EFFECT OF *Curcuma longa* EXTRACT ON GROWTH PERFORMANCE AND ANTIOXIDANT STATUS OF SHEEP REARED UNDER ELEVATED ENVIRONMENTAL TEMPERATURE IN BIDA, NIGERIA

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ABSTRACT
This experiment was conducted to investigate the growth performance and serum antioxidant capacity using three different concentrations of Curcuma leaf extracts (CLE) included per litre of water in growing male sheep under elevated environmental temperature (32^0 C and relative humidity of 78%). Thirty equalized mixed sex Yankassa breed, aged 8–12-month-old with weight ranged from 16–17kg were randomly divided into five groups in a completely randomized experiment. Treatments comprised of the following: the control group with no extract administration (Control), 1mls CLE, 2mls CLE, 3mls CLE and 5mls Vitamin C representing T1-T5 respectively. The results showed that CLE increased the final weight (FW) and Weight gain (WG) in 3mls CLE group, with the FW increasing with a concomitant increase in CLE concentration. There was no significant improvement of CLE on enzymatic antioxidant's parameters, however, a numeric reduction in the lipid peroxidation values was observed. In conclusion, CLE improved the growth performance in a dose-dependent manner. Further research could be designed to evaluate the enzymatic antioxidant potential using higher extract concentrations
Keywords: Growth, Turmeric, Antioxidant, Ruminants Temperature

INTRODUCTION

Sheep meat and milk were one of the earliest staple proteins consumed by human civilization after the transition from hunting and gathering to agriculture (Moubtahij *et al*., 2024). Sheep have a wide advantage over large ruminants in terms of adaptation, small body size, broad feeding habits, and relatively short reproductive cycle (Joy *et al,* 2020). Milk obtained from sheep is an excellent raw material for the milk processing industry, especially in cheese production. Byproducts from the slaughter of sheep are also of value, such as sheep tallow, used for candle and soap making, sheep bone and cartilage, used to furnish carved items, as well as rendered glue and gelatin. Despite its importance, sheep production is hindered by a lot of factors (Tüfekci and Sejian 2023). High environmental temperature is a major constraint in Sheep production under semi-arid and tropical environment (Van Wettere *et al*., 2024). These adversely result into low productivity in terms of growth, reduced reproductive performance, depressed feed intake and mortality. The use of synthetic pharmaceuticals has also been discovered to have residual effects on the tissue and systems of animals prone to having transference effects on human health. A recent use of ethnobotanicals has been observed as the spur of the moment in livestock production, owing to their local availability, more easily accessible and they represent a cheaper option when compared with western drugs (Odebunmi *et al*., 2022). Turmeric is a perennial herbaceous plant containing curcumin, a substance with powerful anti-inflammatory and antioxidant (Fuloria *et al*., 2022). It has been reported to possess strong antioxidant, antiprotozoal, antivenom, antimicrobial, anti-inflammatory, antiproliferative, antiangiogenic, antitumor and antiaging. Its powder contains approximately 60–70% carbohydrates, 6–13% water, 6–8% protein, 5–10% fat, 3–7% dietary minerals, 3–7% essential oils, 2–7% dietary fiber, and 1–6% curcuminoids (Nelson *et al*, 2017). This has prompted the desire to evaluate the antioxidant potential of *Curcuma longa* L on sheep reared under elevated environmental temperature, in Bida metropolis, Nigeria.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at Ismail Livestock Farm, Bida Town, Bida Local Government of Niger State, a Southern Guinea Savannah ecological zone of Nigeria, with an average daytime temperature of 32^0 C and relative humidity of 78 (9.0797° N, 6.0097° E) located at 142.3 meters above mean sea level.

Collection and Processing of Plant Material

The rhizomes of the *curcumin longa* were collected fresh from Ibadan, Oyo State. The rhizomes of *curcumin longa* that were rinsed with distilled water and then air-dried at room temperature (23^{0}C) for twenty – one days. The dried rhizomes were then grounded into a powdery form, using a grounding machine and kept in an air tight container till use. The grounded portion weighed 150g.

Extraction Procedure

150g of dried powdered of *Curcumin longa* was infused in hot (95^0C) distilled water at ratio 1:20 (w/v). The infusion was left overnight under refrigeration (4^0C) to prevent any possible contamination. After 18 hours, the extracts were loaded on rotary shaker at 100rpm for 1.5 hours. Then the extract was centrifuged at 1006.2g for 5 minutes. Extract was filtered with whatman No 1 filter paper and subsequently subjected to lyophilization at – 47.5^0C. The frozen extract was then freeze dried to a powder, weighed and preserved at -4^0C for future use. Freeze dried sample was later reconstituted for experimental administration. Extraction was prepared using the modified methods of Olivia case (2005) and Njume *et al* (2011).

Administration of the Extract

Sheep assigned to treatment (One) 1 received ordinary clean water, those in treatment 2, 3 and 4 were given 1, 2 and 3mls of *Curcumin longa* rhizome extract per litre of water respectively and for sheep in treatment 5 received 5mls of Vitamin C (0.1g/1000mls). The extracts were administered three times in a week at an interval of two days throughout the period of the experiment.

Experimental Animals and Management

Thirty Yankassa breed of sheep (fifteen male and fifteen female) with age ranging between 8-12 months old, were purchased from a reputable farm in Bida for the experiment. The weights of the sheep ranged from 16–17kg. the sheep were acclimatized for fourteen (14) days in separate pens for physiological adjustment to the environment. Six (6) animals were randomly assigned to each treatment, replicated thrice, with two (2) animals per replicate. Roughage, concentrate and pasture was fed to the sheep in proportion to their body weight gain per day with *ad libitum* clean water supply in a 8-week experimental period. Standardized pen for small ruminant experimental studies were constructed for the experiment. A heating device was included in each pen to maintain the temperature at 40 ±2ºC throughout the period of the experiment. Digital thermometer was affixed to the pens to monitor the temperature and humidity of the micro-environment of the study area.

Chemical Analysis

The proximate analysis of *Curcumin longa* sample was determined chemically according to the official methods of analysis described by the Association of Official Analytical Chemistry (AOAC, 18th Edition, 2005). The *Curcumin longa* rhizome extract was also subjected to phyto chemical screening. Qualitative tests were carried out on the powdered sample of *Curcumin longa* using standard procedures to identify the phytochemical constituents as described by Sofowora (1993), Trease and Evans (1989) and Harborne (1973).

Experimental Design And Statistical Analysis

The experiment was a completely randomized design (CRD). All data collected was analyzed using one way analysis of variance (ANOVA) using SPSS software package, the mean was separated using Duncan Multiple Range Test (Duncan, 1955) at 5% significant level.

RESULT AND DISCUSSION

Table 1 show the result of proximate analysis of *Curcumin longa* root. This result showed that *Curcumin longa* contains; moisture (11.45%), ash (8.20%), CHO (43.12%), caloric value of 3917.7KJ/mole, crude fibre (2.84%), 16.38% crude fat and 18.11% crude protein. The result obtained might vary in comparison with other recorded values, probably due to differences in their geographical location, stage of plant, soil types and weather condition of the place and the plant source. The result of the phytochemical screening of *Curcumin longa* is shown in Observation shows that similar value was recorded for saponin and Phenolics)0.004mg/100g), flavonoid and Coumarine also had values 139.92 mg/kg and (20.35 pmol/kg) respectively.

Table 1: Proximate and Phytochemical screening of *curcumin longa*

Parameters	Moisture (%)	Ash (%)	CHO (%)	Calorific value (kj/Kg)	DM (%)	EE(%)	Crude Fibre (%)	CP (%)
Values	11.45	8.20	43.12	3917.7	88.35	16.38	2.84	18.11

Phytoconstituents	Saponin (mg $100g^{-1}$)	Phenolics (mg/100g)	Flavonoids (mg/kg	Coumarine (pmol/kg)
Value	0.0004	0.0004	139.92	20.35

DM- Dry Matter, EE-Ether Extract, CHO-Carbohydrate, CP-Crude Protein

The growth performance of the experimental sheep administered with CLE is as shown in Table 2. Amongst growth performance parameters highlighted, the final weight and weight gain were noticeably significant ($p>0.05$) across the treatments. 3mls CLE sheep recorded the significantly highest FW and WG, while the lowest values were observed in the control (0.0) and 1.0 mls CLE

Table 2: Growth Performance of sheep given *Curcumin longa* extract in the tropics

Treatments	0.0 (Control)	1mls CLE	2 mls CLE	3 mls CLE	5mlsVit C	SEM
IW (kg)	16.50	16.67	16.17	16.50	16.50	0.23
Fw (kg)	19.50[b]	19.92 [b]	20.67 [ab]	21.98 [a]	20.67 [ab]	0.19
FI (kg)	21.93	21.93	21.83	21.93	21.08	1.09
WI (mls)	56.00	56.00	56.00	56.00	56.00	1.05
WG (kg)	3.00	3.25 [b]	4.50 [ab]	5.48 [a]	4.17 [ab]	0.30
FCR	7.31	6.75	4.85	4.00	5.06	0.32

IW = Initial Weight FW= Final Weight FI= Feed Intake WI=Water intake WG=Weight Gain FCR= Feed Conversion Ratio TE = Turmeric extract, VC = Vitamin C

Table 3 shows the influence of CLE on the antioxidant status of sheep been used for this experiment. The lipid peroxidation (MDA) and GPx values were not significantly influenced across the treatments. However, significant difference occurs ($P<0.05$) in the SOD, Serum CAT and cortisol levels across all treatments. The SOD and CAT levels were increased in 5mls Vit C. treatment and lowest in cortisol concentration compared to other treatment groups

Table 3: Antioxidant capacity and cortisol concentration of sheep given *Curcumin longa* extract

Parameters	Treatments					
	0.0	1ml CLE	2mls CLE	3mls CLE	5mlsVit.C	SEM
SOD (u/l)	62.64[b]	65.19[b]	67.42[b]	60.08[b]	72.42[a]	12.64
MDA (u/l)	0.52	0.52	0.46	0.49	0.61	0.02
GPx (u/l)	288.48	329.16	259.67	299.81	410.61	25.96
Serum CAT (u/l)	334.11[b]	312.10[bc]	154.03[c]	144.73[c]	721.52[a]	59.70
Cortisol (u/l)	190.88[a]	148.55[ab]	93.74[bc]	79.84[bc]	6.47[c]	20.05

Means bearing different superscript in the same row differ significantly ($P<0.05$). CLE= ***curcumin longa* extract.** Vit C = Vitamin C, SOD = Superoxide dismutase, MDA = Lipid peroxidation, GPx = Glutathione peroxidation

DISCUSSION

Supplementation of antioxidants is one of the nutritional strategies to combat heat stress in animals. Antioxidants are compounds or systems that delay autoxidation by inhibiting the formation of free radicals or by interrupting propagation of the free radical by several mechanisms (Chaudhary et al., 2023). Oxidative stress reflects an in balance between the systemic manifestation of reactive oxygen special (ROS) and biological system's ability to readily detoxify the reactive intermediates or to repair the resulting damage. Improving the enzymatic (SOD GPx etc) and non-enzymatic antioxidants (Vitamin C and E) levels in heat stressed animals provides intracellular and extracellular aqueous phase antioxidant capacity primarily by scavenging oxygen free radicals via donating proton to membrane lipids while protecting them from oxidant attacks. The weight gain in this study increases with increased concentration of the CLE. This could be attributed to the phytonutrients present in *Curcumin longa* such as curcumin, demethoxycurcumin, bisdemethoxycurcumin and volatile oils, several phenolic compounds and flavonoids. These compounds and essential nutrients function to boost the antioxidant enzymatic performance and to minimize cellular damage caused by endogenous peroxides (El-Shahat and Abdel Monem, 2011). Previous research by Antonise et al. (2018) revealed that dietary *Curcumin longa* promotes the digestibility of neutral detergent fiber to increase milk production and growth. The result obtained in this study is congruent with the findings recorded by Tian et al. (2023) who noted an increased average daily weight gain (ADG) after administering curcumin at 300mg/kg in growing lambs. Cortisol is the primary glucocorticoid a stress hormone found in livestock which measures the extent of environmental assault an animal is exposed to. This might be possibly because of its anti-inflammatory properties which help to lower cortisol levels. Studies by Sureshbabu et al. (2023) have shown that dietary supplementation with turmeric can significantly reduce the levels of stress hormone in animals. It also improved immune function turmeric can also support a healthier immune system. An improved oxidative performance was discovered to have been enhanced by non-enzymatic

antioxidants (Vitamin C) in this study and the CLE revealed a depression in the enzymatic antioxidant. This could mean that the maximum concentration of CLE used in this study (3mls CLE) was too low to exhibit an enzymatic antioxidant improvement compared to the 5mlsVit C treatment.

CONCLUSION

The result showed that CLE improved the growth performance in a dose-dependent manner, however, further research could be designed to evaluate the enzymatic antioxidant potential using higher extract concentrations

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