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Performance Characteristics of Pregnant Goats Fed Diets Containing Turmeric (*Curcuma longa*) Powder Supplementation

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ABSTRACT

Thirty pregnant primiparous does which consist of 15 KalaWAD Crossbred (Kalahari Red x West African Dwarf) and 15 West African Dwarf (WAD) goats were used in this study to determine the effect of different inclusion levels of turmeric (*Curcuma longa*) powder supplementation and breed on the performance characteristics. The goats were subjected to 3 dietary treatments of basal concentrate diet (TU0), basal concentrate diet + 2g/kg turmeric powder (TU2) and basal diets +5g/kg turmeric powder (TU5) with 5 animals/breed/ treatment in a 2x3 factorial arrangement. Data collected were subjected to analysis of variance in a completely randomized design. The final weight, weight within 24hours post kidding, net weight gain and daily weight gain (g/day) were significantly ($p< 0.05$) influenced by the breed of the goats, while turmeric powder inclusion at 2g/kg significantly ($p< 0.05$) influenced the net weight change of the goats. The interactive effect of breed and inclusion level revealed that KalaWAD does fed TU2 had significant higher value (80.96g/ day) for daily weight gain. It could be concluded that KalaWAD does had better overall growth performance than WAD while turmeric powder inclusion at 2g/kg had the best daily weight gain during gestation period.

Key words: Gestation, Goats, Kalahari red, Parturition, Post kidding, Primiparous, Weight gain.

INTRODUCTION

Goat is numerically and economically important and promising animal resources in the developing countries most especially in Africa (Hassan *et al.,* 2007). It is considered as an important source of income for the poor populace and peasant farmers who raised them with little or no capital investment. Improvements of animal production is one of the key ways to tackle the low protein intake due to increase in world population especially in developing countries like Nigeria. This cannot be achieved without paying keen attention to performance, productivity, health statu and overall management of goat which form the basic part of protein source.

The utilization of phytogenic feed additives which include plants, herbs, spices, fruits, vegetables and nutritional immunomodulators are becoming popular in animal production management to improve flavour and palatability, therefore enhancing productivity and performance of the animals due to their low toxicity, fewer side effects, cost-effectiveness, local availability and other beneficial advantages (Abou-Elkhair *et al.* 2014; Dhama *et al.* 2015). Studies had shown that the active ingredients of these plants have strong antioxidant properties which includes; neutralization of superoxide, hydrogen peroxide and nitric oxide either by scavenging radicals or by increasing the production of catalase (CAT), superoxide dismutase (SOD) and glutathione peroxidase (GSH-Px) (Ali *et al.,* 2006; Yarru *et al.,* 2009; Dhama *et al.,* 2015). Turmeric is a tropical plant which is native to Southern and South-Eastern tropical Asia with India been the major producer of the plant. The plant has been shown to contain curcumin which is the most important bioactive ingredient in turmeric and responsible for it biological activity. Curcumin has been shown to have several biological effects which includes; antioxidant, exhibiting anti-inflammatory and hypolipidemic activities (Nouzarian *et al.* 2011; Dhama *et al*. 2015). It has also been noted to have protective effect on DNA damage repair, prevention of spermatogenic cell apoptosis and development of testicular tissue (Bulku *et al.* 2012)

Gestation period has been noted by Paramesh *et al.* (2019), to be associated with high metabolic demand and elevated requirements for tissue oxygen that leads to an increased production of reactive oxygen species (ROS) which in turn results in oxidative stress. The stress during the early stage are mild while the late stage comes with negative energy balance which may be the reason for the development of oxidative stress; increased lipid peroxidation and reduced antioxidant activity there by

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contributing to the development of complications at birth (Nawito *et al.,* 2016).

According to Adeloye (1998), The West African Dwarf (WAD) goats are found across West Africa in the coastal area which is humid and favors high prevalence of diseases. However, the West African Dwarf goats thrive well here and reproduce with twins and triplet births thereby forming a major part of protein source in the region (Opara *et al.,* 2010). KalaWAD (crosses) goats are breeds of goat obtained from crossing Kalahari Red bucks with West African Dwarf does. The Federal University of Agriculture, Abeokuta, (FUNAAB) in her quest for quality research in the area of sustainable agriculture through her Institute for Food Security, Environmental Resources and Agricultural Research (IFSERAR) imported 60 Kalahari Red goats from South Africa for the purpose of improvement of the small body size, productivity, milk production, meat production and overall performance of the West African Dwarf goats. The University can be said to be the only institution housing KalaWAD crosses on station presently in Nigeria and there are dearth of data on the breed. Thus, this study was designed to investigate the growth performance characteristics of pregnant goats (KalaWAD and WAD) fed diets containing turmeric (*curcuma longa*) powder supplementation.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at the Kalahari Goat unit of the Institute for Food Security, Environmental Resources and Agricultural Research (IFSERAR) of Federal University of Agriculture, Abeokuta, (FUNAAB), Ogun State, South West, Nigeria in year 2016. The experimental site is located in the rain forest vegetation zone of South-Western Nigeria on the Latitude 7° 13' 47.41"N, Longitude 3° 23' 43.48"E and altitude 76m above the sea level Google earth (2016).

Preparation of test ingredient (turmeric powder)

Fresh turmeric rhizomes were sourced from local market in Ibadan, Oyo State, Nigeria. The rhizomes were washed after purchase, sliced into smaller pieces and oven dried at 60°C to a constant weight. The dried rhizomes were then milled into fine powder using electric blender (Panasonic, Japan) before its inclusion in the experimental diet.

Experimental animals and management

A total of thirty (30) pregnant does in their first trimester (1-50 days) consisting of 15 West African Dwarf (WAD) and 15 KalaWAD does within age range of $1\frac{1}{2}$ -2 years with average weight of 20.54±2.01kg were used in this experiment. The goats were selected from the herd at the Kalahari Red goat unit of Institute for Food Security, Environmental Resources and Agricultural Research (IFSERAR), Federal University of Agriculture, Abeokuta, (FUNAAB), Ogun State. The does were mated by well proven experienced Kalahari Red bucks after synchronization using prostaglandin Lutalyse® (contains 5mg/ml Dinoprost Triomethamine) injection at 1ml per doe which was injected through intramuscular route at the interval of ten days (Bitaraf *et al.,* 2007; Kenfack *et al.,* 2013). The animals shortly before mating were dewormed and treated against endo and ecto parasite by intramuscular administration of Oxytetracycline 20% (Oxytetracycline 200mg/ml as dihydrate) at 1ml per 20kg body weight and Ivanor® Injection (Ivermectin 10mg/ml) was also administered subcutaneously at 1 ml per 50 kg bodyweight respectively.

Experimental design

The does were randomly allotted to three treatment groups after balancing for weight comprising of 5 does per treatment in a 2×3 factorial experimental layout in a completely randomized design. The animals were placed in an individual pen with slated floor of adequate spacing. The experimental diets are fed by 08:00h in the morning while Congo signal (*Brachiaria ruziziensis*) grass in dry form was fed by 13:00h. Fresh and clean portable water was made available to the goats daily ad libitum. The animals were fed with the experimental diets for 7days period of adaptation prior to the commencement of the experiment and throughout the experimental period. The does were fed the experimental diets (i.e. TU0, TU2 and TU5) at 5% of their body weight as shown in Table 1. The dietary treatments were as follows:

Diet 1 (TU0): basal concentrate diet + 0g/kg turmeric powder,
Diet 2 (TU2): basal concentrate diet + 2g/kg turmeric powder,
Diet 3 (TU2): basal concentrate diet + 2g/kg turmeric powder.

Performance evaluation

The following growth performance parameters were taken using Avery Weigh-Tronix® Electronic scale- 400kg capacity during the experimental period that lasted for 161days.

Table 1: Shows the gross composition of the experimental diets.

Ingredients	TU0	TU2	TU5
Maize	15.0	15.0	15.0
Wheat offal	42.0	42.0	42.0
Palm kernel cake	30.0	30.0	30.0
Soybean Meal	4.0	4.0	4.0
Groundnut cake	3.0	3.0	3.0
Bone meal	3.0	3.0	3.0
Limestone	1.5	1.5	1.5
Salt	1.0	1.0	1.0
*Premix	0.5	0.5	0.5
Total (Kg)	**100**	**100**	**100**
Turmeric Powder (g)	0.0	200	500

*Contains Vitamin A (I.U) 10,000.000; Vitamin D2 (I.U) 2,000,000; Vitamin E (I.U) 20,000; Vitamin K (mg) 2,250; Riboflavin (mg) 5000; Pyridoxine (mg) 275; Biotin (mg) 50; Pantothenic acid (mg) 7500; Vitamin B1 (mg) 175; Vitamin B12 (mg) 15.0; Niacin (mg) 27,500; Folic acid (mg) 7500; Choline Chloride (mg) 400; Antioxidant (mg) 125; Fe (g) 50.0; Mn (g) 80.0; Cu (g) 5.0; I (g) 12.0; Co (mg) 200; Se (mg) 200.

- **Initial weight of the does**

This was the weight of the experimental does which was taken at mating.

- **Final Weight of the does**

This was the weight of the does taken within 24 hours before kidding.

- **Does' Live–weight after kidding (weight within 24hours post kidding)**

This was the weight of the does which was taken within 24hours after kidding. This was taken when the placenta, umbilical cord and other foetal membranes like allantois, chorion and amnion (with the amniotic fluid) were expelled.

- **Live-weight changes during gestation period**

this was determined by taking the initial weight of the animals at the introduction of bucks followed by weighing of the pregnant does on fourth-nightly (i.e. every two weeks) until the last doe kidded on the 161days.

- **Weight change (Gross weight change)**

This was determined by deduction of initial weight at mating from the final weight of the doe taken 24hours before kidding using the following formula.

Weight change (kg) = final weight (kg) - initial weight (kg)

- **Net weight change (weight gain by does after parturition)**

This was calculated by deduction of the initial weight of the does at mating from the doe's live-weight 24hours after kidding using the following formula.

Net weight gain (kg) =

wt within 24 hr after kidding (kg) - wt at mating

- **Daily weight gain (g/day)** =

weight gain (g) / gestation length (days)

- **Metabolic weights**

a. weight gain ($gday^{-1} W^{-0.75}$) =

$$\left(\frac{\text{initial weight (kg) - final weight (kg)}}{2}\right)\text{^75}$$

b. initial weight ($gday^{-1} W^{-0.75}$) = Initial weight $(kg)^{0.75}$

c. final weight ($gday^{-1} W^{-0.75}$) = Final weight $(kg)^{0.75}$

- **Feed Intake**

A known quantity of concentrate feed and grass were offered to each animal daily throughout the experimental period. The difference in total feed offered and feed left over were taken as the feed intake.

Feed Conversion Ratio=

Total feed consumed (g) / weight gain (g)

Proximate composition

The proximate composition which included; crude protein, crude fibre, ether extract, carbohydrate and ash of the experimental diets, grass and turmeric powder were determined according to the method described by AOAC (2005) at Food Processing Laboratory in the Department of Food Science and Technology, Federal University of Agriculture Abeokuta, Nigeria. The dry matter was determined by oven drying the samples to a constant weight at 65°C. Crude protein was determined as Kjedhal nitrogen ×6.25. The fibre fractions such as neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) was determined using the method described by Van Soest *et al.* (1991). While the hemicellulose and the cellulose were determined by the difference between NDF and ADF, ADF and ADL respectively.

Statistical analysis

All the data collected were subjected to two way ANOVA in completely randomized design using the General linear model (GLM) procedures of Statistical Analysis System (SAS) (2004). Level of significance were taken as ($p < 0.05$) while the different means were separated using Duncan's Multiple Range Test of the same statistical package.

RESULTS AND DISCUSSION

The proximate analysis of the experimental diets, *Brachiaria ruziziensis* and turmeric powder are presented in Table 2. The crude protein of the diet containing 2g/kg of turmeric powder inclusion was found to be highest (18.47%) while diet containing 5g/kg of turmeric powder inclusion was low (12.68%). The crude protein values obtained in this study was in agreement with CP value of 9 - 10% and 13-14% recommendation of NRC (2007) for both early and late pregnancy in goats respectively suggesting the potential of diets to provide adequate nitrogen required by rumen micro-organism to maximally digest the dietary nutrients and enhanced healthy foetus growth and development without causing depletion in the dam's health.

The main effects of breed and different inclusion levels of turmeric powder (*Curcuma longa*) on final weight, weight changes, net weight, daily weight gain, feed intake and feed conversion ratio of the experimental does are shown in Table 3. The result showed that the breed of the goats had significant ($p < 0.05$) effect on the final weight, although the average initial weight of all the goats in each breed were not significantly ($p > 0.05$) different. This can be attributed to the genetically make-up of the individual breed and the rate of foetus development in the uterus which corroborate the findings of Oyeyemi *et al.* (2011) who observed significant change in final weight of two breeds of goats; Red Sokoto and West African dwarf goats during gestation period. Similarly, KalaWAD does had higher significant ($p<0.05$) weight within 24hours post kidding, metabolic final change, weight change, net weight change and daily weight gain compared to WAD does that recorded the least value of 27.67kg, 22.79kg, 12.03g/day, 8.77kg, 3.85kg and 60.82g/day respectively. The significant ($p < 0.05$) metabolic final change, weight change and the daily weight gain observed in the KalaWAD does is an indication of genetically-dependent maternal energy balance during carbohydrate

Table 2: Proximate and fibre fraction composition of the experimental diets.

Composition (%)	Experimental Concentrate Diets			*Brachiaria ruziziensis*	Turmeric Powder
	TU0	TU2	TU5		
Dry matter (DM)	84.79	88.36	90.46	89.12	86.36
Crude Protein (CP)	16.49	18.47	12.68	8.01	13.27
Crude Fibre (CF)	27.49	25.16	24.64	24.54	24.21
Ether extract (EE)	2.48	2.51	1.82	2.48	2.74
Ash	10.98	9.35	6.51	7.78	5.07
Nitrogen free extract	42.57	44.53	54.37	57.27	54.73
Neutral detergent fibre	62.67	66.04	62.38	65.33	66.67
Acid detergent fibre	38.00	40.91	44.29	45.33	38.67
Acid detergent Lignin	10.67	11.32	16.42	13.33	8.00
Hemicellulose	24.67	25.13	18.09	20.00	28.00
Cellulose	27.33	29.29	27.87	32.00	30.67
*ME (MJ/kgDM)	10.76	10.98	11.25	11.14	11.74

*Calculated using MAFF (1984), equation.

Table 3: Main effects of Breed and Inclusion levels of Turmeric powder (*Curcuma longa*) on growth parameters of Goats.

Parameters	Breeds			Levels of Turmeric Inclusion			
	KALAWAD	WAD	S.E.M	TU0	TU2	TU5	S.E.M
Initial live weight (kg)	22.17	18.90	1.10	21.54	20.79	18.96	1.35
Final live weight (kg)	33.58^{a}	27.67^{b}	1.36	31.00	29.13	31.17	2.05
Weight within 24hr post-kidding	29.09^{a}	22.79^{b}	1.06	24.75	24.93	26.79	1.17
Metabolic weight change (gday^{-1} W$^{-0.75}$)	12.12	10.57	0.41	11.55	10.85	11.48	0.56
Metabolic initial change (gday^{-1} W$^{-0.75}$)	10.19	9.04	0.38	9.95	9.08	9.71	0.48
Metabolic final change (gday^{-1} W$^{-0.75}$)	13.94^{a}	12.03^{b}	0.44	13.08	12.53	13.16	0.66
Weight change (kg)	11.42^{a}	8.77^{b}	0.49	9.46	10.17	10.38	0.86
Net weight change (kg)	6.92^{a}	3.85^{b}	0.59	3.67^{b}	6.13^{a}	6.00^{a}	0.84
Daily weight gain (gday^{-1})	74.93^{a}	60.82^{b}	3.29	63.84	69.17	69..23	5.29
Total feed intake (gday^{-1})	1055.66^{a}	922.30^{b}	11.58	995.53	997.16	966.83	32.74
Metabolic feed intake (g/kg W$^{-0.75}$)	185.20^{a}	167.36^{b}	6.27	177.23	177.45	173.38	13.68
FCR	14.21	15.73	0.71	16.09	14.75	14.30	0.97

^{abc}Mean on the same row having different superscripts were significantly different (p<0.05).

TU0, Basal Concentrate diet +0g/kg turmeric powder, TU200, Basal Concentrate diet + 2g/kg turmeric powder. TU500, Basal Concentrate diet + 5g/kg turmeric powder, SEM, Standard Error of Means, WAD, West African Dwarf goat, FCR, feed conversion ratio, Initial weight is the live weight of the doe at buck's introduction, Final weight is live weight taken within 24hours before birth.

and lipid metabolism Butte (2000). The higher net weight recorded for KalaWAD in this present study also signify high maternal post-partum performance which includes; milk production to support kid, milk quality and ability to return to estrus.

The different levels of turmeric inclusion had significant ($p < 0.05$) effect on net weight change of the goats. Does fed TU2 and TU5 respectively had higher net weight changes compared to the unsupplemented groups which reiterated the ability of turmeric to enhanced growth as earlier noted by Habeeb *et al.* (2012) that supplementation of medicinal plant mixture are capable to improved body weight gain in different farm animals.

Table 4 shows the interactive effect of breed and different inclusion levels of turmeric powder on growth characteristics of the does. The weight within 24hours post-kidding, weight change, net weight change and the daily weight gain of the KalaWAD and WAD fed diets supplemented with turmeric powder were significantly higher ($p < 0.5$) compared to those in the unsupplemented group. The significant weight change and net weight change observed in the supplemented does could be attributed to the antioxidant activity of the curcumin contained in the turmeric powder that reduced stress due to oxidation during the whole gestation period and caused there to be energy balanced between both the foetus and the dam (Osawa *et al.,* 1995 and Al-Sultan, 2003).The higher significant ($p< 0.05$) weight within 24hours post-kidding, weight change, net weight change and the daily weight gain observed in the supplemented groups might also be an indication of the protective role of curcumin during the 'dam-foetus' materials exchange which corroborate the findings of Zhiyang *et al*. (2019) who reported that curcumin supplementation had several immune-related protective effects against apoptosis,

Table 4: Interaction effect of Breeds and different Inclusion levels of Turmeric powder (*Curcuma longa*) on growth parameters of Goats.

Parameters	KALAWAD			WAD			
	TU0	TU2	TU5	TU0	TU2	TU5	S.E.M
Initial weight (kg)	24.75	19.25	22.50	18.33	18.67	19.50	0.84
Final weight (kg)	35.00	31.25	34.50	27.00	27.00	28.67	1.18
Weight within 24hr post kidding	29.75^{ab}	27.01^{abc}	30.50^{a}	21.00^{c}	23.38^{c}	24.00^{bc}	1.01
Metabolic weight change (gday^{-1} W$^{-0.75}$)	12.76	11.26	12.33	10.33	10.45	10.85	0.34
Metabolic initial change (gday^{-1} W$^{-0.75}$)	11.08	9.19	10.32	8.82	8.98	9.25	0.29
Metabolic final change (gday^{-1} W$^{-0.75}$)	14.38	13.21	14.23	11.78	11.84	12.36	0.38
Weight change (kg)	10.25^{ab}	12.00^{a}	12.00^{a}	8.67^{b}	8.33^{b}	9.17^{ab}	0.47
Net weight change (kg)	5.00^{b}	7.76^{a}	8.00^{a}	2.33^{b}	4.50^{b}	4.50^{b}	0.55
Daily weight gain (gday^{-1})	67.81^{ab}	80.96^{a}	76.45^{ab}	60.29^{ab}	57.37^{b}	63.81^{ab}	2.92
Total feed intake (gday^{-1})	1061.93^{a}	1072.30^{a}	1032.76^{a}	929.13^{b}	922.03^{b}	917.38^{b}	17.98
Metabolic feed intake (g/kg W$^{-0.75}$)	186.03^{a}	187.39^{a}	182.18^{a}	168.28^{b}	167.32^{b}	166.69^{b}	8.73
FCR	15.77	13.35	13.51	16.42	16.15	14.89	0.56

^{abc} Mean on the same row having different superscripts were significantly different ($p<0.05$)

TU0, Basal Concentrate diet + 0g/kg turmeric powder, TU2, Basal Concentrate diet + 2g/kg turmeric powder. TU5, Basal Concentrate diet + 5g/kg turmeric powder, SEM, Standard Error of Means, FCR, feed conversion ratio, Initial weight is the live weight of the doe at buck's introduction, Final weight is live weight taken within 24hours before birth.

spermatogenic disorders, male infertility and increase in mRNA expression in sheep fed curcumin powder. Hence, curcumin can be said to be related to immune response and making rumen degradable nitrogen available thereby resulting in growth, better performance and wellness.

CONCLUSION

In conclusion, it was discovered from the results gotten from this that KalaWAD does performed considerably better in terms of daily weight gained and net weight change compared to WAD while supplementation of the goats diets by turmeric powder inclusion also enhanced net weight in both breeds.

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