GROWTH PERFORMANCE AND LINEAR BODY MEASUREMENT OF RED SOKOTO GOATS FED CONCENTRATE PARTIALLY REPLACED WITH *Piliostigma thonningii* FORAGE

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ABSTRACT
Fifteen Red Sokoto bucklings of about 6-7 months, with an average initial body weight (BW) of 6.6 ± 0.71 kg, were used to study the effects of concentrate partially replaced with *Piliostigma thonningii* forage on the growth performance and linear body measurement in a 70-day experiment. The bucklings, balanced for their BW, were distributed into three groups of five animals in a completely randomized design experiment. The bucklings in group 1 received 100% concentrate (PT0), group 2 received 25% of concentrate replaced with *Piliostigma* foliage (PT25) and group 3 received 50% concentrate replaced with *P. thonningii* forage (PT50). The diets were fed at the goats' 5% BW while the basal diet, threshed sorghum head (TSH) was provided *ad-libitum*. Intakes of dry matter, TSH, crude protein and average daily gain were not significantly ($p > 0.05$) affected by the diets. Intakes of concentrate, organic matter and ash were significantly ($p < 0.05$) different among the treatments. Linear body measurements were positively significantly correlated ($p < 0.0001$) with final BW. It is concluded that *P. thonningii* forage can replace 50% concentrate when bucklings are fed a basal diet of TSH.

INTRODUCTION
Goats play a vital role in the livelihoods of small-scale farmers in developing countries. Farmers keep goats for many reasons, the major reasons being that they are the sources of food, cash and a form of savings. Dry season feeding of ruminants has always been a constant problem to livestock farmers, as feed supplies are limited both in quantity and quality which result in reduced livestock productivity. Tree fodders are important in providing nutrients to grazing ruminants in tropical environments where inadequate feeds are a major constraint. One of such tree fodders is *Piliostigma thonningii*. *P. thonningii* is a leguminous plant found mostly in woodland habitats (Lock and Simpson, 1999). However, plants contain thousands of compounds such as tannin which, depending on their nature and concentration, can have beneficial or deleterious effects on animals consuming them (Jurgens, 1997). The incorporation of concentrates into ruminant diets is intended to increase dietary energy and nutrients, and to optimize the efficiency of feed utilization. However, concentrates are expensive, unaffordable to smallholder ruminant farmers and any attempt to reduce its use will undoubtedly reduce cost of feeding. Thus, the aim of this study is to investigate the effect of partial replacement of concentrate with *P. thonningii* on the performance of Red Sokoto goats.

MATERIALS AND METHODS
Fifteen Red Sokoto bucklings of about 6 -7 months, with an average initial body weight (BW) of 6.60 ± 0.71 kg, were used for the study. Prior to the experiment, the animals were given prophylactic treatment consisting of oxytetracycline and ivomectin. The goats were weighed, divided into 3 groups of similar BW, individually penned and allowed to adapt to the pens and experimental diets for two weeks. Pen was cleaned twice a week. The basal diet, TSH, and water were offered *ad libitum*, while the diets were fed at the animal's 5% BW for experimental period of 70 days. The fresh leaves of *P. thonningii* used to replace concentrate in this experiment were harvested at mature stage from several stands in the university environment. Concentrate ration was formulated to contain: 25% maize, 27% corn bran, 30% brewers' dried grain, 12% groundnut cake, 1% urea, 2% limestone, 2% salt and 1% vitamin-mineral premix. Animals in group I received concentrates at 5% of their BW, while 25 and 50% of the concentrates were replaced with an equal amount (DM basis) of *P. thonningii* leaves in groups II and III respectively. The three dietary treatments were randomly allocated to the animals in a completely randomized design (CRD) experiment with five animals per treatment. The amount of feed offered was measured daily and representative samples were taken on a weekly basis and pooled together after the experiment. Sub samples were later taken for analysis. The quantity of feed provided and the

residue of each day was weighed to determine the feed intake of each animal. Initial BWs of the goats were taken at the commencement of the experiment and subsequently at 7 days interval in the morning before feeding. Also, body measurements were made using the tailor's tape measurement. Samples of TSH, *P. thonningii* foliage and concentrate supplement were ground separately to pass through a 1 mm sieve in a Wiley mill and sampled for proximate analysis using the standard methods of AOAC (1995). Dry matter was determined by drying at 102^0 for 24 hours. Ash concentration was determined after ignition at 550^0 for 4 hours in a muffle furnace and used to calculate organic matter (OM). Fibre fraction analysis was by the methods of Van Soest et al. (1991). Condensed tannins were determined by the methods of Makkar (2003). Data were subjected to ANOVA in CRD using the SPSS (2009) package. Significant differences between means were separated using DMRT. The relationships of body weight with body measurements were estimated by Pearson correlation and regression analysis.

RESULTS AND DISCUSSION

Table 1 shows the chemical composition of the experimental diets. The DM, NDF, ash and crude protein values of *P. thonningii* in the current study were higher than earlier reports on the same species (Ighodaro *et al.*, 2012). Differences in composition may be due to variation in age, environmental and soil conditions and climatic factors. Although, the NDF was slightly higher than the recommendation of 20-35% for effective degradation in the rumen environment (Norton, 1994; Barski and Wadhuwa, 2004), it was, however, lower than 60% recommended value at which feed intake is affected. The CP content of the *P. thonningii* foliage was similar to the report of Tona (2011) and is above the 8% postulated by Norton (2003) as the dietary threshold level for microbial activities within the ruminal environment. These results suggest *P. thonningii* leaf as a good browse plant for ruminant nutrition. The basal TSH is low in CP (7.21%) but the CP is close to the 8% postulated by Norton (2003) for efficient rumen microbes' activity. The supplementary concentrate diet had high CP content that can ensure optimum growth in ruminants (Hoste *et al.*, 2005). The results of dry matter, nutrients intake and body weight changes of goats fed concentrate partially replaced with *P. thonningii* are presented in Table 2. Intakes of DM (g/day) and CP (g/kg $W^{0.75}$/day) were not significantly ($p > 0.05$) different among the treatments. The result suggests the palatability and acceptability of the *P. thonningii* foliage by the goats. This agrees with the findings of Das *et al.* (2011) who reported that replacing concentrate with Barhar leaves did not affect the total DM and CP intakes of growing goats. However, DM intake expressed as the metabolic weight of the animals was higher ($p < 0.05$) for PT50 compared to the other diets. Intake of minerals was greater ($p < 0.05$) for PT50 than PT0, whereas OM intake was more ($p< 0.05$) for PT0 than PT25 and PT50. Final BW, total weight gain and average daily gain were not significantly ($p > 0.05$) affected by the dietary treatments, though animals fed PT25 had the highest numerical gains. The results show that the diets were efficiently utilized by the animals and concentrate replacement with 50% *P. thonningii* foliage diet did not impair the efficiency of feed utilization or conversion to meat. Therefore, concentrate can partially be replaced with *P. thonningii* foliage up to 50%. The results confirm the earlier reports of Jimoh and Oladiji (2005) and Pathak (2008). Table 3 shows the relationship between final BW (Y) and linear body measurements characteristics (X) of experimental animals. The results show that heart girth (HG), height at wither (HW), body length (BL), scrotum circumference (SC) and scrotum length (SL) were highly significantly ($p < 0.0001$) correlated with BW, and that HG, HW, BL, SC and SL contributed 83.2%, 70.6%, 67.4%, 57.5% and 48.9%, respectively to BW. The results indicate that an increase in BW is as a result of an increase in linear body measurement of the animals. This is in agreement with the findings of Alade *et al.* (2008) and Adediji *et al.* (1999), which suggested that there is a positive correlation between live weight gain and linear body measurement. Body weight was highly significantly positively correlated ($p < 0.0001$; $r = 0.947$) with HG (x_1), HW (x_2) and BL (x_3), with about 90% ($r^2 = 0.897$) of variation in BW being accounted for by these independent variables. The regression equation is $Y = -4.41 + 0.054x_1 + 0.037x_2 + 0.025x_3$. However, HG contributed more ($r^2 = 0.832$) to BW than HW ($r^2 = 0.706$) and BL ($r^2 = 0.674$). It appears that HG is more reliable in estimating BW in consonance with previous reports (Bello and Adamu, 2012). It may thus be used for selection criteria in genetics for prediction of body weight using body measurement to estimate growth performance of goats. Similarly, BW is positively significantly

correlated ($p < 0.0001$; $r = 0.777$) with testicular size (ie, SC and SL). The regression equation is $Y = 0.681 + 0.571\ x_1 + 0.226\ x_2$, where x_1 = SC, x_2 = SL. Though the regression results indicate that both linear body measurements and testicular size are significantly correlated to BW, linear body measurement appears to be better predictor of BW ($r^2 = 0.897$) than testicular size ($r^2 = 0.604$) in the current study.

Conclusion

The results obtained in this study show that concentrate can be partially replaced with *P. thonningii* forage since there were no significant differences in total feed intake and performance. It is therefore concluded that concentrate can be replaced with *P. thonningii* leaves at 50% without compromising goat performance.

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Table 1: Chemical composition (g/kg) of experimental diets

Parameter	*P. thonningii*	Threshed sorghum head	Concentrate
Dry matter	948.8	935.8	936.2
Nutrient (g/kg DM)			
Crude protein	158.3	72.1	186.0
Organic matter	908.6	871.6	935.9
Crude fiber	300.8	350.4	247.4
Ether extract	43.7	64.5	99.9
Ash	91.4	128.4	64.1
Neutral detergent fiber	395.5	603.0	288.2
Acid detergent fiber	332.7	427.2	124.2
Acid detergent lignin	80.6	92.4	39.8
Hemicellulose	63.8	175.8	164.0
Cellulose	252.1	334.8	84.4
Condensed tannins	2.8	1.9	-

Table 2: Dry matter and nutrients intake and bodyweight changes of experimental goats

Parameter	Level of replacement			SEM
	PT0	PT25	PT50	
Threshed sorghum head intake (g/day)	63.37	42.26	44.15	12.01
Concentrate intake (g/day)	354.15^{a}	195.48^{b}	178.76^{b}	10.42
P. thonningii forage intake (g/day)	-	194.59^{b}	239.73^{a}	29.51
Dry matter intake (g/day)	393.13	407.54	436.13	37.81
Dry matter (g/kg $W^{0.75}$/day)	74.14^{b}	72.8^{b}	84.68^{a}	5.55
Crude protein intake (g/kg$W^{0.75}$/day)	11.67	11.69	12.4	1.1
Ash intake (g/kg $W^{0.75}$/day)	5.14^{b}	5.96^{ab}	6.55^{a}	0.53
Organic matter intake (g/kg $W^{0.75}$/day)	95.61^{a}	94.03^{b}	93.45^{b}	0.74
Initial weight (kg)	6.6	6.5	6.6	0.71
Final weight (kg)	13.6	13.7	13.4	1.23
Total weight gain (kg)	7.0	7.2	6.8	0.70
Average daily gain (g/day)	100.0	102.85	97.14	10.03

Means with different superscripts along the same row differ significantly ($p < 0.05$)

Table 3: Relationships between body weight (Y) and linear body measurement (X) of goats

Dependable variables	Regression equation	R	R^2	SEM	P-value
Heart girth	Y= -9.598 + 0.397X	0.912	0.832	0.040	0.0001
Height at wither	Y=-6.863 + 0.382X	0.840	0.706	0.055	0.0001
Body length	Y= -8.506 + 4.10X	0.821	0.674	0.064	0.0001
Scrotum circumference	Y= -6.814 + 1.056X	0.758	0.575	0.203	0.0001
Scrotum length	Y= -0.895 + 1.270X	0.699	0.489	0.291	0.0001