Effect of protein dietary protein levels on milk component, udder parameters, blood and physiological indices of West African dwarf goat

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Abstract

This study was conducted to evaluate the effect of protein supplementation at 12%, 14% and 16.41% crude protein (CP) levels on the milk yield of West African dwarf dams. A total of twelve lactating dams, which were intensively managed and hand-milked on weekly basis were used for the study. Feed intakes, weight gain, feed conversion ratio (FCR) and protein efficiency ratios (PER) were monitored. Milk and blood samples were taken. The udder morphometry and milk composition were determined. Result showed that the dry matter and crude protein values ranged between 89.7 and 90.1% and 11.51 and 14.88% respectively. Dams on 12% protein supplemented feed recorded the highest daily dry matter intake (DMI) of (203.63 g/day) while, 16% protein supplemented feed had the least DMI (195.54 g/day). The value of crude fiber ranged between 9.98 and 13.31% while the value of ash ranged between 6.23 and 9.99%. Also, the values of ether extract ranged between 2.88 and 6.65%. Dams on 16% protein diet gained significantly ($p < 0.05$) more weight (106.19g/day) and had the least feed conversion ratio (1.88). Milk component and nutrient digestibility did not vary among diets except for ether extract that was least in dams on 16% CP level. Dams on 14% and 16% protein diet supported the highest calcium concentration. Udder parameters and blood indices were not significantly ($p > 0.05$) influenced by dietary protein levels. The rectal, respiratory and pulse rate were within the normal range. Pulse rate was more normal in dams on 12% and 16% dietary protein level. It can therefore be concluded that 16% crude protein level could be used for lactating West African dwarf dams to improve milk production and health condition of lactating dams.

Keywords: Protein levels; milk component; udder parameters; blood; physiological parameters

Introduction

Nutritional profile of diets offered to lactating animals has been reported to influence final milk product (Nnadi *et al.* 2007). Production function of animal e.g lactation affect protein intake requirement because there is an increased protein output in form of milk (Pulina *et al.* 2006, Martinez *et al.* 2011, Laudadio and Tufarelli, 2010). Protein is typically the most important and expensive diet. Production functions such

as pregnancy and lactation increases the protein requirement because of increased output of protein in the products of conception and in milk and also, because of an increased metabolic rate. Inadequate protein (N or amino acids) probably is the most common of all nutrient deficiencies because most energy sources are low in protein and protein supplements are expensive. Thus, there is need to determine the optimum level of crude protein

supplement in West African Dwarf lactating does that will result to the highest milk yield, such that crude protein is not in excess which is excreted as urine.

The quantity of milk produced is a function of udder parameters (Adewumi *et al.* 2007, Adewumi *et al.* 2012, Martinez *et al.* 2011). The udder is a very important physiological and conformational characteristic of all dairy animals. Udder conformation has strong influence on milk yield but its relationship with protein levels is unknown in tropical goat.

Physiological parameters and blood indices are indication of the health status of the animal. Lactation is a process that induces more stress on the animals. It is therefore important and necessary for the farmers rearing goats to have an understanding of the nutrients needed by the animals for proper physiological performance, and the feedstuff that is composed of such nutrients. The synergetic effect of protein level on milk, udder parameters, blood and physiological indices has not been investigated in tropical WAD goat. Therefore, the aim of this study is to examine the effect of protein dietary protein levels on milk component, udder parameters, blood and physiological indices of West African dwarf goat

Materials and methods

Experimental animals

The study was carried out using twelve lactating West African Dwarf dams. All dams were in their first parity. They were managed intensively in raised wooden floor house with good ventilation and had access to water *ad libitum*. The animals were allotted randomly to three treatments; 12%, 14% and 16.41% Crude Protein (CP) at 3% body weight. *Panicum maximum* was given as basal diet (table 1). The goats were housed in individual metabolism cage and

allowed for 14 days adjustment period before the commencement of data collection. Data were collected for 21 days. The quantity of feed offered and the orts were measured to determine feed intake. Concentrate was served in the morning and forages in the afternoon with free access to fresh water. Faeces were collected and weighed and 10% was taken for analysis. The proximate analysis for the ash, crude protein (CP), crude fiber (CF), ether extract (EE), nitrogen free extract (NFE) was carried out as described by AOAC, (2000)

Milk yield and milk composition

The milk samples were collected using hand milking method at 7am.. The kids were separated from their does for 12hr before the corresponding measurement of udder traits and milk yield. Milk yield was estimated in each test-day observation immediately after mammary morphology measurement. Proximate analysis of milk was carried out as described by AOAC, (2000). Atomic absorption spectrophotometer was used to determine the mineral elements content in milk.

Udder dimensions

The methodology used for measuring udder parameters were those described by Adewumi *et al.* (2007) and James and Osinowo (2004). The udder and teat dimensions studied were udder length, udder width, udder circumference, udder attachment, udder volume and teat circumference, teat length, teat width, distance between teat, height of teat from the ground.

Blood parameters

Blood samples were collected at the beginning and at the end of the experiment. Blood samples were collected via the jugular vein puncture using EDTA (Vacutainer kits). The EDTA bottles containing the blood samples were stored in an ice pack and was taken to the laboratory

Table 1: Percentage composition of experimental diets

Ingredient (kg)	Treatment			
	12%	14%	16%	
Maize	11.00	12.00	10.00	
Palm Kernel Cake	22.00	28.50	34.00	
Soya Bean Meal	2.00	5.00	3.00	
Wheat Offal	30.00	27.00	25.00	
Cassava Peel	34.00	25.00	25.00	
Limestone	2.00	2.00	2.00	
Salt	0.25	0.25	0.25	
Premix	0.25	0.25	0.25	
Bone meal	0.50	0.50	0.50	
Total	100	100	100	
Chemical composition				<i>Panicum maximum</i>
Dry matter	89.70	90.10	89.90	68.97
Crude protein	11.51	12.71	14.88	10.21
Crude fiber	9.98	10.16	13.31	25.09
Ash	9.99	6.23	6.54	7.42
Ether Extract	2.88	6.56	3.98	2.81

^{abc} Mean in the same row with different superscripts differ significantly (P>0.05)

Table 2: Performance characteristic of lactating West African dwarf dams fed different protein inclusion level

Parameters	Treatment			SEM
	12%	14%	16%	
Initial body weight (Kg)	19.47 ^a	13.56 ^b	15.54 ^{ab}	1.18
Final body weight (Kg)	20.67	15.23	17.77	1.15
Average daily weight gain (g/day)	57.14 ^b	79.68 ^{ab}	106.19 ^a	
FCR	4.01	2.63	1.88	0.46

^{abc} Mean in the same row with different superscripts differ significantly (P>0.05), FCR = Feed conversion Ratio = weight of feed/ goat net weight gain, PER = Protein Efficiency Ratio = Goat net weight gain /crude protein intake, SEM = Standard error of mean

Table 3: Effect of varying levels protein supplementation on the dry matter, crude protein intake and nutrient digestibility of lactating West African dwarf

Parameters		Treatment			SEM
		12%	14%	16%	
Dry matter intake	Concentrate	178.88	176.11	168.19	4.31
	Grass	24.75	26.83	27.35	0.56
	Total DMI (g/animal/day)	203.63	202.95	195.54	3.89
Crude protein intake	Concentrate	22.95 ^b	24.84 ^{ab}	27.83 ^a	0.89
	Grass	13.32	14.44	12.94	0.58
	Total DMI (g/animal/day)	36.27 ^b	39.29 ^{ab}	40.77 ^a	0.86
Nutrient Digestibility (%)	Crude protein	36.11	40.12	46.08	2.53
	Crude fibre	37.08	39.18	29.96	3.53
	NFE	60.50	64.39	51.90	4.39
	Ether extract	72.05 ^{ab}	81.52 ^a	70.45 ^b	2.30

^{abc} Mean in the same row with different superscripts differ significantly (P>0.05), NFE= Nitrogen Free Extract, SEM = Standard error of mean

Table 4: The effect of dietary protein levels on milk parameters of West African dwarf dams

Parameter	Crude protein levels			SEM	P-value	L	Q
	12%	14%	16%				
Milk yield (%)	207.00	208.18	207.04	14.77	0.99	NS	NS
Total solid (%)	15.41	15.32	15.94	0.25	0.57	NS	NS
Moisture (%)	84.71	84.68	84.10	0.25	0.55	NS	NS
Potassium (mg/litre)	12.88	13.72	14.31	0.36	0.08	S	NS
Calcium (mg/itre)	7.28 ^b	8.75 ^a	10.47 ^{ab}	0.51	0.03	NS	S
Sodium (mg/litre)	3.14	3.52	3.51	0.40	0.99	NS	NS
Iron (mg/litre)	0.23	0.41	0.50	0.10	0.76	NS	NS
Magnesium (mg/litre)	3.29	3.13	4.15	0.18	0.80	NS	NS

a,b. means on the same row with different superscript are significantly different.

Table 5 : The effect of dietary protein levels on udder parameters of lactating West African dwarf dams

Parameter (cm)	Crude protein levels			SEM	P-Value	L	Q
	12 %	14 %	16%				
UC	31.47	29.73	31.96	0.45	0.10	NS	NS
UL	9.38	9.00	9.25	0.16	0.61	NS	NS
UW	14.19	12.63	13.54	0.35	0.18	NS	NS
UAT	1.78	1.46	1.55	0.08	0.07	NS	NS
TTL	2.11	2.09	2.21	0.04	0.42	NS	NS
TTW	1.44	1.48	1.61	0.07	0.54	NS	NS
TTC	3.93	3.96	3.97	1.41	0.93	NS	NS
DBT	7.80	7.31	8.04	0.14	0.11	NS	NS
HTG	16.24	17.02	15.45	0.34	0.17	NS	NS

Table 5 shows the effect of diet on udder dimensions of lactating WAD goat. Udder dimensions were not influenced ($P>0.05$)

by dietary protein levels. The linear and quadratic trends were not significant.

Table 6 : The effect of dietary protein levels on haematological and biochemical parameters of lactating West African dwarf dams

Parameters	Crude protein levels			SEM	P-value	L	Q
	12%	14%	16%				
Heam atological							
PCV	28.33	28.33	25.83	1.24	0.67	NS	NS
Hb	9.15	9.32	8.60	0.36	0.72	NS	NS
RBC	13.43	13.30	12.03	0.49	0.47	NS	NS
WBC	11.48	10.85	11.90	0.48	0.69	NS	NS
NEUT	33.17	34.50	34.00	0.83	0.82	NS	NS
LYM	65.50	64.50	64.33	0.92	0.87	NS	NS
EOS	0.67	0.33	0.50	0.19	0.79	NS	NS
BAS	0.17	0.17	0.33	0.10	0.76	NS	NS
MONO	0.50	0.50	0.83	0.16	0.66	NS	NS
Biochemical							
TPROT	5.80	6.87	6.97	0.23	0.06	NS	NS
GLOB	3.25	3.77	4.13	0.16	0.23	NS	NS
CHOL	2.55	3.10	2.83	0.13	0.05	NS	NS
TRIG	57.17	60.00	51.33	2.19	0.27	NS	NS

^{a, b} means with different superscript along the same column are statistically different ($P < 0.05$)

PCV: packed cell volume; HB: haemoglobin, WBC: white blood cell, RBC: red blood cell, NEUT: neutrophil; Lymphocyte; EOS: Eosinophil, BAS basophil, MONO:monocytes, TPROT: total protein, ALB: Albumin, GLO: globulin, CHOL: cholesterol, TRIGLY: triglyceride.

for haematological and biochemical analysis.

Physiological parameters

Physiological parameters (rectal temperature, respiratory rate and pulse rate) were taken before milking commenced and immediately after milking at 0900-1100am weekly. Data was collected on the rectal temperature using digital thermometer which was inserted into the rectum of the animal at depth of 5cm with the bulb touching the mucosa wall of the rectum, while that of respiratory rate was collected through the use of stethoscope to hear the sound of the lungs, and the pulse rate was collected by placing the tip of the finger on the femoral artery at the interior part of the animals' thigh.

Statistical analysis

Data generated were analyzed using one way analysis of variance (ANOVA) and Tukey studentised tests was used to separate means where there were significant difference at ($p < 0.05$). Orthogonal comparism was also applied to determine the linear and quadratic trend of the data using SPSS 16.0, 1999.

Results

Effect of varying levels of protein supplementation on performance, feed intake and digestibility of lactating West African dwarf goats

The composition of the experimental diets is as shown in table 1. The dry matter and crude protein values ranged between 89.7 and 90.1% and 11.51 and 14.88% respectively. The 12% protein supplemented feed recorded the highest daily dry matter intake (DMI) of (203.63 g/day) while, 16% protein supplemented feed had the least DMI (195.54 g/day). The value of crude fiber ranged between 9.98 and 13.31% while the value of ash range between 6.23 and 9.99%. Also the values of

ether extract ranged between 2.88 and 6.65%. Dams on 14% diet had the highest dry matter (90.1%). The highest crude protein (14.88%), crude fiber (13.31%) and ether extract (3.98%) was obtained in 16% protein diet. Table 2 shows the performance characteristics of lactating does fed different protein inclusion level. Higher weight gain (106.19g/day) was recorded ($p > 0.05$) for animals placed on 16% (Table 2). It was followed by animals on 14% while animals on 12% had the lowest weight gain. Table 3 shows the dry matter intake, **crude protein intake and nutrient digestibility** nutrient intake of lactating **West African Dwarf goats**. Goats on 12% had a mean crude protein digestibility of 36.11%, followed closely by goats in 14% with a mean crude protein digestibility of 40.12%. Goats on 16% diet recorded the highest crude protein digestibility. The group fed with 14% diet had the highest crude fiber digestibility at the value of 39.18%, followed by those fed on diets 12%, (37.08%), 16% (29.96%), respectively. Dry matter intake decreased with increase in crude protein level (Table 3).

Milk yield and milk composition

The effect of dietary protein levels on milk yield, composition and mineral concentration is shown in Table 4. Milk yield, proximate and mineral composition of milk of dams did not differ significantly among treatment diets except for calcium concentration. The weekly milk yield for different protein levels was 207.00, 208.18 and 207.04mL for 12, 14 and 16% inclusion level respectively The 16% and 14% protein diet supported the highest calcium concentration diet. .

Table 6 shows the influence of diet on heamatological and biochemical parameters on lactating WAD dams. The influence of diet on heamatological and

biochemical parameters did not differ.

Physiological parameters

The physiological parameters as affected by dietary treatments are presented in Table 7. There was no significant ($P<0.05$) influence of diets on physiological parameters

examined except for 12 and 16% inclusion level of test diet. Pulse rate was higher in dams on 12% and 16% dietary protein level. The rectal, respiratory and pulse rate were within the normal range.

Table 7: The effect of diets on physiological parameters of lactating West African dwarf dams

Parameters	Crude Protein levels			SEM	P-value	L	Q
	12%	14%	16%				
RT	39.13	38.87	39.08	0.05	0.08	NS	NS
RR	44.46	42.08	41.59	1.05	0.30	NS	NS
PR	59.00 ^a	52.06 ^b	58.00 ^a	1.03	0.003	NS	NS

^{a, b}; means with different superscript within the columns are significantly ($P<0.05$ and $P<0.01$) different.

RT= rectal temperature, RR= respiratory rate, PR= pulse rate, bth/m=breath/minute, bt/m=beat/minute.

Discussion

The proximate composition of the experimental diets is shown in table 1. The dry matter of the experimental diets in this study ranged between 89.70 (12% CP diet) and 90.10 (14% CP diet) and these values favourably compared with the values reported by Asaolu *et al.* 2012 for goats fed (*Moringa oleifera*), (*Gliricidea sepium*) and (*Leuceana leucocephala*) dried leaves as supplements to Cassava peels. Crude protein intake and weight gain increased with increase in protein quality. High crude protein in the diets has been considered an important factor that enables high intake of the feed. Oldham and Alderman (1980) stated that sometimes *ad libitum* intake of feed by the animals increase the crude protein content of the diet. The crude fibre values observed in this study ranged from 9.98% (12% CP diet) to 13.31% (16% CP diet) and these were lower than the values (16.98-27.33%) reported by Fajemisin, (2015) who fed a high fibrous panicum maximum-moringa diets. The diet (12%CP diet) had the highest ash value (9.99%) which was more than the value reported by Adededeji *et al.* 2014 for corn-cob groundnut concentrate diet. The lowest ether extract value (2.88%) was observed in 12%CP diet.

The values favourably compared to values (2.57-4.78%) reported by Adededeji *et al.* 2014.

The increased crude protein digestibility is an indication that ruminant animals require high CP levels to enhance microbial activities in the rumen. Nutrient digestibility values obtained was higher than values reported by Abegunde, (2008) fed polita leaves and *panicum maximum* diet.

The growth rates were higher than the range (23.33 – 28.57 g/animal/day) reported by Odeyinka, (2001) for WAD goats fed leucaena and gliricidia leaves. The variation could be because of the age difference of the experimental animal. Better efficiency of digestion in animals on 16% protein supplement could also be accounted for the weight gains and enhanced protein efficiency. Another factor that could also be considered in this experiment is the quality of the protein. Results showed that protein supplementation enhanced digestibility (Arigbede *et al.*, 2005; Fasae *et al.*, 2005).

Feed conversion ratio was best on 16 % CP. Earlier, similar observations (Tripathi *et al.*, 2006) between growth and feed conversion efficiencies of growing lambs fed varying

levels of tree leaves and concentrates were attributed to the influence of better nutrient density and quality of nutrients available for utilization. McNeill *et al.*, (1998) reported that higher proportions of by-pass protein have been reported to result in faster weight gains in livestock. The least feed conversion ratio in animals on 16% diet suggests better efficiency of converting feed to flesh.

The partial mean milk yield of 207.00-208.18mL was similar with 237.29mL and 215.79mL for WAD and Red Sokoto goat respectively, reported by (Bemji and Osinowo, 2004). The non-significant effect of diet on total solids implies that any of the diet would produce the same quantity of cheese. The total solids range of 15.32-15.94% as observed in this study was lower than 17.70-19.87 as reported by Akinsoyinu *et al.* (1977) and Alamede *et al.* (2001) but higher than 12% and 13.5% reported by Sabahelkhier *et al.* (2012) and Ceballos *et al.* (2009) and falls within the range of 12 to 18 as reported by Jandal (1995a).

The highest macro-mineral was observed in the diet containing 16% crude protein. This agreed with earlier findings of (Alamede *et al.*, 2001). The mean iron concentration is similar to that reported by (Freund, 2003). The Insignificant effect of levels of crude protein inclusion on magnesium is in line with the report of (Cashman, 2002). Also, Cashman, (2002) reported that potassium is high concentration while iron is low in concentration in goat milk.

Udder circumference (29.73-31.96cm) and distance between teat (7.31-8.03cm) observed in this study were similar to 28.49cm and 7.33cm respectively reported by Bemji and Osinowo, 2009. Udder circumference (29.73-31.96cm), udderwidth (12.63-14.19cm) had lower values than udder circumference (43.00cm) and udder width (14.7cm) reported in Frizarta dairy sheep but lower than that

reported by Kominakis *et al.* (2009) in temperate sheep but higher than that reported by Agbede *et al.*, 1997 in the tropics. Interestingly, milk yield was shown to be positively associated with distance between teat (Bemji and Osinowo, 2009). Udder circumference and distance between teats had higher values in animals on diet 12 and 16% as compared to goats on 14%. The higher values in animal on 12% diet as compared to 14% may be due to the smaller body size of goat on 14% diet

Packed cell volume (PCV) in this study was comparable to 27.06%-28.95% obtained for Sahel goats in the north (Waziri *et al.*, 2010), 30% reported by (Opara *et al.*, 2010) in the south eastern Nigeria, 29.3% by (Daramola *et al.*, 2005) but higher than 23.67 and 23.00% reported for West African Dwarf goats at 9.04-10.4% protein levels and 25.7% obtained for Red Sokoto goat (Tambuwal *et al.*, 2002) and fell within normal range of 21-35% for healthy goats in Guinea Savanna zone of Nigeria. The finding of this study implies PCV varies among breed and nutrition. The values obtained in this study suggest that there were no presence of toxic factor (such as haemagglutinin) which had adverse effect on blood formation (Abdul and Daniel, 2013). Haemoglobin (Hb) concentration in this study fell within the normal range (7-15g/dl) for healthy animal and did not differ from 9.8, 9.03- 9.86, 9.9 reported by (Daramola *et al.*, 2005) in WAD goat in South Guinea Savannah (Waziri *et al.* 2010), in Sahel goats (Opara *et al.*, 2010) in south eastern Nigeria but higher than 7.50-7.67 for WAD goats on lower protein level. White blood cell in this present study were close to those reported in the other breeds (Oduye, 1976, Vrzgula *et al.*, 1985) and Abdul and Daniel, 2013) but similar to 9.1-12.54 reported by Waziri *et al.* (2010). However, the values obtained in this study

fell within the blood range recorded for Red Sokoto goats (Tambuwal *et al.*, 2002). thus suggestive of a well developed immune system in the WAD goats Also, the total protein, albumin, globulin were within the same range as reported by (Opara *et al.*, 2010). Albumin at 14% and 16% inclusion level shows a significant ($p < 0.05$) difference. Also cholesterol was higher 76.33-91.67 compare to normal range 47.4±4.5 (Opara *et al.*, 2010). Tietz (1994) observed that increase in cholesterol during lactation maybe attributed to the physiological alteration of endocrine system.

The rectal temperature recorded in this study is comparable to the findings of (Aye and Alokun, 2006) who reported a temperature of 38.9-39.5°C for goats under confinement. Also, temperature range between 38.64-39.48°C recorded is within the range of 38.5-39.7°C and 38.7-39.5 °C reported in goat (Adewumi *et al.*, 2007 and Smith, 2014) but lower than 37°C obtained by Ojo and Adewumi, 2011. For pulse rate, 48.42-63.92 beats/minute is lower than 70-90beats/minute, 59.7-71.1, 78-81 beats/minute observed in temperate goat by Adewumi et al. 2007, Ojo and Adewumi *et al.*, 2011, Smith, 2014), and the 36.75-49.61breadths/minute observed in the respiratory rate is lower than 10-30 breadths/minute reported by Smith, (2014) but higher than 38.15-47.63 breadths/minute reported by Adewumi *et al.*, 2007. The respiratory and pulse rate values were higher than 23.33-26.42beadths/minute reported by (Aye and Alokun, 2006), and lower than 69.20 and 72.80beats/minute respectively reported for goats under confinement. The high value of respiratory rate indicates that the animals were thermally stressed. The increase in respiratory rates of goats after milking is one of the adaptations of the animals to

restore the increase in the rectal temperature (Pagot, 1992). Sevi *et al.* (2002) showed that marked increase in the rectal temperature, metabolism alteration and a reduction in milk yield after exposure to average daily temperature of 35°C or after prolonged exposure to mean ambient temperature of 30°C and a decline in milk hygiene.

Conclusion

It can therefore be concluded that 16% crude protein level could be fed to lactating West African dwarf dams to improve milk production and at the same time maintain their health.

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