EFFECT OF DIETARY INCLUSION OF TURMERIC POWDER ON GROWTH AND RUMEN FERMENTATION OF SHEEP

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ABSTRACT
Feeding sheep with herb plant additives have been recognised as an important strategy for manipulating rumen to improve growth performance. Dietary inclusion of turmeric powder has proven to be necessity for livestock farmers as it provides beneficial effects for sheep performance. Therefore, this study was carried out to determine the dietary inclusion effect of turmeric powder on growth and rumen fermentation by sheep. Sixteen West African dwarf female sheep of 6 – 7 months old were randomly allotted to four dietary treatments in a completely randomized design. The treatment diets TD1, TD2, TD3 and TD4 contained 0, 1, 2 and 3% turmeric powder inclusion, respectively. At the end of the feeding trial, growth and rumen fermentation parameters were assessed. Results showed that sheep on TD1 were significantly ($p<0.05$) higher in feed conversion ratio (7.62), rumen ammonia nitrogen (19.23mg/dL), acetate (62.04mol/100mL) and butyrate (5.82mol/100mL). Feed intake (269.11g/day), daily weight gain (46.19g/day), total volatile fatty acids (99.67mol/L) and propionate (24.98mol/100mL) were significantly better in sheep on TD4. It can be concluded that inclusion of turmeric powder in diets improve growth performance and enhance rumen fermentation parameters of sheep.
Keywords: ***turmeric, crop-residues, growth, rumen, sheep.***

INTRODUCTION

Sheep production in Nigeria is traditionally based on exploitation of free rangelands with seasonal migrations. With recent increase in sedentary human populations, sheep rearing is now gradually becoming semi-intensive system in the tropics. This has led to scarcity of feed ingredients that are in strict competition with man's dietary needs (Okoruwa *et al.*, 2023). However, sheep farming is faced with numerous challenges relating to nutritional status, most especially during the dry season that is characterized by insufficient forages and unfavourably deficit in feed nutrients. This brings about rapid decline in sheep productivity and ability to attain their maximum potential in terms of performance. Subsequently, identifying and developing alternative feed resources are good strategy to improve the existing feeds. Ruminant nutritionists are now actively engaged in research into the use of natural herb plant additives as supplementary feeds to ascertain better performance (Candyrine *et al.*, 2019). Several years ago, antibiotics were used as feed additives to maximize production and reduce mortality caused by pathogens in livestock (Pham and Le, 2023). Recently, increasing concerns about the excessive use and negative impact of their residues in animal tissues, have posed significant threat to both animal and human health status (Muhammad *et al*., 2023). Hence, supplementation based on dietary turmeric powder has proven to be necessity for sheep farmers to preserve the structure of their flocks.

Turmeric (*Curcuma longa. L*) is a rhizomatous herbaceous perennial plant belonging to the *Zingiberaceae* family (Muhammad *et al*., 2023). It is widely used as spice and medicinal plant that contains curcumin, demethoxycurcumin, bisdemethoxycurcumin and several bioactive compounds which exhibit antimicrobial and antioxidant properties. Pham and Le (2023) noted that efficacy of turmeric has beneficial effects on feed efficiency, potential increase in digestive enzyme activity and performance in animals. Hence, the objective of this study was to investigate the response of turmeric powder supplementation on growth and rumen fermentation parameters of sheep.

MATERIALS AND METHODS

The study was carried out in Sheep and Goat Unit of Livestock Section in the Teaching and Research Farm, Ambrose Alli University, Ekpoma, Nigeria. Guinea grass was cut within the farm, allowed to

wilt overnight before chopped into smaller parts of about 5 to 6cm lengths. Fresh but mature turmeric was cleaned, peeled, thinly sliced into smaller pieces and dried sufficiently by exposing to sunlight for a period of 4-5 days. Thereafter, the required amount of turmeric powder was prepared by fine grinding to make powder form. Potato peels, pineapple pulp-peel and broken groundnut were gathered from different strategic locations of potato, pineapple and groundnut sellers at Ekpoma. They were cleaned, dried and incorporated with turmeric powder and other feed ingredients to formulate supplementary diets (Table 1). The basal diet of Guinea grass and supplementary diets were used in a ratio of 60:40 respectively. Thus, four compared diets of TD_1, TD_2, TD_3, and TD_4 comprised 0, 1, 2 and 3% turmeric powder inclusion, respectively.

Table 1: Gross composition (%) of experimental diets

Ingredients	Treatment Diets			
	TD_1	TD_2	TD_3	TD_4
Wheat offal	50.00	49.00	48.00	47.00
Potato peels	21.50	21.00	20.50	20.00
Pineapple pulp-peel	12.50	13.00	13.50	14.00
Broken groundnut	10.50	10.50	10.50	10.50
Turmeric powder	-	1.00	2.00	3.00
Bone meal	2.50	2.50	2.50	2.50
Vitamin premix	2.00	2.00	2.00	2.00
Common Salt	1.00	1.00	1.00	1.00
Total	**100.00**	**100.00**	**100.00**	**100.00**

Sixteen West African dwarf female sheep of about 6-7 months old with initial average body weight of about 6.00 ± 0.60kg were used for the study. They were adapted for 14 days during which they were adequately treated against ecto and endo-parasites. At the end of this adaptation period, sheep were randomly allotted to four treatment diets that were replicated two times with two animals per replicate in a completely randomized design. Sheep were housed in individual semi-opened pens and diets were given at 5% dry matter of their body weight twice daily. They had free access to drinking water and the study lasted for 84 days exclusive the 14 days adaptation period.

Amount of feeds offered and leftover were weighed and recorded daily for each animal to calculate feed intake. Sheep were weighed at the beginning of the study and subsequently on weekly basis to compute changes in body weight of individual animal. However, fore-stomach sampling was preceded once weekly during the feeding trial. About 40mL of rumen liquor sample was collected from two sheep per treatment using oral stomach suction tube and thrust into the middle part of the rumen through the oesophagus approximately 3hr after the incoming morning feeding. The fluid was monitored visually to ensure that they were not polluted with saliva. Rumen temperature and pH of the fluid was immediately measured using a temperature meter (HANNA instruments HI 8424 microcomputer, Singapore) and portable digital pH meter (Mettler-Toledo Ltd, England) respectively. Thereafter, the liquor was filtered through four layers of cheese cloth to remove the feed coarse particles. The filtered liquor was divided into two equal sub-samples, one of it was acidified with a 1m sulphuric acid solution to measure ammonia nitrogen ($NH_3 – N$) concentration and total volatile fatty acid (VFA) as previously reported by Li *et al.* (2019). The other sub-sample was treated with 2ml of 25% meta-phosphoric acid (prepared 5N sulphuric acid) kept overnight at 4^0C and centrifuged at 584rpm for 15min to measure individual volatile fatty acids using gas chromatography according to the procedures reported by Li *et al.* (2019).

Guinea grass and experimental diets were analysed for proximate composition following the methods reported by AOAC (1990).

Data generated from growth and rumen fermentation parameters were subjected to analysis of variance (ANOVA) and significant difference between means were separated using Duncan's multiple range test (SAS, 2009) .

RESULTS AND DISCUSSION

The proximate composition of Guinea Grass (GG) and Treatment Diets (TD) were indicated in Table, 2. Dry matter content of GG and TD were quite high, explaining better nutrient storage in the feeds. The crude protein value recorded for GG was almost within the critical level of 8% requirement for minimum performance of sheep (Okoruwa *et al.*, 2023). Hence, TD was supplemented to augment the nutrient content of GG. However, the proximate composition recorded for GG was within the values reported by Okoruwa and Ikhimioya (2020).

Table 2: Proximate composition (%DM)of guinea grass and experimental diets

Parameters	Experimental diets				
	GG	TD_1	TD_2	TD_3	TD_4
Dry matter	90.86	92.75	94.03	94.47	94.76
Crude protein	8.57	14.83	14.58	14.36	14.24
Crude fibre	37.04	14.56	14.97	15.08	15.17
Ether extract	7.42	5.73	5.81	6.05	6.23
Ash	2.86	4.82	5.29	5.63	5.98
Nitrogen free extract	34.97	52.81	52.88	53.01	53.05

GG = *Guinea grass*, TD_1 = *0% Turmeric powder*, TD_2 = *1% Turmeric powder,* TD_3 = *2% Turmeric powder,* TD_4 = *3% Turmeric powder*

As seen in Table 3, feed intake was significantly ($p< 0.05$) higher in sheep on test diets (TD_2, TD_3 and TD_4) than the control diet (DT_1). The phytogenic components of turmeric could have probably improved the appetite of the sheep which reflected in their higher feed consumption rate. Final body weight, total and daily weight gains were also found to be significantly better ($p< 0.05$) in sheep on diets with turmeric supplementation as compared with control diet. This implies that test ingredient in the treatment diets had some bioactive properties that promoted feed utilization which reflected in positive change in their body weight gains. However, this higher growth rate noticed in sheep on test diets further explained the ability of the sheep to tolerate the phytogenic nature of turmeric which accounted for effective feed intake and utilization efficiency as expressed in low significant ($p< 0.05$) difference in their feed conversion ratio. The average daily weight gain of sheep obtained in this study was higher than the value of 33.21g/day of sheep fed on herb oil supplementation as reported by Candyrine *et al*. (2019).

Table 3: Growth performance and rumen fermentation parameters of sheep fed experimental diets

Parameters	Experimental diets				
	TD_1	TD_2	TD_3	TD_4	**SEM ±**
Feed intake(g/day)	248.64^{c}	259.28^{b}	260.01^{a}	269.11^{a}	0.97
Initial body weight (kg)	6.94	6.78	6.43	6.23	0.03
Final body weight (kg)	9.68^{c}	9.99^{b}	10.05^{a}	10.11^{a}	0.29
Total weight gain (kg)	2.74^{b}	3.21^{a}	3.65^{a}	3.88^{a}	0.04
Daily weight gain (g/day)	32.62^{c}	38.21^{b}	43.45^{a}	46.19^{a}	0.42
Feed conversion ratio	7.62^{a}	6.79^{b}	5.92^{c}	5.83^{c}	0.06
Rumen fermentation					
Rumen temperature(^{0}C)	38.99	38.79	38.72	38.69	0.59
Rumen pH	6.72	6.78	6.81	6.84	0.08
NH_3-N (mg/dL)	19.23^{a}	14.01^{b}	13.82^{b}	12.11^{c}	0.21
Total VFAs (mmol/L)	94.34^{b}	97.97^{a}	98.92^{a}	99.67^{a}	0.74
Acetate (mol/100mL)	62.04^{a}	60.99^{b}	59.84^{c}	59.52^{c}	0.62
Propionate (mol/100mL)	19.79^{c}	23.48^{b}	24.62^{a}	24.98^{a}	0.38
Butyrate (mol/100mL)	5.82^{a}	3.76^{b}	3.43^{b}	3.25^{b}	0.05

NH_3-N = Ammonia nitrogen, VFAs = Volatile fatty acids

^{a,b,c} Means in the same row with varying superscript differ significantly ($P < 0.05$)..

Remarkable significant differences ($p< 0.05$) were also observed in rumen fermentation parameters except rumen temperature and pH that were not significantly affected ($p> 0.05$) by treatment diets (Table, 3). The rumen temperature and pH obtained in this study were within the normal average range of 38.92^0C and 6.83 respectively, as suggested by Karimizadeh *et al. (*2017) for optimal microbial digestion activity. The significant ($p< 0.05$) reduction in values of rumen ammonia nitrogen concentration registered in sheep on diets with turmeric powder was expected and associated with the activity of secondary metabolites of the plant. This was seen to be advantageous to the animals as they associated with greater rumen escape of microbial protein out flows into the duodenum, this could be probably translated to higher supply of protein for efficient performance ln sheep. Candyrine *et al.* (2019) noted that herb plants provide optimum anti-microbial effect that delay rumen protein degradation for efficient rumen escape of protein that facilitate nutrient retention. The noticeable difference ($p< 0.05$) observed in total VFAs and its fractions in diets were traced to the role of turmeric in rumen manipulation. This reason might attribute to the enhancement of rumen fermentation activities that led to improvement in feed utilization efficiency for higher growth performance. Nguyen *et al.* (2020) noted that slight reduction in acetate and butyrate with high propionate improves energy production for better growth performance in ruminants.

CONCLUSION

Based on study, it can be concluded that supplementation with turmeric powder in diets of sheep improved growth performance and enhanced rumen fermentation parameters.

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