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Biochem. Cell. Arch. Vol. 21, No. 2, pp. 3025-3032, 2021	www.connectjournals.com/bca	*ISSN 0972-5075*
DocID: https://connectjournals.com/03896.2021.21.3025		*eISSN 0976-1772*

INFLUENCE OF GRADED LEVELS OF TURMERIC (*CURCUMA LONGA*) AS FEED ADDITIVES ALTERNATIVES TO PROMOTE GROWTH AND ENHANCE HEALTH STATUS IN LAMBS

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(Received 10 May 2021, Revised 9 July 2021, Accepted 18 July 2021)

ABSTRACT : The study objective was for investigating the influence of feeding graded levels of turmeric on growth performance, nutrient intake and nutrient digestibility haematology and serology indices. In the current study, sixteen entire male lambs aged 3-4 months were used, with 13.56 ± 0.4 kg as average primary body weight (BW). The lambs were allocated to one of four experimental diets, without additive control diet (T_1); concentrate mixture +1% Turmeric powder (T_2); concentrate mixture +1.5% Turmeric powder (T_3) and concentrate mixture +2% Turmeric powder (T_4). Lambs received daily concentration at 1% BW plus ad libitum lucerne hay + urea-treated wheat straw up to 90 d. The results indicated that dietary turmeric supplements with 1% and 2% DM could increase significantly (P<0.05) in final BW gain and average daily weight gain (DWG) compared with T_3 and control diet. Diets showed a significant improvement (P<0.05) on feed conversion ratio (FCR) in T_2 and T_4 in comparison to the control diet. In this study, the haematological and serology indices are indicated by significant increase (P<0.05) in RBC, Hb albumin, globulin and HLDL. In conclusion, supplementation of turmeric up to 2% DM concentrate has improved lambs' growth performance and health status.

Key words : Turmeric (*Curcuma longa*), lambs, growth performance, haematological and biochemical analysis.

How to cite : Kifah J. Odhaib, Nadhim M. Jawad Ali, Hanaa Alameer and Nameer A. Khudhair (2021) Influence of graded levels of turmeric (*Curcuma longa*) as feed additives alternatives to promote growth and enhance health status in lambs. *Biochem. Cell. Arch.* **21**, 3025-3032. DocID: https://connectjournals.com/03896.2021.21.3025

INTRODUCTION

In recent years, one of the feeding techniques to improve products of ruminant suitability and yields like milk and meat has been used phytogenic additives; as a result, the use of natural substances has a beneficial influence on the health of humans (Karásková *et al*, 2015). Wencelová *et al* (2015) found that herbs being medicinal and their extracts comprising essential oils, polyphenols, flavonoids, saponins, and other secondary metabolites can boost ruminal fermentation and metabolism. Consequently, using herbal plants to feed ruminants has become very popular. However, the use of plants with nutraceutical properties must be investigated (Garca-Hernández *et al*, 2017) as synthetic promoters of growth replacements (FrAnKI *et al*, 2009; Khan *et al*, 2016). Additionally, Because of the composition and secondary metabolites, different action mechanisms and the optimum dose for every physiological case, every additive of feed plant should be evaluated (FrAnKI *et al*, 2009; Mendel *et al*, 2017). Nonetheless, the findings are generally less consistent. Thus, more research is required in various production systems to make informed decisions about using herbs in ruminant nutrition as natural feed additives. Turmeric (*Curcuma longa*) as natural feed additives are examples of medicinal herbs in animal nutrition.

Turmeric, also known as *Curcuma longa* is a Zingiberaceae (ginger) family perennial herb widely cultivated in Asian countries. Rhizomes are the plant portion that is medicinally utilized as powder being yellow that is utilized as a flavouring in several foods and as a medicine for treating various diseases, especially as an anti-inflammatory and for flatulence treatment, haemorrhage, hematuria, jaundice and as an ointment for treating various diseases of the skin. Several volatile oils, *i.e.*, atlantone, zingiberone, tumerone and flavonoid

curcumin (diferuloylmethane) are the active turmeric ingredients. Portions of curcumin and turmeric are of high activity as antioxidants compared to vitamins E and C in both fat and water-soluble extracts. The hepatoprotective properties of turmeric are primarily due to its antioxidant properties, which increases cellular resistance to oxidative damage and reduces the output of proinflammatory cytokines (Labban, 2014). Thomas *et al* (2020) showed that the final BW has significantly increased in 0.5 per cent turmeric supplemented group (T_2) followed by T_6 (0.5% turmeric and ginger supplemented group) and T_5 (0.75% ginger supplemented group), while the lowest BW was observed in control and T_3 (0.75% turmeric supplemented group) in Gramapriya chicks.

Most preceding studies investigated the haematological and biochemical modifications caused by turmeric in monogastric animals (Guil-Guerrerro, 2017), while in ruminants, less work has been done. Since turmeric is a promising feed additive due to its known nourishing and protective effects, the purpose of this research was to inspect the influence of different turmeric levels on growth performance, digestibility and intake of nutrients and blood haematological parameters in lambs

MATERIALS AND METHODOLOGY

Animals and experimentation design

In the current work, sixteen entire male lambs of 3-4 months age were used; with 13.56 ± 0.4 kg initial BW as average. All lambs were held in separate pens measuring 1.5 m × 2 m with feeding and drinking access. According to the NRC (2007) guideline, the dietary treatments for lambs have been designed to meet the nutritional requirement. Each group was allocated randomly to one of the following 4 treatments of diete (as fed basis). The concentrate mixture without additive control diet (T_1); concentrate mixture with +1% Turmeric powder (T_2); a concentrate mixture with +1.5% Turmeric powder (T_3) and a concentrate mixture with +2% Turmeric powder (T_4). Following a two-week acclimatization period, lambs received daily concentration at 1% BW gain with *ad libitum* lucerne hay + urea-treated wheat straw up to 90 days. At 0800 and 1600 h, the lambs were given an equal amount of concentrate. Water and mineral blocks were available to all lambs at any time. Every day, the amount of feed consumed was registered. The changes in BW gain have been estimated by animals weighing at the beginning of trial then every two weeks following that. Feed consumption was determined and the FCR and average DWGs were calculated.

Urea- treated wheat straw preparation

Wheat straw has been chopped by machine to a length of around 5 cm. Then 100 L water has been mixed with three kg urea at 46% N. 100 kg of chopped wheat straw was sprayed with the urea-water mixture, then stored, covered and excluded air by pressing it in barrels for up to two weeks until the lambs are fed.

Table 1 : Diet chemical composition.

Parameter	**Treatment**					
Ingredient (% DM)	**T_1**	**T_2**	**T_3**	**T_4**	**UTWS**	**LH**
Yellow corn	55.00	54.00	53.50	53.00		
Soybean meal	20.00	20.00	20.00	20.00		
Barley	20.00	20.00	20.00	20.00		
Sunflower oil	3.00	3.00	3.00	3.00		
$CaCO_3$	1.00	1.00	1.00	1.00		
NaCl	0.5	0.5	0.5	0.5		
Mineral-vitamin premix	0.5	0.5	0.5	0.5		
Turmeric		1.00	1.50	2.00		
Chemical composition % DM						
D M	93.20	92.48	93..15	93.6	95.80	90.65
O M	95.83	96.85	95.46	96.33	90.06	92.87
Ash	6.96	7.20	7.42	6.91	1.29	2.56
Crude Protein	20.56	20.17	20.35	20.20	4.98	6.75
Ether extract	2.07	2.10	1.98	1.87	1.43	1.95
Crude Fiber	7.50	8.10	7.95	7.76	33.50	28.65
Neutral detergent fiber	42.36	41.73	43.23	42.16	83.75	67.32
Acid detergent fiber	12.83	12.87	13.18	13.20	52.50	38.63

(DM) DM (UTWS) urea-treated wheat straw (LH) lucerne hay. T_1= concentrate mixture; T_2= concentrate mixture + 1% Turmeric; T_3= concentrate mixture + 1.5% Turmeric; T_4= concentrate mixture + 2% Turmeric.

Chemical composition

Organic matter (OM) and Dry matter (DM) were measured in feed. DM content was determined for drying samples for 12 h at 105°C. In a muffle furnace, samples were held at 600°C for six h to determine ash content, as OM has been calculated as the difference between ash content in (g/kg DM) and DM. According to the AOAC (1990) method, the samples were analyzed for ether extract and crude protein. Van Soest *et al* (1990) protocol was utilized to examine the neutral and acid detergent fibre. The chemical composition of the experimental diet, urea-treated wheat straw and lucerne hay are illustrated in Table 1.

The apparent digestibility of nutrient

The apparent digestibility of the nutrient experiment was carried out at the last of the trial. In every treatment, animals as whole in the metabolic pen were placed in which the place was equipped with facilities of drinking and feeding for 15 days (5 days for adaptation and 10 days for faeces collection). The feed residual was collected while feed intake was recorded and faecal samples were collected. Per day, about (200) g of faecal or feed samples was taken from all lambs and stored until analysis.

Sampling of blood

Blood samples were taken from lambs via jugular venipuncture into a vacuum tube having (EDTA) as anticoagulant and simple bottles of serum on days 0, 30, 60 and 90 of the experiment. Using a haematology analyzer, blood samples in (EDTA) bottles were analyzed for (RBC), (WBC), (MCV), haemoglobin, monocytes, basophil, lymphocytes, neutrophil and eosinophil. Blood samples in simple tubes were centrifuged for 20 min at 4 °C at 3,000 g × min. Serum was separated to determine biochemical blood profiles like total serum protein, albumin, globulin, glucose, triglycerides, (LDL), (VLDL), (HLDL), (AST), (ALT), urea and total cholesterol by an automatic analyzer.

Statistical analysis

The experimental design was (CRD), which feed intake, and nutrient digestibility, as well as growth efficiency parameters, have been analyzed utilizing (GLM) procedure by SAS (2003), which diets have been fitted as a fixed influence while parameters and lambs were fitted as effects being random. Haematology and serology indices have been subjected to a repeated measures design using SAS means sampling days, experimental diets, and interaction between days sampling and experimental diets have been fitted as fixed effects whereas values of parameters also lambs have been fitted as random effects. Duncan's multiple range tests were used at $p<0.05$ for means comparison.

RESULTS

Effects of turmeric on BW and BW gain

The growth performance of lambs fed diets with various Turmeric levels is shown in Table 2. The initial BW of lambs had no significant difference among the treatments. T_2 and T_4 lambs were significantly higher ($P<0.05$) in final BW gain (BWG) and daily gain as average (ADG) than T_3 and control treatment, while final BW had differed numerically. The intake of treated wheat straw and lucerne hay in lambs fed medicinal plants did not differ between supplemented diets and the control diet but also increased numerically as the levels of Turmeric increased. Diets showed significant improvement ($P<0.05$) on FCR compared to the control. That T_2 and T_4 were higher in FCR compared with control lambs.

Effects of turmeric feed intake and nutrient digestibility

The dietary supplementation effects with different turmeric levels on nutrient intake and nutrient digestibility in lambs as presented in Table 3. Diet of no significant effect ($P>0.05$) on nutrient intakes of DM, CP and EE in lambs but also increased numerically as the levels of turmeric increased. Supplemented diets groups are of no significant effect ($P>0.05$) in ADF, NDF and OM intakes compared to lambs in control treatment. The control lambs are of lower digestibilities (ADF and NDF) ($P<0.05$) in comparison to other diet treatments. T_2 and T_4 lambs were greater in NDF and ADF digestibility than other diets. The CP, DM, OM and EE digestibility had no significant difference among the treatments.

Effects of turmeric on hematology parameters in lambs

The haematology parameters of lambs Turmeric fed at different levels are shown in Table 4. Either diet or sampling time influenced the RBC, haemoglobin, MCV and WBC in the blood of lambs. Red blood cell (RBC) was significantly increased in T_2 and T_4 lambs as compared to T_3 and control lambs. Also, RBC has been observed on days 60 and 90 were significantly superior ($p<0.05$) compared to those detected on 0 day and days 30. Haemoglobin (Hb) was the highest in T_2 and T_4 lambs differed significantly compared with control lambs and T_3. Also, Hb has been observed on days 90 was higher significantly ($p<0.05$) compared to that detected on days 0, 30 and 60. Moreover, MCV was higher significantly ($p<0.05$) in groups of all treatments compared to control treatment. The neutrophil level was significantly higher

Table 2 : Influence of feeding graded levels of turmeric on lambs growth performance features (n=4).

Parameters	Exp. diets					
	T_1	T_2	T_3	T_4	SEM	*P value*
Initial wt. (kg)	13.58	13.50	13.75	13.56	0.56	0.99
Final wt. (kg)	26.725	29.195	26.863	28.915	1.06	0.2682
BW gain (BWG) (kg)	13.14[b]	15.69[a]	13.11[b]	15.35[a]	0.69	0.0445
Average daily gain (ADG) (g/d)	146.00[b]	174.36[a]	145.69[b]	170.59[a]	7.69	0.0445
Concentrate DMI (g/day)	300.00	300.00	300.00	300.00	3.82	1.0000
Lucerne hay DMI (g/day)	599.08	646.24	630.35	634.81	18.45	0.4254
wheat straw DMI (g/day)	397.40	407.52	396.69	394.87	12.61	0.8927
Total DMI (g/day)	1296.48	1353.75	1327.04	1329.68	28.64	0.6375
FCR FCR (g DM /g LWG)	8.89[b]	7.87[a]	9.13[b]	7.83[a]	0.30	0.0351

[a,b,c] mean of various superscripts differ significantly (P< 0.05). SEM = mean standard error. T_1 = concentrate mixture; T_2= concentrate mixture + 1% Turmeric; T_3= concentrate mixture + 1.5% Turmeric; T_4= concentrate mixture + 2% Turmeric.

Table 3 : Influence of lambs feeding turmeric graded levels on nutrient intake and apparent digestibility (n=4).

Parameters	Experimental diets					
	T_1	T_2	T_3	T_4	SEM	*P value*
Intake of Nutrient (g/d)						
D M	1296.48	1353.75	1327.04	1329.68	28.64	0.637
Crude protein	166.42	170.27	166.69	171.78	2.38	0.38
Extract of ether	7.49	8.10	8.15	7.97	0.48	0.78
Fiber as neutral detergent	804.63	772.98	800.35	761.86	33.97	0.77
Fiber as acid detergent	477.75	480.85	461.20	476.10	17.86	0.87
O M	1145.98	1043.99	1105.82	1024.18	63.91	0.55
Apparent digestibility (%)						
D M	58.28	59.31	56.40	58.74	1.29	0.512
Crude protein	49.69	48.26	49.55	49.76	0.56	0.269
Extract of ether	50.19	48.95	52.50	48.96	1.79	0.553
Fiber as neutral detergent	37.53[b]	42.32[ab]	42.02[ab]	45.69[a]	2.13	0.147
Fiber as acid detergent	55.39[c]	56.88[b]	54.99[c]	57.97[a]	0.44	0.0047
O M	69.84	68.60	70.76	71.09	1.61	0.7084

[a,b,c]means of various superscripts are different significantly (p<0.05). T_1= concentrate mixture; T_2= concentrate mixture + 1% Turmeric; T_3= concentrate mixture + 1.5% Turmeric; T_4= concentrate mixture + 2% Turmeric, SEM = means standard error.

in control and T_2 compared with the other dietary treatments. Lymphocytes were marginally increased at days 60 compared with days 0, 30 and 90. Monocytes, Eosinophil and Basophil were increased at 0 days and decreased afterwards as the sampling period progressed. However, Lymphocytes Monocytes, Eosinophil and Basophil had no significant difference between treatments.

Physiological parameter and kidney function test

Table 5 presents the influence of feeding different Turmeric levels in diets on biochemical parameters of serum. There was a significant upsurge (p<0.05) in serum AST in T_1 and T_2 compared to those fed the treated diet. Also, ALT, ALT and urea were elevated significantly (p<0.05) as the sampling period progressed. Glucose and total Protein had no significant difference between treatments or sampling time but increased numerically as the levels of turmeric increased and with the sampling period progressed. In addition, albumin and globulin had a significant (p<0.05) higher in groups of treatments than with control treatment. Supplementations with different levels of turmeric significantly improved (HLDL) (p< 0.05), while no effects were observed on the total cholesterol, LDL, VLDL and serum TG concentration. Also, total cholesterol and VLDL have been increased significantly while HLDL significant reductions (p<0.05) as the sampling period progressed

DISCUSSION

At the current work, the diet of animals was further supplemented by Turmeric to improve growth performance. Growth performance is a significant component key to the production system of ruminants. Thus, it is necessary to supplement inorganic feed additives to animal feed up to the required level because

Table 4 : Influence of feeding graded levels of turmeric on hematological indices in lambs (n=4).

Parameters	Experimental diets					Time of sampling					*P value*		
	T_1	T_2	T_3	T_4	SEM	0	30	60	90	SEM	Diets	Time	D*T
RBC (10^6/ìl)	1.60^b	1.82^a	1.70^b	1.98^a	0.08	1.72^b	1.60^b	1.80^a	1.98^a	0.098	0.009	0.01	0.084
Hemoglobin g/dl	10.78^b	11.04^{ab}	10.88^{ab}	11.45^a	0.22	10.52^b	10.76^b	10.95^b	11.91^a	0.62	0.102	<.0001	0.873
Mean corpuscular volume (fl)	50.21^b	50.68^{ab}	50.97^{ab}	51.08^a	0.30	50.64	50.59	50.79	50.93	1.24	0.1349	0.821	0.008
White blood cells(10^3/ìl)	7.83	7.90	7.34	7.08	0.26	7.55	7.68	7.08	7.85	1.21	0.122	0.245	0.71
Neutrophil (10^6/ìl)	3.50^{ab}	3.67^a	3.02^{bc}	2.90^c	0.20	3.33	3.27	3.15	3.35	0.50	0.008	0.862	0.00
Lymphocytes (10^6/ìl)	3.278	3.386	3.660	3.498	0.18	3.72^b	3.80^b	2.83^a	3.45^b	0.34	0.302	<.0001	0.016
Monocytes (10^6/ìl)	0.212	0.209	0.169	0.165	0.01	0.24^a	0.17^b	0.14^b	0.18^b	0.005	0.180	0.006	0.618
Eosinophil (10^6/ìl)	0.042	0.030	0.031	0.028	0.005	0.042^a	0.033^{ab}	0.023^b	0.030^b	0.0003	0.15	0.008	0.131
Basophil (10^6/ìl)	0.021	0.022	0.027	0.017	0.004	0.029^a	0.028^a	0.011^b	0.019^b	0.0003	0.55	0.043	0.035

[a,b,c] means of various superscript are different significantly (P< 0.05). SEM = means standard error. T_1= concentrate mixture; T_2= concentrate mixture + 1% Turmeric; T_3= concentrate mixture + 1.5% Turmeric; T_4= concentrate mixture + 2% Turmeric.

of their function in the metabolic and productive processes (Pallauf and Muller, 2006).

As found in the current study, T_2 and T_4 had improved in (BWG) and (ADG) than with T_3 and control diet and the final BW has been improved numerically. The observation in this study could be due to the increase in feed intake efficiency as well as nutrient digestibility of treatment diets compared with control diets. Meanwhile, current results showed that the intake of treated wheat straw and lucerne hay in lambs fed turmeric did not differ between supplemented diets and the control diet but also increased numerically as the levels of turmeric increased as well as FCR has been improved. Such result was of similarity to that of Odhaib *et al* (2018), who stated that the lambs fed T2 group (1% *R. officinalis* leaves) was higher in total BW gain and DWG compared to other diets, but did not effect on FCR in sheep. Wang *et al* (2017) were also in agreement with this finding by showing that diet supplemented with (100-300) mg/kg turmeric rhizome extract of no influence on the BW in broilers, but the FCR has been improved compared with control diet for weeks 9 to 12 weeks. Despite birds were fed on a diet of turmeric rhizome extract at 100 and 200 mg/kg that caused a higher DWG as average in comparison to control treatment from 9 to 12 weeks (P<0.05). Contrarily, diets containing 1% turmeric, 2% green tea and their combination had no effect on lamb performances (Heriyadi *et al*, 2019). In addition, dietary supplementation with *Piliostigma reticulatum* pod meal is of no influence on DM intake, final BW, DWG and FCR in goats (Zubair *et al*, 2019).

In addition to that, results obtained from this study Proved that improve on intake of DM, CP and EE numerically, if the turmeric levels increased compare with control diet as well as diets had significantly (P<0.05) enhance in nutrient digestibility, this finding might be attributed to that adding turmeric into the diets had no effect on palatability of feed but rather improved it. Such results were in accordance with Heriyadi *et al* (2019), who observed that adding 1% turmeric or 2% green tea powders, or their combination in diets of no influence on local lambs feed intake, approved that their utilizes did not minimize palatability of diet. In addition, goats fed diet supplemented with *Piliostigma reticulatum* pods of no influence on DM intake, intake of nutrient *i.e.*, crude fibre, crude protein, ash, ADF, NDF and extract of ether among the treatments (Zubair *et al*, 2019). Contrarily, supplemented diets with leaves of *R. officinalis* or seeds of *N. sativa* at levels 1% improved nutrient intake in Dorper lambs but the mixture of seeds of *N. sativa* along with leaves of *R. officinalis* (T_4) decreased apparent

Table 5 : Influence of feeding graded levels of turmeric on physiological parameter and kidney function test of lambs (n=4).

Parameters	Experimental diets					Time of sampling					*P value*		
	T_1	T_2	T_3	T_4	SEM	0	30	60	90	SEM	Diets	Time	D*T
Alanine Aminotransferase (ALT) U/L	17.86	19.32	18.71	18.97	0.79	19.70^{a}	16.75^{b}	18.99^{a}	19.42^{a}	3.09	0.58	0.039	0.36
Aspartate Aminotransferase (AST) U/L	85.23^{a}	83.73^{b}	79.48^{b}	86.80^{a}	1.84	83.55^{b}	76.29^{c}	87.83^{a}	87.56^{a}	5.39	0.002	<.0001	0.012
Urea mg/dl	41.66	40.50	39.37	41.80	1.24	37.47^{b}	40.30^{ab}	42.74^{a}	43.01^{a}	4.37	0.401	0.002	0.473
Glucose mg/dl	73.34	75.63	73.00	73.65	1.18	74.41	72.73	73.68	74.61	4.85	0.428	0.697	0.47
Total protein g/dl	5.39	5.62	5.49	5.58	0.11	5.44	5.40	5.55	5.69	0.43	0.44	0.23	0.13
Albumin g/dl	2.90^{b}	3.12^{a}	2.84^{b}	3.07^{a}	0.30	3.01^{b}	2.86^{bc}	2.70^{c}	3.36^{a}	0.30	0.034	<.0001	0.27
Globulin g/dl	2.40^{b}	2.45^{b}	2.63^{a}	2.46^{a}	0.10	2.208^{b}	2.28^{b}	2.62^{ab}	2.82^{a}	0.27	0.118	<.0001	0.003
Total Cholesterol mg/dl	48.31	47.03	46.92	47.45	0.89	44.70^{b}	48.76^{a}	48.64^{a}	47.61^{a}	3.36	0.646	0.004	0.706
Triglycerides mg/dl	28.353	27.32	24.44	28.03	1.44	25.972	26.62	28.40	27.14	5.68	0.20	0.66	0. 14
Low-density lipoproteins (LDL) mg/dl	22.13	21.36	22.54	21.55	0.55	21.76	21.28	22.20	22.15	2.26	0.4461	0.776	0.456
Very low-density lipoproteins (VLDL) mg/dl	6.09	6.26	5.63	6.09	0.32	4.73^{c}	5.73^{b}	6.67^{a}	6.94^{a}	1.03	0.368	<.0001	0.767
High-density lipoprotein (HLDL) mg/dl	27.65^{b}	28.33^{a}	24.80^{b}	30.02^{a}	1.70	35.35^{a}	27.57^{ab}	23.73^{b}	24.15^{b}	5.01	0.039	<.0001	0.121

^{a,b,c}means of various different superscript are different significantly ($p<0.05$). T_1= concentrate mixture; T_2= concentrate mixture + 1% Turmeric; T_3= concentrate mixture + 1.5% Turmeric; T= concentrate mixture + 2% Turmeric, SEM = means standard error.

digestibility, this may attributed to the diet has a higher overall polyphenol content than other diets. Also, a reduction in fibre digestibility in T_4 lambs might be due to the decrease in the population of fibre degrading microbes caused by a great polyphenol content in diets (Odhaib *et al*, 2018). Furthermore, adding herbal plants containing a high amount of plant secondary metabolites like tannins in diets of the ruminant could decline the diets palatability due to tannins bitter taste and as a result decrease in feed intake (Mueller-Harvey, 2006; Po *et al*, 2012).

Diets may affect parameters of blood biochemicals that are responsive health indicators and represent the intensity of the metabolic process for ruminants (Adeyemi *et al*, 2016). Blood parameters could indicate the effect of herbs on ordinary physiology in the diets (Kim *et al*, 2013). Haematological profiling observed in the current work was the effect of different turmeric levels in diets on RBC and Hb were significantly increased in T_2 and T_4 lambs compared to the control lambs and T_3. Also, RBC has been observed on days 60 and 90 were higher significantly ($p<0.05$) in comparison to that observed on days 0 and days 30. Moreover, MCV is of higher significance ($P<0.05$) in all dietary treatments compared to control treatment.

Increasing RBC and Hb as the experimental period progressed could be attributed to changes in the demands for metabolism occasioned by the increase in the BW of the lambs and the need for high oxygen demand resulting from an increase in BW of the lambs. Currently, results are in line with El-Halim *et al* (2014), who illustrated a significant increase ($P\leq0.05$) in the total RBCs count and Hemoglobin concentration in lambs fed on a diet of seed oil of *Nigella sativa* afterwards six weeks than the transient reduction at week 2 in both the treated and control groups. Furthermore, MCV was not affected via feeding oil of *N. sativa* during the lambs' experiment. Contrarily, dietary supplemented with *R.*

officinalis leaves or *N. sativa* seeds had no changes in the RBC and Hb measured over a 90 d feeding trial despite changes in BW (Odhaib *et al*, 2018).

Similarly, supplemented diets with *Piliostigma reticulatum* pods did not affect haemoglobin concentration, RBC and WBC besides goats as control are of lower significance ($p<0.05$) (PCV) compared to goats that fed on different treatments (Zubair *et al*, 2019). These findings recorded that WBC had no significantly differed between treatments. Supplemented diets with turmeric had lower neutrophil than control and T_2 diets. Lymphocytes were marginally increased at days 60 compared with days 0, 30 and 90. Monocytes, Eosinophil and Basophil were increased at 0 days and decreased afterwards as the sampling period progressed. Such results parallel with El-Halim *et al* (2014), who observed that white blood cells (WBC) level in the dietary treatment was not dependent on time. Monocytes total means were alike in both groups, but the cells in the oil-treated group of *N. sativa* were lower significantly ($P\leq0.05$) at week four than the control diet. Dietary treatments with different Turmeric levels of no effect on serum total protein, glucose, LDL, VLDL, TG, cholesterol and ALT but increased in albumin, globulin and HLDL significantly ($P<0.05$) in lambs treatments in comparison to control treatment. For metabolism, HDL transports plasma cholesterol to the liver, whereas LDL transports cholesterol to other tissues. It is normally thought that higher and lower HDL is beneficial to the organism. The current work is in line with Shin *et al* (2011), who mentioned that mice fed high cholesterol with curcumin reduced the plasma concentrations of triglyceride, LDL cholesterol, cholesterol as total and elevated HDL cholesterol of plasma and led to transcriptional HMG-CoA reductase inhibition. Contrarily, Jiang *et al* (2019) observed that curcumin supplementation had no effect in changing serum glucose concentrations, triglyceride, HDL, LDL and total cholesterol.

In this study AST, cholesterol and VLDL have been increased significantly while HLDL significant reductions ($p<0.05$) as period of sampling proceeded but values were within the normal range for lambs. High transaminase activity might be associated with changes in internal organs histopathology, particularly in the liver (Moskwa *et al*, 2001; Darul and Kruczyñska, 2005). Also, elevated activity of ALT and AST might be indicative of stress and problems with the body's energy metabolism (Kupczyñski and Chudoba-Drozdowska, 2003; Darul and Kruczyñska, 2005). Therefore, the serum ALT level similarity among the treatments is a signal in which supplementation of different Turmeric levels in diets of no -ve effects on lambs organs and tissues. Likewise, supplemented diets with seeds of *N. sativa* or leaves of *R. officinalis* and their mixture had no effect on cholesterol, serum total protein, ALT and AST but reduced serum urea in Dorper lambs (Odhaib *et al*, 2019). Contrarily biochemical indicators measurements mentioned a glucose level reduction and alkaline phosphatase increasing activity, particularly AST high activity that was found in the inspected lactating cows (Górsk and Saba, 2012).

CONCLUSION

Dietary turmeric supplement with 1% and 2% DM could increase weight gain as total and daily average gain compared with T_3 and control diet. The final BW has been improved numerically, which indicates turmeric promotes feed intake efficiency and improves nutrient digestibility in lambs. Different levels of turmeric in diets on haematological parameters have been improved by increasing the levels of RBC significantly, Hb and MCV in T_2 and T_4 lambs compared to the control lambs and T_3. Dietary turmeric supplement improves serum biochemical parameters by increasing albumin, globulin, and HLDL concentrations significantly ($P<0.05$) in treatment lambs compared to control treatment. Supplementation of turmeric up to 2% DM concentrate have been improved growth performance and health status in lambs

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