into two lots and used to determine the biochemical and hematological components as described by (9). The hematology and blood biochemical were determined in laboratory of the Department of Chemical Pathology, Faculty of Veterinary Medicine, University of Ilorin, Nigeria

Chemical analysis

The feeds and faeces samples were analyzed for the chemical constituents using the procedures of (10). The detergent fibre components were determined using the procedure of (11). The hematological values of the blood samples were estimated by auto-haemacytometer and the Mean corpuscular hemoglobin (MCH), mean corpuscular volume (MCV), and mean corpuscular hemoglobin concentration (MCHC) were calculated from RBC, HB and PCV values, according to (9)

$$MCV = \frac{\text{PCV}}{\text{RBC}}\ X\ 10; \qquad MCH = \frac{\text{Hb}}{\text{RBC}}\ X\ 10;$$

$$MCHC = \frac{\text{Hb}}{\text{PCV}}\ X\ 100$$

Clinical chemistry semi-auto analyzer and a commercial biochemical assay kit was use to analyzed serum. Spectrophotometric linked reaction methods (12) was employed to determine the enzymatic activities of AST, ALT and ALP. Enzymatic colorimetric method described by (13) was used to determine urea,

Statistical analysis

Data obtained were subjected to analysis of variance (14) and the significant means were separated by Duncan Multiple Range Tests (15).

Results and Discussion

The physico-chemical parameters and chemical composition of silage (Table I) indicate good quality of silage as reported by (16; 17). The pH of 4.20 agrees with the findings of (18). The DM value (22.60%) recorded agreed with findings of (19), however, the 5.38% CP recorded was lower than 8% recommended by (20) for ruminant hence, supplementation of this silage with protein source would improve the performance of the goat. The chemical composition of the concentrate supplement (Tables II) reveals that

the CP, NFE, TDN and GE values decreased significantly (P<0.05) while EE, CF, NDF, ADF, ADL and Ash significantly increased (P<0.05), but total DM decreased marginally (P>0.05) between treatment means as PKC levels increased. The variation recorded in the chemical compositions of supplementary diets may be due to the proportional replacement of Formulated Concentrate (FC) with PKC from 0-100% level. The highest CP (18.90%) recorded in the control diet containing 0% PKC can be attributed to the constituents of the supplement (FC) which may have contributed to the overall protein content of the supplement. The CP (16.57-18.90%) and TDN (84.52-87.96%) values across the studied supplement concentrates suggested that the moderate levels of protein and energy in PKC are considered sufficient to meet the requirement of most ruminants as reported by (6; 7).

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***Table 1: Physico-chemical and chemical composition of the Pennisetum purpureum* silage**

Physico-chemical parameters		Chemical composition	
Parameter	**Observations**	**Parameter (%)**	**Value**
Appearance	Dull green	Dry matter (DM)	22.60
Smell	Pleasant banana fruity smell	Crude Protein (CP)	5.38
Texture	Firm	Crude Fibre (CF)	8.96
pH	4.20	Ether extract (EE)	1.80
Temperature	22^{o}C	Nitrogen free extract (NFE)	39.76

Table 2: Chemical composition (%) of formulated concentrates with palm kernel cake supplements

Chemical composition (%)	A	B	C	D	E	SEM ±
Moisture	11.03	11.10	11.26	11.46	11.96	0.32
Dry Matter (DM)	88.97	88.90	88.74	88.54	88.08	0.69
Crude Protein	18.90	18.12^{b}	17.64^{b}	16.84^{c}	16.57^{c}	0.35
Ether Extract	3.71^{c}	3.83^{c}	4.11^{b}	4.61^{a}	4.81^{a}	0.20
Crude fibre	5.20^{d}	8.00^{c}	10.70^{b}	14.78^{a}	14.78^{a}	0.23
NDF	18.57^{d}	24.89^{c}	29.63^{b}	37.37^{a}	45.14^{a}	0.23
ADF	6.03^{c}	11.73^{d}	16.37^{c}	22.64^{b}	27.37^{a}	0.25
ADL	2.09^{d}	4.36^{c}	5.79^{b}	7.17^{a}	8.40^{a}	0.24
Ash	3.26^{d}	4.28^{c}	4.83^{b}	5.01^{b}	5.77^{a}	0.20
NFE	57.90^{a}	54.82^{b}	51.46^{c}	47.30^{d}	41.64^{c}	0.45
TDN	87.96^{a}	87.02^{b}	86.6^{c}	85.78^{d}	84.52^{c}	0.30
GE (MJ/KG)	13.9572^{a}	13.5042^{b}	13.2242^{c}	12.8033^{d}	12.6153^{c}	0.12

*means in the same row with common superscripts are not statistically different (P>0.05).
NDF -Neutral detergent fibre, ADF -Acid detergent fibre, ADL -Acid detergent lignin, NFE -Nitrogen free extract, TDN -Total digestible nutrient , GE -Gross energy

DM intake (Tables 3) shows that silage DM intake increased (P<0.05) while concentrate supplement DM intake decreased (P<0.05) as PKC replaced FC, however, the total DM intake were marginally different (P>0.05) among the treatment groups. The acceptance of all supplements by the goats as revealed in the DM intake (Table 3) is suggestive of sustained total dry matter intake as PKC replaces FC and agreed with (21) that PKC is palatable for ruminants and inclusion do not have negative effect on voluntary feed intake. Goats fed concentrate supplement 75/25 had the highest significantly different (P<0.05) weight gain

(21.11g/d). The increased live weight recorded in all treatment groups agreed with report of (6) who reported improved performance and increased live weight in beef cattle fed traditional rations supplemented with PKC. Supplementation of silage with concentrates containing PKC showed improved apparent digestibility of fibre fractions and this could be attributed to the high fibre nature of PKC, as reported by (22).

Table 3: Dry matter intake, apparent nutrient digestibility and growth performance of growing WAD goat bucks fed *Pennisetum purpureum* silage and formulated concentrate with PKC supplement

Parameter	A	B	C	D	E	SEM ±
Dry mater intake						
Silage (g)/day	264.29^{b}	277.38^{ab}	278.17^{ab}	279.37^{ab}	302.38^{a}	18.05
Concentrate (g)/day	165.87^{a}	152.78^{ab}	138.56^{bc}	130.56^{bc}	110.12^{c}	15.19
Silage + Conc. Supple.(g)/day	430.16	430.16	416.73	409.93	412.50	22.29
Nutrient digestibility %						
Crude Protein (%)	68.82^{a}	75.23^{b}	66.36^{b}	63.84^{ab}	70.47^{ab}	3.44
Crude Fibre (%)	55.98^{c}	60.27^{b}	60.41^{b}	75.85^{a}	75.85^{a}	1.78
Ether Extract (%)	66.25^{b}	68.77^{b}	70.70^{b}	88.54^{a}	88.54^{a}	3.72
Ash (%)	58.22^{b}	77.00^{a}	70.86^{a}	59.47^{b}	59.47^{b}	3.48
ADF (%)	43.02^{c}	46.13^{c}	53.37^{b}	65.22^{a}	65.22^{a}	3.50
NDF (%)	47.93^{d}	50.88^{dc}	53.21^{bc}	58.00^{b}	63.28^{a}	2.44
Growth performance						
Total Weight gain (kg/90d)	1.1666^{c}	1.900^{a}	1.200^{bc}	1.100^{c}	1.433^{b}	131.66
Daily Dry matter intake g/day	417.07	443.25	428.73	417.86	412.50	22.29
Daily weight gain (g)	12.96^{c}	21.11^{a}	13.33^{bc}	12.22^{c}	15.93^{b}	1.57
Feed conversion	32.18^{ab}	21.00^{c}	30.60^{ab}	34.19^{a}	25.89^{bc}	3.54

*means in the same row with common superscripts and are not statistically different (P>0.05).

Table 4 illustrates hematology and biochemistry status of goats. The RBC values from goats fed supplements 100/0 and 0/100 were similar but significantly (P<0.05) different to others. The RBC value (14.87x10^{6}µ/l) of the goat obtained at 0/100 supplement fell within the normal range of 8-18x10^{6}µ/l reported for goats by (23). The values for animals fed 75/25 to 25/75 supplements (13.87 to 17.73x10^{6}µ/l) were higher than 12.63-13.03 x10^{6}µ/l reported by (24). The Hb (g/dl) value (11.17) from goat fed 0/100 falls within the range of 7-15g/dl and 11.88-12.20 g/dl reported (25; 24) for goats and higher than 7.5-9.75 g/dl reported by (26). This suggests that PKC promote RBC count and Hb concentration in growing WAD buck goats. PCV (%) values from goats fed 75/25 and 0/100 supplements (30%) falls within the range of 21-38% reported by (27) for healthy goats. This concludes that PKC as supplement in goats grass-silage ration does not induce reduction in PCV. The results of both MCH (g/l) and MCV (fl) are comparable to the values (5-8pg) for MCH and 16-25fl for MCV reported by (27) for some exotic goat breeds. A high Mean Corpuscular Volume (MCV) value implies the presence of Marcocystosis (28) but the MCV values in this study shows normal level. The urea concentration mean value of 2.93mmol/l obtained from growing WAD goats fed 0/100 supplement falls within the range of 1.63 and 5.08mmol/l reported by (29), but lower to 3.5-10mmol/l reported by (23) for healthy goats. The average low blood urea concentration in this study may indicate

better protein quality of PKC as reported by (30). The blood creatinine decreased as the PKC replaced formulated concentrate in all the diets except 0/75 supplement diet. According to (31) abnormal high blood creatinine would indicate muscle wastage, however, the experimental animals used exhibited no weight loss, implying that the animals are not drawing from body reserves corroborating (12) that the total amount of creatinine in the blood and urine of goats and sheep are directly proportional to their body weight. The cholesterol, triglycerides, HDL and LDL values (mmol/l) obtained were low compared to values reported by Daramola et al. (2004), for healthy goats. ALT values fall within the normal range of 7-24µ/l reported by (32), but higher than values (5-7.5) reported by 33). However, AST values fell slightly below the range of 43-132 µ/l reported by (32), but higher than 15.25-16.50u/l reported by Daramola *et al.* (33) in female WAD goats. The ALP results were within the range of 67.1-68.25µ/l reported by (33) for female WAD goats. The serum total protein values were within the range of 18.9-44.5g/dl for healthy goats as reported by (34). Weight gains were maintained, feed conversion ratio proved better and blood parameters considered were normal for goats fed diets PKC contained supplements.

Table 4: Hematological indices and blood chemistry of growing WAD goats kids fed elephant grass silage supplemented with palm kernel cake as replacement formulated concentrate

	Formulated concentrate/Palm Kernel Cake Ratio					
Blood parameters	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**SEM±**
FC/PKC	**100/0**	**75 / 25**	**50 / 50**	**25 / 75**	**0 / 100**	
RBC ($X10^6$µ/l)	13.87^{c}	16.47^{ab}	16.80^{ab}	17.73^{a}	14.87^{bc}	1.20
Hb (g/dl)	8.67^{d}	11.33^{c}	14.50^{b}	17.17^{a}	11.17^{c}	0.49
PCV (%)	25.00^{b}	30.00^{b}	43.33^{a}	41.67^{a}	30.00^{b}	2.82
MCV (Fl)	18.02^{b}	18.21^{b}	25.79^{a}	23.50^{b}	20.17^{b}	0.56
MCH (pg)	6.25^{a}	6.89^{a}	8.80^{a}	9.69^{a}	7.75^{a}	0.45
MCHC (g/dl)	34.68^{b}	37.78^{b}	33.46^{c}	41.20^{a}	37.23^{b}	0.77
Blood chemistry						
T.CHOL (mmol/l)	0.47^{d}	0.80^{a}	0.53^{cd}	0.60^{c}	0.70^{b}	0.04
TRIGS (mmol/l)	0.10	0.13	0.07	0.10	0.13	0.04
HDLCHOL (mmol/l)	0.07^{c}	0.07^{c}	0.17^{b}	0.30^{a}	0.17^{b}	0.02
LDL-CHOL (mmol/l)	0.37^{c}	0.70^{a}	0.37^{c}	0.57^{b}	0.67^{a}	0.05
UREA (mmol/l)	1.27^{d}	2.00^{c}	2.00^{c}	2.57^{b}	2.93^{a}	0.11
CREATININE (mmol/l)	2.13^{d}	3.03^{b}	2.87^{c}	3.17^{a}	1.97^{e}	0.54
AST (µ/l)	41.00^{a}	33.67^{b}	28.67^{d}	30.00^{c}	24.67^{e}	0.72
ALT (µ/l)	23.37^{a}	20.83^{a}	19.50^{a}	21.68^{a}	21.78^{a}	2.16
ALP (µ/l)	77.60^{a}	58.27^{d}	71.47^{b}	57.20^{e}	65.33^{c}	0.27
T.PROTEIN (g/l)s	54.00^{b}	60.33^{a}	48.67^{c}	44.67^{d}	37.33^{e}	0.62
ALBUMIN (g/l)	23.33^{b}	25.33^{a}	24.00^{b}	19.67^{d}	14.33^{e}	0.49
GLOBULIN (g/l)	30.33^{b}	34.33^{a}	31.66^{b}	24.67^{c}	24.00^{c}	0.56

* Means in the same row with common superscripts are not statistically different ($p>0.05$)

PCV - Packed cell volume (Hematocrit), RBC - Red blood cell counts, MCV - Mean corpuscular volume, MCH - Mean corpuscular hemoglobin, MCHC - Mean corpuscular hemoglobin concentration, Hb – hemoglobin, T.chol – Total cholesterol, Trigs – Triglyceride, T.protein – Total protein, HDLCHOL – High density lipoprotein cholesterol, LDLCHOL – Low density, lipoprotein cholesterol, AST – Aspatate aminotransferase, ALT – Alanine aminotransferase, ALP –Alkalinphosphatase, SEM - standard error means.

Conclusion and Application

1. Results of this study shows that all goats fed grass silage supplemented with PKC replaced formulated concentrate indicated efficient utilization of the ration by goat
2. The values of blood parameter of goat studied that fall within the range reported for healthy goat in literature conclude the non-detrimental effect of PKC to the health of goats.
3. Where PKC is readily available it is recommended that PKC be made at least 25% of concentrate supplement to silage made from elephant grass to improve the feeding economy and health status of the growing goats.

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