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Milk Yield (Offtake), Composition, Dam and Kid Weight Changes of West African Dwarf Goats Fed Dietary Levels Of Palm Kernel Cake

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Abstract: *The milk yield, composition, dam and kid weight of nine lactating West African Dwarf goats fed dietary levels of palm kernel cake were assessed. The completely randomized design with three dietary treatment levels (0, 20 and 30%) of palm kernel cake and three goats per treatment was used. The values of the milk yields (milk offtake) were all significant P<0.05). The average milk yield per day ranged from 40.00 - 205.00 gday^{-1}. The mean milk yield at the three dietary levels (0, 20 and 30%) were 138.33, 159.44 and 175.56 gday^{-1} respectively. The milk of the lactating WAD goats was rich in nutrients. The highest values of the milk nutrients were as follows: 4.14% milk fat, 3.76% protein, 13.07% total solids, 8.94% solids-not-fat, 4.41% lactose and 0.87% ash. The lactating WAD goats had highest P<0.05) average body weight change of 2.31 kg during the whole lactation period, and this is equivalent to daily weight gain of 18.33 gday-1. The weekly kid weights increased consistently from initial range of 1.81 – 1.93 kg to a final range of 9.10 – 12.80 kg. All the lactating WAD goats used in this experiment had twin kids and there was no mortality recorded during the experimental period. In conclusion, the inclusion of palm kernel cake in the concentrate diets of WAD goats resulted in higher average milk yield and kid weights at the 20% and 30% levels than at the 0% level of inclusion of palm kernel cake in the concentrate diets.*

Key words - *Concentrate, kid weight, milk offtake , nutrients*

I. Introduction

Milk production for human consumption is usually obtained from cattle. However, there is a growing awareness of the importance of goat as a source of milk offtake for home consumption. Bawala *et al.* (2006) stated that goat milk has unique qualities over those of other animals as it is nearest to human milk in its contents of fat and protein and also serves as a good dietary source of minerals which makes it a complete food for the new born animal. Ibeawuchi *et al.* (2003) reported that goat milk is more easily digested than cow milk since the fat in goat milk is finer and more easily assimilated. They also mentioned that goat milk is found to be particularly rich in antibodies and is usually prescribed in the treatment of many human ailments. In Nigeria, the West African Dwarf goat is ranked second to the Red Sokoto goat in terms of milk yield. A common practice by goat farmers is the feeding of concentrate supplements which are inexpensive and locally available. One of such feedstuffs is the palm kernel cake. Palm kernel cake is considered as a medium quality energy feed for ruminants with moderate content of crude protein (Carvalho *et al.*, 2005). There is dearth of information about the yield and composition of milk from the West African Dwarf goat. Akinsoyinu *et al.* (1977) stated that information on milk yield of goats will contribute to the feeding and management of kids for increased livestock production.

This research was thus conducted to investigate the average milk yield, composition, body weight change in lactating goats and kid weight changes in WAD goats fed different dietary levels of palm kernel cake.

II Materials And Methods

2.1 Study location

The study was conducted in February, 2014 at the Small Ruminant Unit of the Ladoke Akintola University of Technology (LAUTECH) Teaching and Research Farm, Ogbomoso, Oyo State, Nigeria.

2.2 Experimental animals

Nine lactating does in their second parity were used for the study. They were reared under the intensive management system. The initial body weights of the lactating does were between 23 and 26kg and the animals

were balanced for weight and allocated into 3 treatment groups. Each of the does used nursed twin kids. The does and their kids were placed in experimental pens three days after kidding. The kids were weighed weekly and the average weight per kid was recorded. The does were weighed at the start and end of the experiment.

2.3 Routine management and feeding

The pens, feeders and drinkers were cleaned every morning. Animals were given weighed amounts of the basal diet of wilted *Panicum maximum* and *Gliricidia sepium* browse plants. The does were served with the forage diets at 8.00 am. The concentrate diets at three levels of palm kernel cake (0%, 20% and 30% PKC) were given at 9.00 am and at 2 pm daily. The dams were given about 2% of their body weight (500 g day^{-1}) of the concentrate diets daily. Salt licks and fresh water were provided *ad libitum*.

2.4 Milking of lactating goats

The does were hand milked once a day, at 8.30 am daily for a period of 18 weeks. The kids were separated from their dam at 7 pm the previous day to enable the does retain enough milk for the next morning milk production. The milk yield was measured with the measuring cylinder and average daily milk yield was recorded. About 50 ml milk sample per treatment were stored in sterilized sample bottles and kept in a refrigerator at about 4^oC and then taken to the laboratory for the determination of milk proximate and mineral contents. Remaining milk was fed to the kids using feeding bottles.

2.5 Average body weight changes in does and kids

Initial and final body weights of the lactating does at the beginning and end of the study were measured using a hanging spring weighing balance. Weekly body weights of the kids were measured using an electric weighing balance and then recorded.

2.6 Chemical analysis of feed samples

Chemical composition of the *Panicum maximum* and *Gliricidia sepium* (basal diets) and the three dietary levels (0, 20 and 30%) concentrate diets were determined. Dry matter was determined by oven drying samples at 105^oC for 24 hours to a constant weight, and ash by igniting the samples in a muffle furnace at 600^oC for 8 hours. Nitrogen, crude fibre and ether extract were determined according to the methods of AOAC (2005). Crude protein was calculated (N x 6.25) and NFE was also calculated (100 – (% CP + % CF + % EE + % Ash + % moisture). Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were measured by the methods of van Soest *et al.* (1991). Hemi cellulose (HC) was calculated (HC = NDF – ADF). Non fibrous carbohydrate was calculated (100 – (% NDF + %CP + %EE + % ash).

2.7 Proximate and mineral composition of milk samples

Milk samples were analysed for proximate composition by analysing for total solids, fat (Gerber method), nitrogen and ash (AOAC, 2005). Percent protein (N X 6.38), solids-not-fat (%SNF) was calculated by difference (%SNF = % total solids - % fat). Percent lactose was determined by using Fehlings solution method (Triebold, 2000).

Milk samples were analysed for minerals according to the methods of AOAC (2005).

Digestion: Amounts of 0.5g of the milk samples were weighed into a set of digestion tubes and 10mls each of perchloric and nitric concentrated inorganic acids were dispensed into the sample tubes. The samples were digested on the digestion block at 120^oC for 2 hours, until the organic substances were completely decomposed. At the end of the digestion, the samples were allowed to cool to room temperature. Digested samples were made up to the 50 mls volume with de-ionized water and then transferred into centrifuge tubes and shaken for 10 minutes. The solutions were transferred to the centrifuge machine and centrifuged at the rate of 4500 rpm for 5 minutes. Finally, the supernatants were placed in duplicates in a set of pyrex glass vials and analysed for Ca, P, Mg and Na levels. The Ca and Mg were burnt off in an atomic absorption spectrophotometer (AAS) and the intensity of their flame was measured at the appropriate wavelength, current and pressure. Sodium was read off in the flame photometer. Phosphorus was measured calorimetrically using the vanado-molybdate reagent (AOAC, 2005). The results were then expressed in mg/kg.

2.8 Statistical analysis

One way analysis of variance (ANOVA) in a completely randomized design was used to analyse the data (SAS, 2000). Means were separated using the Duncan's multiple range test of the same package. Mean differences were considered significant at $P<0.05$.

III Results And Discussion

3.1 Ingredients and chemical composition of feedstuffs and concentrate diets

The ingredients and chemical composition of feedstuffs and concentrate diets are presented in Tables 1 and 2. The crude protein (CP) contents of *P. maximum* grass (7.09%), *G. sepium* browse plant (18.61%) and the concentrates (10.68 to 18.02%) are close to the values reported for similar diets (Ibeawuchi *et al.*, 2003; Bawala *et al.*, 2006; Ahamefule *et al.*, 2007). The CP contents (7.09 to 18.61%) of the diets conformed to the recommended range of 14 to 18% CP for lactating goats (NRC, 1981). These were also within the minimum of 8% CP necessary to provide the minimum ammonia levels required by rumen micro-organisms to support optimum rumen activity (Norton, 2003). The CF, NDF and ADF levels of the experimental diets ranged from 21.21 to 34.44%, 40.50 to 55.80%, and 18.25 to 30.25% respectively. The CF content of the diets was within the range of 4.41 to 34.02% reported in similar diets for lactating WAD goats (Bawala *et al.*, 2006). The high CF content of the diets also support the findings of Nouala *et al.* (2006) who outlined that the environmental conditions of the rumen are normally in favour of the fibrolytic micro-organisms which aid the degradation of high fibre diets in contrast to the negative effects of concentrate high in carbohydrates. The range of 2.29 to 10.15% ash content of the diets observed in this study was within the range of 6.68 to 9.48% ash content recommended for ruminants feeding (Ogunbosoye *et al.*, 2015). Hemicellulose (12.30- 34.70%) and non fibrous carbohydrate (24.30 – 39.54%) content of the diets were observed and these served as sources of energy. Thus, the optimal dietary level of 30 to 40% non fibrous carbohydrate required in the diets of dairy animals (Abdollahzadeh *et al.*, 2010) was satisfied.

Table 1 Chemical composition of grass and legume browse (basal diet) fed to lactating West African Dwarf goats

Parameters (%)	*Panicum maximum*	*Gliricidia sepium*
Dry matter	75.15	86.02
Crude protein	7.09	18.61
Ether extract	3.20	2.51
Crude fibre	31.26	21.21
Ash	2.29	10.15
Nitrogen free extract	31.31	33.54
Neutral detergent fibre	55.80	42.55
Acid detergent fibre	21.10	30.25
Hemi cellulose	34.70	12.30
Non fibrous carbohydrate	31.62	26.18

Table 2 Ingredients and chemical composition of concentrate diets

	Dietary levels of palm kernel cake (%)		
	D1 (0% PKC)	D2 (20% PKC)	D3 (30% PKC)
Ingredients (%)			
Dried cassava peels	67.00	57.00	47.00
Palm kernel cake	-	20.00	30.00
Wheat offal	30.00	20.00	20.00
Bone meal	2.00	2.0	2.00
Salt	1.00	1.00	1.00
Total	100.00	100.00	100.00
Chemical composition (%)			
Dry matter	88.84	88.48	88.96
Crude protein	10.68	16.43	18.02
Ether extract	3.00	3.28	3.60
Crude fibre	21.65	34.44	32.69
Ash	6.28	5.66	5.93
Nitrogen free extract	47.23	28.67	28.72
Neutral detergent fibre	40.50	50.33	46.10
Acid detergent fibre	18.25	21.65	24.15
Hemi cellulose	22.25	28.68	21.95
Non fibrous carbohydrate	39.54	24.30	26.35

3.2 Average milk yield

The average milk yield (g day^{-1}) obtained for the experimental WAD goats are reported in Table 3, and these ranged between 40.00 and 205.00 g day^{-1}. The values were lower when compared with 185.30 to 340.05 g day^{-1} observed in WAD goats in another research (Bawala *et al.*, 2006). Akinsoyinu *et al.* (1977) similarly observed low milk yield between 0.060 and 4.83 kg $week^{-1}$ in WAD goats. Adewumi and Olorunisomo (2009) found out that milk yield was related to body size in WAD sheep. Makun *et al.* (2013) observed significant effect of breed and protein supplementation on milk yield of indigenous goats in Nigeria. Thus the low milk yield of the WAD goats used in this research could be due to the small body size of the WAD goat breed. Also the fact that the WAD goats used in this study nursed twin kids could also have contributed to the low milk yield.

Table 3 Average daily milk yield (g/day) (milk offtake) of West African Dwarf goats

Stage of lactation	Week	Dietary levels of palm kernel cake (%) D1 (0% PKC)	D2 (20% PKC)	D3 (30% PKC)	SEM
Early lactation	1	130.33[c]	155.33[b]	170.01[a]	5.79
	2	150.02[c]	170.67[b]	190.02[a]	5.78
	3	160.01[c]	180.33[b]	200.17[a]	5.80
	4	155.33[c]	175.67[b]	205.33[a]	7.26
	5	150.17[c]	170.01[b]	190.03[a]	5.75
	6	155.02[c]	175.07[b]	195.33[a]	5.82
	7	170.67[c]	185.67[b]	200.20[a]	4.27
Mid lactation	8	160.67[c]	185.00[b]	205.00[a]	6.41
	9	160.00[c]	180.00[b]	195.00[a]	5.07
	10	155.00[c]	190.00[b]	200.00[a]	6.82
	11	155.00[c]	180.00[b]	200.00[a]	6.51
	12	140.00[c]	170.00[b]	190.00[a]	7.26
	13	130. 00[c]	165.00[b]	185.00[a]	8.04
Late lactation	14	135.00[c]	160.00[b]	185.00[a]	7.22
	15	120.00[b]	160.00[a]	160.00[a]	6.67
	16	120.00[c]	150.00[b]	155.00[a]	5.47
	17	95.00[a]	70.00[b]	95.00[a]	4.17
	18	50.00[a]	50.00[a]	40.00[b]	1.67
Mean	-	138.33	159.44	175.56	-

[a,b,c] Means in the same row with different superscripts are significantly different (P<0.05)

3.3 Proximate and mineral composition of milk

The proximate and mineral composition of milk of the experimental WAD does are shown in Table 4.The WAD does fed 0% (control diet) and 20% PKC had higher (P<0.05) percentages of milk fat (4.14 and 4.13%). These also had higher protein contents of 3.76 and 3.69% respectively. The percent milk lactose value of 4.41% was highest (P<0.05) at the 30% PKC inclusion level.

The mean calcium and phosphorus contents ranged from 1280.33 to 1360.02 mg/kg and 1060.13 to 1091.00 mg/kg respectively. The calcium to phosphorus ratio in this study varied between 1.17:1 and 1.26:1. This was moderate as compared to the normal calcium: phosphorus ratio of 1.4:1 (Hawk *et al.*, 1954) but below calcium: phosphorus ratio of 4.6: 1 for WAD goat milk reported by Belewu and Aiyegbusi (2002). The observed ranges of other mineral levels in this study were as follows: magnesium, 130.67 – 160.08 mg/kg and sodium, 460.03 – 520.15 mg/kg. Calcium and magnesium constituted the highest and lowest concentrations of minerals in the milk of the WAD goats.

Table 4 Proximate and mineral composition of milk of West African Dwarf goats

	Dietary levels of palm kernel cake (%) D1 (0% PKC)	D2 (20% PKC)	D3 (30% PKC)	SEM
Proximate composition (%)				
Fat	4.14[a]	4.13[a]	4.01[b]	0.008
Protein	3.76[a]	3.69[b]	3.47[c]	0.020
Total solids	12.96[b]	13.07[a]	12.67[c]	0.009
Solids-not-fat	8.82[b]	8.94[a]	8.66[c]	0.049
Lactose	4.22[c]	4.38[b]	4.41[a]	0.010
Ash	0.87[a]	0.87[a]	0.78[b]	0.019
Mineral composition (mg/kg)				
Calcium	1280.33[c]	1310.07[b]	1360.02[a]	0.423
Phosphorus	1091.00[a]	1060.13[c]	1080.03[b]	1.160
Calcium : Phosphorus	1.17 : 1	1.24 : 1	1.26 : 1	
Magnesium	130.67[b]	110.04[c]	160.08[a]	0.784
Sodium	491.67[b]	460.03[c]	520.15[a]	1.841

[a,b,c] Means in the same row with different superscripts are significantly different (P<0.05)

3.4 Average body weight changes of the lactating WAD goats

As revealed in Table 5, the average initial and final body weights of the lactating goats were significantly (P<0.05) different. The does fed the 0% PKC had the lowest (P<0.05) initial and final average body weights but showed the highest (P<0.05) average daily weight gain. The result obtained in this study is in agreement with the report of Makun *et al.*, 2013 that there could be differences in the genetic potentials of lactating goats in terms of weight gains.

Table 5 Average body weight changes of the lactating West African Dwarf goats

Parameters	Dietary levels of palm kernel cake (%) D1 (0% PKC)	D2 (20% PKC)	D3 (30% PKC)	SEM
Initial weight (kg)	23.21[c]	26.52[a]	25.82[b]	0.050
Final weight (kg)	25.52[c]	26.82[a]	26.32[b]	0.063
Weight change (kg)	2.31[a]	0.30[c]	0.50[b]	0.037
Daily weight gain (g)	18.33[a]	2.38[c]	3.97[b]	0.019

[a,b,c] Means in the same row with different superscripts are significantly different (P<0.05)

3.5 Average kid weight

In Table 6 is shown the average weekly kid weight (kg) of the West African Dwarf goats. The average of the weekly weights of the twin kids born to each experimental WAD goat were observed to increase consistently from the first week till the 18th week of the study. This is in agreement with the research work of Makun *et al.* (2013) who observed that the kid weights of Red Sokoto and Sahelian breeds of goats was lowest at birth, as expected and increased linearly till the end of the study. No kid mortality was recorded during this study.

Table 6 Average weekly kid weight (kg) of lactating West African Dwarf goats

Stage of lactation	Week	Dietary levels of palm kernel cake (%) D1 (0% PKC)	D2 (20% PKC)	D3 (30% PKC)	SEM
Early lactation	1	1.83[b]	1.93[a]	1.81[b]	0.02
	2	2.41[b]	2.51[a]	2.50[a]	0.02
	3	3.02[b]	2.92[c]	3.11[a]	0.03
	4	3.20[b]	3.71[a]	3.70[a]	0.08
	5	4.01[c]	4.31[b]	4.41[a]	0.06
	6	4.81[a]	4.61[c]	4.71[b]	0.03
	7	5.17[a]	5.21[a]	5.32[a]	0.05
Mid lactation	8	5.43[c]	5.60[b]	5.80[a]	0.05
	9	5.70[c]	6.30[b]	6.40[a]	0.11
	10	6.00[c]	7.00[a]	6.90[b]	0.16
	11	6.40[c]	7.70[a]	7.40[b]	0.20
	12	6.80[c]	8.40[a]	7.70[b]	0.23
	13	7.00[c]	9.20[a]	8.20[b]	0.32
Late lactation	14	7.40[c]	9.50[a]	8.70[b]	0.31
	15	7.60[c]	9.70[a]	9.20[b]	0.32
	16	8.10[c]	11.10[a]	9.60[b]	0.43
	17	8.60[c]	12.10[a]	10.00[b]	0.51
	18	9.10[c]	12.80[a]	10.40[b]	0.54
Mean	-	5.68	6.92	6.43	-

[a,b,c] Means in the same row with different superscripts are significantly different (P<0.05)

IV Conclusion

The results of this study has shown that the inclusion of palm kernel cake in the concentrate diets of WAD goats resulted in higher average milk yield (offtake) and kid weights at the 20% and 30% levels than at the 0% level of inclusion of palm kernel cake in the concentrate diets.

Higher milk yield (offtake) of between 165 and 205 g/day were observed during the mid lactation period, at the 20% and 30% palm kernel cake dietary levels. The low level of milk yield in this study implies that the milk should be suitable as milk offtake for home consumption by the dairy farmer's household.

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