

Effects of Turmeric Powder Treated Diets on Physiological Performance and Haemato-biochemical Parameters of West African Dwarf Bucks

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Abstract

This study investigated the effect of graded levels of Turmeric powder diet on physiological performance and haemato-biochemical parameters of West African Dwarf Buck (WAD). Thirty (30) WAD bucks were randomly assigned to five treatments (A, B, C, D and E) in a completely randomized design for a period of eight weeks. Animals were given diets containing 0, 2, 4, 6 and 8g turmeric powder/kg feed. Animals were weighed and blood samples collected at the beginning of the experiment and subsequently forth nightly before the end of the experiment for haematology and serum-biochemical assay. Other body parameters such as Body weight (BW), Height at Withers (HW), Body Length (BL) were measured. All data collected were analyzed using the General Linear Model procedure of Statistical Analysis software. Significant means were separated using Duncan's Multiple Range Test of the same software. Results obtained showed significant ($p<0.05$) improvement in feed intake, feed conversion ratio (FCR) and weight gain. The nutrient digestibility test showed a significant increase ($p<0.05$) in crude fat, nitrogen free extract (NFE) and acid detergent fibre (ADF) with increase in turmeric powder levels in the diet. The blood

parameters also showed significant improvement in red blood cells, albumins, white blood cells and a reduction in blood glucose, urea, calcium and sodium levels with continuous increase in turmeric supplementation while potassium increased. The liver enzymes alkaline phosphatase (ALP) and alanine aminotransferase (ALT) were significantly reduced while aspartate aminotransferase (AST) increased with increased supplementation with turmeric powder. It is concluded that turmeric powder should be supplemented at a moderate level as too high levels could lead to loss of other nutrients (glucose, calcium and sodium) while increasing others (potassium). It is therefore recommended that 6g of turmeric powder per kg basal feed should be incorporated for better performance of West African Dwarf Buck.

Keywords: Turmeric powder, West African Dwarf buck, Growth performance

1.0 Introduction

West African dwarf (WAD) goats are native to tropical Africa and are reared in the humid rainforest belt of Nigeria (Hadjipanayiotou *et al.*, 2009; Amao *et al.*, 2021). This is due to their trypanotolerant and hardy nature. The goat is slow maturing, but often gives birth to twins and triplets when well managed (Herrera *et al.*, 2020). It is prone to health issues under intensive management with reduced reproduction and increased mortality. This may be as a result of non-balanced diet and poor health management due to non-availability of necessary therapeutic and prophylactic medications when diseases arise (Anaeto *et al.*, 2009). This elicits the desire for phytomedication for prophylactic management of the animal for improved growth performance and animal health.

Turmeric (*Curcuma longa*), characterized by distinctive rhizomes, is a well-known in traditional medicine for the management of various stress induced diseases. This remarkable plant has been employed in the treatment of numerous medical conditions such as fever, inflammation, wounds, infections, dysentery, arthritis, injuries, trauma, jaundice, and other liver issues (Lal, 2012; Verma *et al.*, 2018). Its active principles-curcumin and curcuminoids, has extraordinary molecular structure which shows strong antioxidative and anti-inflammatory properties. Curcumin acts as a scavenger of harmful free radicals and contributes to the reduction of cellular oxidative stress. This antioxidant capability is believed to protect cells and tissues from damage associated with various chronic diseases (Aggarwal *et al.*, 2013). Research has explored the various curcuminoids present in turmeric and their potential impacts on human health (Hewlings and Kalman, 2017).Turmeric's potential role in supporting joint health, cognitive function, and cardiovascular well-being has garnered attention (Gupta *et al.*, 2013; Chuengsamarn *et al.*, 2014). It also contains a diverse array of phytochemicals such as turmerones, essential oils, and polysaccharides. These compounds contribute to the unique flavor, aroma, and potential biological activities of turmeric. Studies have explored the chemical composition and potential health effects of these lesser-known phytochemicals (Aggarwal *et al.*, 2013; Suresh and Srinivasan, 2021).

The present research therefore aims to evaluate the effect of graded levels of turmeric powder diets on the physiological performance and heamato-biochemical parameters of West African dwarf bucks.

2.0 Materials and Methods

2.1 Location of the Study

The feeding trial was conducted from the month of February – May, at the University of Ilorin Teaching and Research farm located (14° N 11° E) in sub-humid tropical environment with an annual rainfall range of 1500-1700 mm and average maximum and minimum temperature readings of 18°C and 25°C respectively (KWSG, 2017).

2.2 Experimental Design and Processing of *Curcuma longa* powder for Inclusion in Concentrate Diet

Curcuma longa rhizomes were collected in University of Ilorin Teaching and Research farm, the rhizomes were air-dried at a room temperature, cleaned and ground using an electric blender LG^R model.

Thirty (30) adult male West African Dwarf goats with initial weights of between 10.63 and 12.50kg were divided into five groups, balanced for body weights. The goats were assigned to five dietary groups in a completely randomized design A, B, C, D and E (Table 2.1) containing 0, 2, 4, 6 or 8g *Curcuma longa*/kg feed. The concentrate was fed at 2% equivalent of the body weight (Elamin *et al.*, 2016) in two equal rations (0800 and 1600 hours) daily as supplement to basal *Panicum maximum* hay (9.18% CP). Goats were housed individually in concrete floored pens (1 x 1.5m²) for 56days, with regular supply of water. The goats were treated against external and internal parasites before the commencement of the feeding trial.

2.3 Collection of Samples and Analyses

Body weight and other physiological measurements were recorded prior to early morning feeding on the first day of the 56-day feeding trial and subsequently at 14-day intervals. The difference between two consecutive measurements was used to estimate body weight gain over the interval period. Blood samples were collected through the jugular vein from individual goats into plain and ethylene diaminetetracetic acid (EDTA) coated bottles for serum biochemical and haematology assay respectively. Blood collected was put into plain bottles, taken to the laboratory and centrifuged at 1200xg for 20 minutes for serum using Minifuge RF, Heraeus, and Hannover, Germany. Separated serum was stored frozen at -4°C until assayed. Serum components were measured by an auto analyzer (Hitachi 747, Boehringer Mannheim, Madrid, Spain) which followed the principles of enzyme linked immuno sorbent assay, ELISA kit (Lifespan Biosciences, Inc). Samples of feeds and orts were composited every two weeks, oven dried (60° C) to constant weights and allowed to air-equilibrate before being ground to pass through 1-mm sieve. About 10% of the ground feed and orts

samples were preserved for later dry matter and proximate analyses. Preserved feed and faeces subsamples were analyzed for dry Kjeldahl nitrogen, crude fibre, ether extracts and total ash (Van Soest, 1991; AOAC, 2005).

Empirical data were subjected to analysis of variance of a completely randomized design experiment using SAS (statistical Analysis software) package, 2015 model. Differences between treatment significant means was separated using Duncan's Multiple Range Test of the same model.

Table 2.1: Composition of the basal experimental feed

Ingredients, %	Dietary Treatment Groups				
	A	B	C	D	E
Brewer's Dried Grains	50.00	50.00	50.00	50.00	50.00
Wheat offal	16.50	16.50	16.50	16.50	16.50
Palm Kernel Cake	20.00	20.00	20.00	20.00	20.00
Corn Bran	8.00	8.00	8.00	8.00	8.00
Oyster Shell	4.75	4.75	4.75	4.75	4.75
Salt	0.50	0.50	0.50	0.50	0.50
Vitamins	0.25	0.25	0.25	0.25	0.25
TOTAL	100.00	100.00	100.00	100.00	100.00
Turmeric powder, g	0.00	2.00	4.00	6.00	8.00
Proximate composition of feed (%)					
Dry matter	92.92	93.90	94.70	92.16	91.14
Crude Protein	17.85	18.47	14.68	14.79	14.87
Crude fibre	22.33	22.11	20.69	21.70	21.30
Crude fat	4.63	4.70	5.76	5.35	5.94
Nitrogen-free extract	30.66	30.07	40.85	33.10	33.05
Ash	17.48	18.05	12.73	16.52	16.98

A - 0g of Turmeric per kg of basal feed; B - 2g of Turmeric per kg of basal feed; C - 4g of Turmeric per kg of basal feed; D - 6g of Turmeric per kg of basal feed; E - 8g of Turmeric per kg of basal feed.

3.0 Results

Table 3.1 shows the Effects of graded levels of turmeric on the growth performance of WAD bucks. There were significant differences ($p < 0.05$) in all the parameters studied. The inclusion of turmeric in the diet of WAD bucks significantly ($p < 0.05$) increased the feed intake and weight gain as the level of turmeric was increased. Goats fed 6g of turmeric powder per kg basal feed had improved feed conversion ratio, although it was not lower than the control.

There were significant differences ($p < 0.05$) in the nutrient digestibility of animals fed turmeric powder diets (Table 3.2). There was significant improvement in dry matter, crude protein, crude fat, nitrogen free extract and acid detergent fibre (ADF) digestibility. ADF digestibility significantly improved with increase in turmeric powder administration while the neutral detergent fibre significantly decreased.

The effects of graded levels of turmeric powder diets on haematology parameters of West African dwarf bucks are shown in Table 3.3. The inclusion of turmeric powder in the diets significantly affected ($p < 0.05$) the values of the packed cell volume (PCV), haemoglobin (Hb), red blood cell (RBC), white blood cell (WBC), and mean corpuscular volume (MCV). There was significant reduction in Hb, WBC and MCV while PCV and RBC gradually improved with increase in turmeric powder supplementation.

Table 3.1: Effects of graded levels of turmeric powder diet on growth performance of West African Dwarf Bucks

Parameters	Dietary Treatment Groups					SEM \pm	P-Value
	A	B	C	D	E		
IW kg	7.67 ^c	9.33 ^a	8.67 ^b	7.33 ^{cd}	7.00 ^d	0.12	<.0001
FW kg	9.00 ^{ab}	10.17 ^a	9.50 ^{ab}	8.85 ^{ab}	8.33 ^b	0.30	0.013
WG kg/goat/day	0.01 ^a	0.004 ^b	0.004 ^b	0.01 ^a	0.01 ^a	3.27x10 ⁻⁴	<.0001
FI	0.38 ^{ab}	0.35 ^b	0.36 ^b	0.44 ^a	0.45 ^a	0.02	0.003
FCR	48.10 ^e	83.33 ^b	85.71 ^a	55.00 ^d	67.16 ^c	0.22	<.0001

^{a, b, c, d, e} Means with difference superscript along the same row for each parameter are significantly different ($p < 0.05$); IW, initial weight; FW, final weight; WG, weight gain; FI, feed intake; FCR, feed conversion ratio; SEM, Standard error of mean; A - 0g of Turmeric per kg of basal feed; B - 2g of Turmeric per kg of basal feed; C - 4g of Turmeric per kg of basal feed; D - 6g of Turmeric per kg of basal feed; E - 8g of Turmeric per kg of basal feed.

Table 3.2: Effects of Turmeric powder diets on nutrient digestibility of West African Dwarf Bucks

Parameters (%)	Dietary Treatment Groups					±SEM	P-value
	A	B	C	D	E		
Dry matter	7.28 ^b	8.45 ^a	7.20 ^b	6.28 ^c	5.16 ^d	0.18	<.0001
Crude protein	9.34 ^b	10.39 ^a	7.04 ^c	7.32 ^c	6.92 ^c	0.19	<.0001
Crude fat	1.17 ^b	1.26 ^b	2.26 ^a	1.81 ^{ab}	1.81 ^{ab}	0.15	0.0025
Crude fibre	2.87 ^a	2.95 ^a	3.40 ^b	3.45 ^b	3.60 ^b	0.24	<.0001
Ash	8.67 ^a	9.07 ^a	2.91 ^c	6.43 ^b	5.67 ^b	0.22	<.0001
NFE	8.70 ^d	0.33 ^d	0.39 ^a	0.83 ^c	0.89 ^b	0.18	<.0001
ADF	77.83 ^d	89.62 ^c	91.80 ^b	93.01 ^b	96.00 ^a	0.42	<.0001
NDF	22.00 ^a	10.38 ^b	8.20 ^c	6.99 ^c	4.00 ^d	0.40	<.0001

^{a, b, c, d} Means with difference superscript along the same row for each parameter are significant different ($p < 0.05$); NFE; nitrogen free extract; ADF, Acid detergent fibre; NDF, neutral detergent fibre; SEM, Standard error of mean; A, 0g of Turmeric per kg of commercial feed; B, 2g of Turmeric per kg of commercial feed; C, 4g of Turmeric per kg of commercial feed; D, 6g of Turmeric per kg of commercial feed; E, 8g of Turmeric per kg of commercial feed.

Table 3.4 shows the serum biochemical parameters of WAD bucks fed varying levels of turmeric powder diets. There were significant differences ($p < 0.05$) in all the serum biochemical parameters measured across all treatments except in globulin, creatinine, and bilirubin. There were significant increases in total protein, glucose, aspartate aminotransferase (AST) and potassium while albumin, alkaline phosphatase (ALP), alanine aminotransferase (ALT), urea, calcium and sodium gradually decreased after the initial increase as the levels of turmeric inclusion was increased.

4.0 Discussion

Graded levels of Turmeric were incorporated into the diet of animals to improve growth performance. Growth performance is a significant component key to the production system of ruminants. Thus, it is necessary to supplement basal feed with additives for balanced nutrients and growth stimulation for enhanced metabolic and productive processes (Pallauf and Muller, 2006). The improvement in weight gain with increased supplementation of turmeric powder might be as a result of the nutrients and phytochemical constituents of turmeric powder. It has been inferred to promote growth and enhance health status of lambs with a +1.5% turmeric powder (Verma *et al.*, 2018).

Table 3.3. Effects of graded levels of turmeric powder diets on haematology parameters of West African Dwarf Bucks

Parameters	Dietary Treatment Groups					±SEM	P value
	A	B	C	D	E		
PCV, %	34.84 ^a	21.14 ^b	23.63 ^{ab}	24.63 ^{ab}	28.11 ^{ab}	2.89	0.054
Hb, %	9.45 ^a	8.68 ^{cb}	9.02 ^b	8.76 ^b	8.35 ^c	0.08	<.000
RBC, ×10 ⁶ /ml	10.10 ^b	12.06 ^a	12.03 ^{ab}	11.21 ^{ab}	11.09 ^{ab}	0.42	0.043
WBC, ×10 ⁶ /ml	13.50 ^a	7.84 ^b	8.37 ^{ab}	7.62 ^b	7.41 ^b	1.13	0.016
MCH, pg	9.36	7.20	7.50	7.81	7.52	1.75	0.909
MCV, fl	34.50 ^a	17.53 ^b	19.64 ^b	22.27 ^b	25.32 ^{ab}	2.58	0.007
MCHC, %	28.99	41.06	38.17	35.08	29.70	2.89	0.057

^{a, b, c} - Mean with different superscripts along the same row differ significantly (p<0.05); SEM – Standard error of mean; Hb - Haemoglobin; PCV - Packed cell volume; RBC - Red blood cell; WBC - White blood cell; MCH -Mean corpuscular haemoglobin; MCV -Mean cell volume; MCHC -Mean corpuscular haemoglobin concentration ; A - 0g of Turmeric per kg of basal diet; B - 2g of Turmeric per kg of basal diet; C - 4g of Turmeric per kg of basal diet; D - 6g of Turmeric per kg of basal diet; E - 8g of Turmeric per kg of basal diet.

It was also observed that there was a relationship between feed intake and weight gain as there was improved intake after the initial depression. This must have resulted in the improved weight gain observed in the latter treatments similar to the report of Okukpe *et al.* (2024) with *Vernonia amygdalina* leaves. These must have necessitated the improvement in the feed conversion ratio (FCR) observed in the treatments with higher inclusion of turmeric powder. This supports the report of Ogunbosoye *et al.* (2018) that feed supplementation could improve feed conversion ratio in ruminants. The significant decrease in dry matter digestibility as the level of turmeric supplementation increased may be attributed to the presence of secondary metabolites in turmeric such as tannins which can negatively affect nutrient digestibility in ruminants (Kumar *et al.*, 2017). The reduction in dry matter digestibility could potentially limit the overall nutrient intake and utilization by the WAD bucks.

Table 3.4. Effects of graded levels of turmeric powder diets on serum biochemical parameters of West African Dwarf Bucks

Parameters	Dietary Treatment Groups					±SEM	P value
	A	B	C	D	E		
Total	7.50 ^a	7.35 ^b	7.02 ^c	6.88 ^d	6.15 ^e	0.022	<.0001
Protein (g/l)							
Albumin (g/l)	3.00 ^{ab}	3.06 ^a	2.96 ^{ab}	2.94 ^b	2.73 ^c	0.022	<.0001
Globulin (g/l)	0.35	0.33	0.33	0.33	0.32	0.022	0.9032
Glucose (mg/dl)	45.00 ^b	45.54 ^a	44.73 ^c	44.73 ^d	43.86 ^e	0.024	<.0001
ALP (iu/l)	85.20 ^b	86.01 ^a	84.78 ^c	84.78 ^c	81.05 ^d	0.021	<.0001
ALT (iu/l)	26.50 ^a	26.53 ^a	25.31 ^b	25.17 ^c	24.76 ^d	0.023	<.0001
AST (iu/l)	34.50 ^d	34.50 ^d	34.99 ^c	35.12 ^b	36.70 ^a	0.021	<.0001
Creatinine (µmol/l)	0.30	0.31	0.32	0.32	0.33	0.022	0.8901
Bilirubin (mg/dl)	0.05	0.04	0.04	0.04	0.03	0.022	0.9784
Urea (mg/dl)	9.00 ^b	9.84 ^a	8.86 ^c	8.81 ^c	7.89 ^d	0.022	<.0001
Calcium (mmol/l)	2.00 ^b	2.21 ^a	1.96 ^b	1.93 ^b	1.55 ^c	0.022	<.0001
Potassium (mmol/l)	3.00 ^d	3.13 ^c	3.23 ^{bc}	3.25 ^b	3.77 ^a	0.022	<.0001
Sodium (mmol/l)	125.0 ^b	125.44 ^a	124.76 ^c	124.52 ^d	123.89 ^e	0.022	<.0001

^{a, b, c, d, e} Means with difference superscript along the same row for each parameter are significant different (p<0.05); ALP, Alkaline phosphatase; ALT, Alanine transaminase; AST, Aspartate transaminase; SEM, Standard error of mean; A, 0g of Turmeric per kg of commercial feed; B, 2g of Turmeric per kg of commercial feed; C, 4g of Turmeric per kg of commercial feed; D, 6g of Turmeric per kg of commercial feed; E, 8g of Turmeric per kg of commercial feed.

Similar to dry matter, the digestibility of crude protein significantly decreased with increasing turmeric supplementation. This finding aligns with the results of previous studies (Jiao *et al.*, 2019), which suggest that turmeric compounds can reduce the availability of protein in the rumen, possibly due to their antimicrobial properties. This decrease in protein digestibility may have implications for the growth and overall performance of the bucks.

The NDF and ADF digestibility patterns were interestingly divergent. NDF digestibility significantly decreased across treatment groups from A to E, indicating that turmeric supplementation negatively impacted the utilization of neutral detergent fiber. In

contrast, ADF digestibility increased significantly from A to E. This contrasting response may be due to the complex interactions between turmeric compounds and the rumen microbiota, which can influence fiber digestion differently (Zhang *et al.*, 2020). Turmeric has been reported to influence lipid metabolism and lipid absorption in the digestive tract (Panahi *et al.*, 2016), which may explain the observed differences in crude fat digestibility. The significant decrease in ash digestibility at treatment C warrants further investigation, as it may reflect changes in mineral utilization.

Haematology values could serve as baseline information for comparison in condition of nutrient deficiency, physiology and health status of farm animals (Daramola *et al.*, 2005). Blood cell serves as a carrier of haemoglobin which helps to transport oxygen to tissues of the animal for oxidation of ingested feed so as to release energy for other body functions (Ugwuene, 2011). The haemoglobin range reported herein was within the physiological ranges of 7-15g/dl for clinically healthy WAD goats reported by Opara *et al.* (2011). The increase in the Packed Cell Volume from 2 - 8g of tumeric shows better transportation and thus results in an increased primary and secondary polycythemia. It was within the range reported for clinically healthy WAD goats (Daramola *et al.*, 2005). The biological active compounds in the treatment diets may have improved nutrition utilization or oxygen-carrying capacity of the blood, resulting in improved PCV at the end of the trial. The red blood cells were within the physiological ranges 9.2- 13.5g/l reported by Olaifa and Opara (2011) which indicated that the diets supported good health status and hence the animals were unlikely to suffer from anaemia-related problems. The MCV and MCHC values were significant with increase in 2 to 8 of tumeric in MCV, and MCHC differed with control having the lowest value and 2g having the highest value. The non- significant effects observed in this study for MCH values are in agreement with Carew (2018) for WAD goats fed fungal treated rice straw, this implies that the nutritional quality of the diets was not impaired. The normal range for RBC differentials reported in this investigation demonstrated the absence of anaemia among the experimental goats. The WBC was within the normal physiological range reported by Daramola *et al.* (2005).

Serum parameters have been reported to be important in the proper maintenance of the osmotic pressure between the circulating fluid and the fluid in the tissue space so that the exchange of materials between the blood and cell could be facilitated (Ogunbosoye *et al.*, 2018). All the parameters measured were significantly different ($p < 0.05$) except for globulin, creatinine, and bilirubin. The observed values for total protein were within the normal ranges reported by Babale *et al.* (2019). A high level of serum urea has been attributed to excessive tissues protein catabolism associated with protein deficiency (Opara *et al.*, 2011). Therefore, the result of this study shows that there was no sign of protein deficiency exhibited by the WAD used in the study. Serum albumin and serum glucose values were significantly different at ($p < 0.05$) with treatment B and A having significantly higher values. These values were within the range reported by Opara *et al.* (2010) and Adegbeye *et al.* (2021).

These observed ranges for serums calcium, potassium and sodium were within the range reported by Ikhimioya and Imasuen (2007). Although the serum calcium and potassium values were lower than that reported by Shittu *et al.*, (2016), this could be attributed to the high feeding regime and the potential of turmeric to enhance mineral absorption and regulation (NRC, 2007; Gupta *et al.*, 2020).

The liver enzymes (ALP, ALT and AST) were significantly influenced by the diet. This could be due to the phytochemical compounds present in turmeric which had been reported to improve health and physical well-being of animals when administered within the right limit and route (Opara *et al.*, 2011). The activities of ALT and AST reflect the integrity of hepatocytes and are often used as indicators of liver injuries/infarction. This is because, when liver damages occur, there is leakage of some of these organ specific enzymes beyond the concentration expected in the blood. Although these enzymes are available in the blood at a level, undue increases could suggest a liver damage especially with ALT enzyme (Adegbeye *et al.*, 2021).

The bilirubin and globulin observed value ranges did not fall within the recommended ranges reported by (Opara *et al.*, 2011). Bilirubin formation is often due to the activity of the liver in removing toxic elements in haemoglobin destruction in the body. Turmeric powder must have reduced the destruction of haemoglobin by enhancing haemoglobin performance in the body.

5.0 Conclusion

Dietary supplementation of turmeric powder significantly influenced the digestibility parameters in West African Dwarf bucks. These findings highlight the importance of considering the potential impact of turmeric on nutrient utilization when incorporating it into livestock diets. It can be concluded that supplementing WAD feed with turmeric up to 6g will not pose any health risk to the animals since the parameters measured in the blood of the animals under the study conditions, were within normal blood range for a healthy animal. Future research should delve deeper into the mechanisms behind these effects and assess the long-term implications for animal performance and health.

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