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The Effect of Dried Moringa Oleifera Leaves on Growth Performance, Carcass Characteristics and Blood Parameters of Broiler Chicken

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Abstract

Infection is the major challenge facing the poultry industry resulting in high mortality. Therefore, phytobiotics attracted attention as natural alternatives to chemical growth promoters. Among the market phytobiotics, Moringa is common in Egypt; which has been previously shown to have anti-carcinogenic and antioxidant effects. The aim of this study was to investigate the addition of Moringa Oleifera leaf meal (MOLM) in broiler diets in different levels on growth performance, carcass characteristics and blood parameters of broiler chickens. The trial was conducted with 150 one day old broiler chicks (Cobb) weighed and randomly distributed into 5 equal groups, each of 30 chicks. Diets were formulated to contain approximately the same level of crude protein (CP) (23% for starter, 20% for the grower, 18% for finisher) and metabolizable energy 3100 Kcal/kg. In the first group, birds were fed on the diet without the addition of MOLM and this group was assigned as control. Chicks in second, third, fourth, fifth groups were fed on the basal diets containing 1%, 3%, 5% and 7% MOLM (M1, M3, M5, and M7, respectively). The trial was extended for 6 weeks. The results showed that feed intake was not affected by the addition of MOLM. On the other hand, broilers fed on a diet containing 3% MOLM achieved higher body weight (2564 ±9.53 g; $P < 0.001$) and better feed conversion (1.59; $P < 0.001$) compared with other experimental groups. The supplementation of MOLM increased significantly ($P = 0.03$) dressed weight and dressing percentage ($P = 0.07$). Moreover, dressed weight were significantly higher ($P < 0.05$) in M3 group compared to control (+25% and +29%, respectively) and M1 (+29% and +28%, respectively) groups. Total serum protein and albumin levels did not differ among the experimental groups while levels of serum glucose, triglycerides and cholesterol showed different reactions to supplementation of diets with MOLM. In conclusion, the Addition of MOLM to the diet of broiler chicks improved growth performance and carcass traits. The best growth performance was observed in broilers fed on diets containing 3% MOLM.

Key words: Moringa Oleifera, Growth Performance, Blood Parameters, Phytobiotics.

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Introduction

Poultry production plays important economic role in developing countries because chickens provide an important source of animal protein and can be produced in circumstances with restricted feed resources (Olwande et al., 2010). Moreover, the broiler meat is one of the best and cheapest sources of quality protein for human consumption. But unfortunately, broiler industry is facing several microbial threats from various pathogenic microbes. Therefore, safe and healthy production of chicken requires proper microbial control to produce meat of high quality (Ravindran, 2017). For decades, the use of antibiotics in animal diets was a common practice to protect against infection or to promote performance of livestock (Phillips et al., 2004). However, the use of antibiotics in animal diets was banned in the European Union in 2006 due to the toxicity problems and development of bacterial resistance. Before the ban, poultry industry was exceptionally reliant on antibiotics as growth promoters to control intestinal pathogens (Wallace et al., 2010). In perspective on rising worries on the considerable loss in poultry due to gut pathogens and the application of strict laws to the use of antibiotics as growth promoters, creates demand of alternative sources to improve performance and reduce the uses of antibiotics (Mirzaei-Aghsaghali, 2012). Therefore, phytobiotics attracted the attention in animal nutrition as alternatives to antibiotics growth promoters (Puvača et al., 2013). They have been shown to stimulate feed intake, activate digestion, improve immune system and have coccidiostatic, anthelmintic and antimicrobial properties (Panda et al., 2006). Furthermore, supplementation of the diet of commercial animals with phytobiotics improve animal production through promoting animals' performance, modulating feed properties and improving quality of the products obtained from these animals (Windisch et al. 2008). Moringa Olifera belongs to a family Moringaceae which known to have high content of protein (Olugbemi et al., 2010a) and low anti-nutritional factors (Makkar and Becker, 1997). A high extent of this protein is conceivable accessible for digestion due to low content of acid detergent insoluble protein and high content of pepsin soluble nitrogen (Makkar and Becker, 1997). Moreover, protein of M. Oleifera is reported to be a good source of essential amino acids that allegedly boost immunity (Olugbemi et al., 2010a). Therefore, M. Olifera can be used as a dietary supplement in poultry (Mahajan et al., 2007). In addition, studies revealed that M. Olifera leaves act as a good source of natural antioxidants due to its high content of macro and micro elements, Vitamin C and Beta- carotene (Amadi et al., 2014). Consequently, there is a growing interest to use M. Olifera as a feed additive in poultry nutrition, therefore, the demand for M. Olifera products was increased (AbouSekken, 2015). Previous studies showed that, replacing antibiotic growth promoters with M. Oleifera leaf meal (MOLM) has beneficial effects on the growth performance and carcass yield of broiler chicken (David et al., 2012). In addition, inclusion of MOLM in the diet of broilers improved growth performance, enhanced weight gain (Banjo, 2012). Due to its anti-microbial effect and pharmacological properties, M. Oleifera could be used as alternatives to growth promoters for poultry (Mehta et al., 2003; Suarez et al., 2005). Although, M. Oleifera has medicinal importance for the health and performance of the chickens, the using of M. Oleifera in farm animals to promote performance and health status is limited. In addition, the optimal inclusion level of M. Oleifera leaves in poultry diets and their mode of action are still under consideration (Mahfuzand Piao 2019). We hypothesize that the use of MOLM in small concentration might improve growth performance. This study, therefore, aimed to evaluate the effect of different levels of MOLM on performance, carcass traits and blood parameters in broiler chicks.

Materials and Methods

Experimental rations and treatments

The experiment was conducted in research farm of Faculty of Veterinary Medicine, South Valley University; Qena (approved by ethical committee of animal care and welfare no 1918_201). Five experimental diets were formulated from commercially available ingredients in three stages (starter, grower and finisher) comprised of 0% MOLM which served as the control (C), while, the other four diets contained 1, 3, 5 and 7% MOLM (M1, M3, M5 and M7, respectively).

Ingredients and nutrient composition of the ration is shown in Table 1. The starter diet contained 23% CP with 3100 Kcal ME/kg, grower diet contained 20% crude protein (CP) with 3100 Kcal ME/kg and finisher diet contained 18% CP with 3200 Kcal ME/kg. All experimental diets meet the minimum nutrient requirements recommended for Cobb broilers.

A total number of 150 one day old unsexed broiler chicks (Cobb, obtained from a local commercial hatchery) were divided randomly into five groups having 30 birds each. Experimental birds were allocated to the groups according to completely randomized design. Each group was further subdivided into three replicates of 10 birds each. Birds were housed in experimental chambers under the recommended optimal conditions of temperature, humidity and ventilation. The diets and water were available ad-libitum throughout the experimental period. The diets offered in a mash form. Feed intake was recorded daily while live body weight was weekly recorded throughout the 6 weeks of the experimental period.

Preparation of leaf meal

Fresh green and undamaged mature M. Oleifera leaves were dried in a shady area with no direct sunlight exposure to avoid leaching with constant turning over to avert fungal growth. After drying, the leaves were crushed to a fine powder and stored in clean dry plastic bag at dark cool place for further use. The chemical analysis of used MOLM was dry matter (DM) 90.16%, CP 35.20%, ether extract (EE) 6.20%, crude fiber (CF) 4.60% and ash 11.20% while nitrogen-free extract (NFE) was calculated according to the methods of Association of Official Analytical Chemists (AOAC, 2005) and was 32.69%. The metabolizable energy (ME) was 3271 kcal/kg (according to Tijani et al. (2016).

Feed analysis

The chemical analysis for the diet ingredients was carried out to determine DM, CP, EE, CF and ash while NFE was calculated according to the methods of Association of Official Analytical Chemists (AOAC, 2005). The ME content of the feed ingredients and experimental diets was calculated based on chemical composition (NRC, 1994).

Carcass traits and blood analysis

At the end of the trial, three randomly selected birds from each group (one bird per replicate) were slaughtered after fasting overnight and allowed to bleed. Afterwards,the birds were scalded, de-feathered and carcasses were eviscerated. The weight of carcass, gizzard, heart, liver and proventriculus were taken, and data were expressed as the relative weight of live body weight.

Table 1: Physical and chemical composition (%) of the experimental diets

	Starter diets					Grower diets					Finisher diets				
Groups[1]	C	M1	M3	M5	M7	C	M1	M3	M5	M7	C	M1	M3	M5	M7
Feed stuff (%)															
Yellow corn	46.7	46.3	46.0	45.7	45.4	59.00	58.80	58.60	58.50	58.40	65.44	65.24	65.04	64.94	64.84
Soybean meal	43.0	42.5	41.0	39.5	38.0	33.00	32.30	30.70	29.00	27.30	26.50	25.8	24.20	22.50	20.80
Sunflower oil	6.65	6.55	6.35	6.15	5.95	4.79	4.69	4.49	4.29	4.09	4.69	4.59	4.39	4.19	3.99
MOLM	0	1	3	5	7	0	1	3	5	7	0	1	3	5	7
Lime stone	1.44	1.44	1.44	1.44	1.44	1.47	1.47	1.47	1.47	1.47	1.50	1.50	1.50	1.50	1.50
Di calcium phosphate	1.4	1.4	1.4	1.4	1.4	1.00	1.00	1.00	1.00	1.00	1.10	1.10	1.10	1.10	1.10
Common salt	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Premix[2]	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Dl Methionine	0.11	0.11	0.11	0.11	0.11	0.04	0.04	0.04	0.04	0.04	0.07	0.07	0.07	0.07	0.07
Calculated analysis															
CP (%)	22.96	23.0	23.1	23.1	23.1	20.06	20.09	20.09	20.08	20.06	18.00	18.04	18.05	18.03	18.01
ME (Kcal/kg diet)	3095.2	3094	3099	3103	3108	3124	3126	3131	3138	3145	3186	3188	3194	3201	3208
Calcium (%)	1.00	1.03	1.10	1.16	1.23	0.9	0.92	0.99	1.01	1.10	0.91	0.93	1.00	1.07	1.13
Available phosphorus (%)	0.46	0.46	0.46	0.46	0.47	0.37	0.37	0.37	0.37	0.37	0.38	0.38	0.38	0.38	0.38
Methionine (%)	0.48	0.49	0.50	0.51	0.52	0.37	0.38	0.39	0.40	0.41	0.37	0.37	0.39	0.40	0.41
Lysine (%)	1.37	1.40	1.45	1.45	1.47	1.11	1.13	1.15	1.17	1.19	094	0.96	0.98	1.00	1.02

[1]C, control group fed basal diet; M1, group fed basal diet supplemented with 1% MOLM; M3, group fed basal diet supplemented with 3% MOLM; M5, group fed basal diet supplemented with 5% MOLM and M7, group fed basal diet supplemented with 7% MOLM.

[2]Each 3 kg contains: Vit. A, 1200000 IU; Vit. D_3, 300000 IU; Vit. E, 700 mg; Vit. k_3, 500 mg; Vit. B_1, 500 mg; Vit. B_2, 200 mg; Vit. B_6, 600 mg; Vit. B_{12}, 3 mg; Vit. C, 450 mg; Niacin, 3000 mg; Methionine, 3000 mg; Pantothenicacid, 670 mg; Folicacid 300 mg; Biotin, 6 mg; Choline chloride, 10000 mg; Magnesiumsulphate, 3000 mg; Copper sulphate, 3000 mg; Ironsulphate, 10000 mg; Zinc sulphate, 1800 mg; Cobalt sulphate, 300 mg.

Blood samples were collected from the selected birds, allotted to clot at ambient temperature, centrifuged for 15 minutes at 3000 rpm and serum from each sample was extracted. The sample bottles were stored at -20ºC prior to biochemical analyses. Total serum protein, albumin, globulin, glucose and cholesterol were analyzed using standard test kits supplied by SGM (Rome, Italy).

Statistical analysis

Data were subjected to analysis of variance using the Graph-Pad Prism (GraphPad Software, San Diego, CA, USA). All values are reported as least square means and standard error of the mean (SEM). Significance was declared at $P < 0.05$ and a trend was set at $0.05 < P < 0.10$. Comparisons among treatments were evaluated using Tukey᾽s test.

Results

Productive Performance

The total feed intake was 4037, 3987, 3990, 4100 and 4120 g/bird for C, M1, M3, M5 and M7, respectively with no significance differences between the experimental groups. Final body weight, weight gain and total feed conversion ratio data according to treatments are summarized in Table 2. The data on growth performance of birds fed different levels of MOLM showed that, birds fed MOLM were significantly heavier than those fed with the basal diet at 6 weeks of age ($P < 0.001$). In addition, final body weight of birds fed diets contained 3% MOLM showed the heaviest final body weight (2546±9.53 g) compared to other groups (P<0.05), while birds fed diets supplemented with 7% MOLM showed the lowest final body weight (2197±15.83g; P<0.05). The same trend was observed in final weight gain ($P < 0.001$). Compared with other experimental groups, the final weight gain of birds fed M3 diets (3%MOLM) was the highest ($P < 0.05$). While the final weight gain of birds fed on basal diet (control) and M5 (5% MOLM) diets did not significantly differ ($P <0.05$). Similarly, supplementation of the diets with MOLM significantly improved daily weight gain ($P < 0.001$) with the highest improvement was in birds fed diet contain 3% MOLM, while both birds fed the basal control diet and birds fed 5% MOLM diet did not show any significant difference ($P < 0.05$). Similarly, supplementation of diets with MOLM increased daily weigh gain by 2.25% compared to control diet ($P < 0.001$). In addition, the daily weigh gain followed the same trend like final weight gain with the best results appeared in birds fed diet supplemented with 3% MOLM while C and M5 groups did not show any significant difference ($P < 0.05$). Generally, the addition of MOLM showed a strong effect on feed conversion ratio ($P < 0.001$). In details, inclusion of MOLM in the diets of birds enhanced feed conversion ratio (+1.40%). The feed conversion ratio was significantly different between the five groups and was in the following order M3<M1<M5<C<M7 ($P < 0.05$).

Carcass traits and relative weight of some internal organs

The supplementation of MOLM increased significantly dressed weight ($P = 0.03$) and dressing percentage ($P = 0.07$). Moreover, dressed weight were significantly higher ($P < 0.05$) in M3 group compared to control (+25% and +29%, respectively) and M1 (+29% and +28%, respectively) groups (table 3). For the dressing percentage, there were no significant differences between the different experimental groups (table 3). The proventriculus relative weight was significantly decreased (P= 0.005), while relative weight of gizzard, heart and spleen remained unaffected by MOLM dietary supplementation (table 3).

Blood serum biochemical parameters

The effect of different dietary treatments on blood biochemical parameters are shown in Table 4. The results revealed that, the total protein and albumin level were not affected by supplementation of MOLM. In contrast, the glucose (P = 0.001) and triglycerides (P = 0.01) levels were significantly increased in chicks fed MOLM as compared to control. Birds fed diets supplemented with 3% MOLM had a higher glucose level than those fed the control diet (P < 0.05), while birds in M1 group showed the lowest glucose level when compared to other supplemented groups (P < 0.05). Furthermore, the triglycerides level was the highest (P < 0.05) in birds supplemented with 5 and 7% MOLM compared to those fed control diet. The concentration of cholesterol increased by 38% with supplementation of MOLM (P = 0.005) and was the highest in M1, M3 and M5 groups (P < 0.05). On the other hand, the birds in control group showed the lowest blood cholesterol level (P < 0.05).

Table 2: Performance of broilers fed different experimental diets (from day 1-42)

	Groups[1]					P Value
Item	**C**	**M1**	**M3**	**M5**	**M7**	
Initial body weight (g)	48.73±0.618	50.77±0.740	51.07±0.686	50.17±0.738	49.63±0.714	0.134
Final body weight (g)	2295±9.52^{bc}	2344±10.05^{b}	2564±9.53^{a}	2266±15.58^{c}	2197±15.83^{d}	< 0.001
Weight gain (g)	2247±9.37^{bc}	2293±10.26^{b}	2512±10.03^{a}	2216±15.75^{cd}	2147±16.63^{e}	< 0.001
Daily weight gain (g)	53.50±0.185^{c}	54.66±0.209^{b}	59.89±0.223^{a}	52.84±0.316^{c}	51.44±0.378^{d}	< 0.001
FCR	1.80±0.007^{c}	1.74±0.008^{d}	1.59±0.006^{e}	1.85±0.013^{b}	1.92±0.015^{a}	< 0.001

[1]C, control group fed basal diet; M1, group fed basal diet supplemented with 1% MOLM; M3, group fed basal diet supplemented with 3% MOLM; M5, group fed basal diet supplemented with 5% MOLM and M7, group fed basal diet supplemented with 7% MOLM.
[*]Means of treatments sharing no common superscripts are significantly different (P< 0.05).

Table3: The carcass trait parameters and relative weight of broilers as influenced by different dietary treatments

Carcass traits	Groups[1]					P Value
	C	M1	M3	M5	M7	
Preslaughter weight (g)	1689±19.74[b]	1636±54.99[b]	2103±86.11[a]	1979±108.0[ab]	1891±112.8[ab]	0.014
Dressed Weight (g)	1214±10.14[b]	1225±47.25[b]	1574±88.61[a]	1352±76.10[ab]	1304±96.29[ab]	0.030
Dressing %	71.89±0.440	75.04±3.77	74.74±1.19	68.30±0.360	68.84±1.03	0.075
Relative weight (%)						
Gizzard	2.48±0.22	2.31±0.17	2.27±0.12	1.95±0.07	2.15±0.09	0.224
Liver	2.44±0.30	2.51±0.20	1.99±0.03	2.09±0.04	2.22±0.096	0.221
Heart	0.787±0.13	0.643±0.13	0.540±0.01	0.573±0.02	0.593±0.07	0.414
Proventriculus	0.670±0.03[a]	0.693±0.03[a]	0.510±0.02[b]	0.540±0.01[b]	0.563±0.03[b]	0.005

[1]C, control group fed basal diet; M1, group fed basal diet supplemented with 1% MOLM; M3, group fed basal diet supplemented with 3% MOLM; M5, group fed basal diet supplemented with 5% MOLM and M7, group fed basal diet supplemented with 7% MOLM.
[*]Means of treatments sharing no common superscripts are significantly different (P< 0.05).

Table 4: The blood biochemical parameters of broilers as influenced by different dietary treatments

Blood parameters	Groups[1]					P Value
	C	M1	M3	M5	M7	
Total serum protein (g/dl)	3.53±0.54	3.60±0.30	3.63±0.08	2.97±0.23	3.10±0.25	0.482
Albumin (g/dl)	1.60±0.11	1.50±0.10	1.53±0.12	1.43±0.03	1.300±0.05	0.264
Glucose (mg/dl)	196.7±6.49^{bc}	172.7±8.41^{c}	256.7±4.26^{a}	220.0±11.59^{ab}	217.3±10.90^{ab}	0.001
Triglyceride (mg/dl)	85.67±5.55^{b}	102.7±4.63^{ab}	110.3±8.37^{ab}	131.3±5.24^{a}	126.0±11.59^{a}	0.010
Cholesterol (mg/dl)	83.00±6.66^{b}	116.0±7.00^{a}	122.3±5.36^{a}	116.7±4.98^{a}	102.0±4.93^{ab}	0.005

[1]C, control group fed basal diet; M1, group fed basal diet supplemented with 1% MOLM; M3, group fed basal diet supplemented with 3% MOLM; M5, group fed basal diet supplemented with 5% MOLM and M7, group fed basal diet supplemented with 7% MOLM.
[*]Means of treatments sharing no common superscripts are significantly different (P< 0.05).

Discussion

This study primarily aimed to investigate the possible role of using M. Oleifera as a natural feed additive in poultry ration and to govern its effect on performance consequently on carcass characteristics. Although the feed intake was not different among the experimental groups, the production and serum parameters were significantly affected. The M. Oleifera leaves are rich in many nutrients as minerals, vitamins and protein especially with eight essential amino acids (Moyo et al., 2011). In addition, the M. Oleifera leaves are characterized by high digestibility and they did not contain any factor could limit feed consumption (Sanchez et al., 2006; Teteh et al., 2017). The improvement in growth performance and FCR was observed by Hassan et al., (2016) with broilers fed diets with different levels of MOLM (0.1, 0.2 and 0.3 % MOLM), Khan et al., 2017 who used Moringa leaf powder as dietary supplement with 1.2% levels in broilers and Voemesse et al., (2018) with egg type chickens fed diets supplemented with 1 and 3 % MOLM. The clear effects of MOLM were observed at inclusion level not more than 5% of intake, however, Gadzirayi and Mupangwa, (2014) observed a decreased in weight gain and increased in FCR when dietary MOL inclusion level was more than 5%. On the other hand, increased weight gain and decreased FCR were observed when dietary supplementation of MOLM was 2.5% (Onu and Aniebo 2011). In the present study, the

improvement of growth performance could be attributed to the high content of essential nutrients and the digestibility of MOLM. Consequently, the FCR were better in birds supplemented with MOLM. Furthermore, the higher body weight and better FCR could be ascribed somewhat to the many bioactive components in M. Oleifera which may improve nutrient utilization in supplemented broilers (Alabi et al., 2017). The best performance was observed in bird fed 3 % MOLM (higher body weight, higher weight gain and lower FCR), while the FCR of broilers was poor when in diets supplemented with 5 and 7 % MOLM. This diversity in the performance results may be contributed to the low digestibility of fiber content of the leaves which in turn has a detrimental effect on protein and energy availability when supplementary of MOLM was high in the diets (Lu et al., 2016).
Generally, the results obtained from this study confirmed the previous findings indicated that dietary supplementation of MOLM had positive effects on growth and productivity in poultry attributed to its nutrients and phytochemical content (Kakengi et al., 2007). However, the inclusion levels of M. Oleifera in poultry diets and their mode of actions are still under investigations (Mahfuz and Piao, 2019).

In accordance with previous studies (David et al., 2012; Nkukwana et al., 2014; Safa et al., 2014; Onunkwo et al., 2015) the results of this study revealed that feeding with MOLM could improve dressing weight. On the other hand, the current results are congruent with those of Zanuand Asiedu (2012) who reported that inclusion of MOLM at different levels (5, 10, and 15%) in the diet of broilers has no effect on dressing weight. Moreover, the dressing percentage was not affected by inclusion of MOLM. Similarly, the values obtained showed no variations across the relative organ weight except for the proventriculus relative weight. It could be deduced from this results that supplementation of MOLM to the broiler diets has no effect on organ proportion of the birds. The carcass characteristics of this study are similar to the findings of previous studies either with broilers or rabbits. The authors reported that there were no significant differences among treatments for carcass characteristic for rabbits (Nuhu 2007)and broilers chicks (Onunkwo et al., 2015) fed diets supplemented with MOLM. The variation in results between the previous studies can be due to the difference in the inclusion level of MOLM or the part of the plant which is used (leaves, seeds, extract, etc).
The M. Oleifera leaf extracts was reported to exhibit a cholesterol lowering activities due to the presence of active substances that could reduce the intestinal uptake of dietary cholesterol (Ghasiert al., 2000; Jain et al., 2010; Maheshwari et al., 2014). Moreover, it was observed that cholesterol levels were reduced with increasing the inclusion level of level of MOLM in the diet of broilers (Aderinola et al., 2013; Alnidawi et al., 2016). In addition, Olugbemi et al., (2010b) investigated the capability of MOLM as a hypo-cholesterolemic agent that help reductions of egg cholesterol content. The reduction in blood cholesterol level may be due to increase lipid metabolism in broilers body resulted from the higher amounts of fiber in MOLM (Mahfuz and Piao, 2019). On the contrary, in the current study, the cholesterol and triglycerides levels were increased by inclusion of MOLM. The maximum inclusion level of MOLM in the current study was 7% with low fiber content which may explain the lack of hypo-cholesterol effect of MOLM.

Glucose is the major carbohydrate is required as a precursor for energy and it is substrate that is effectively utilized by the most body cells for energy purposes

(Hazelwood, 2000; Klasing, 2000). It was reported that M. Oleifera leaves showed anti-diabetic effect through decreasing the blood glucose level in rats (Jaiswal et al., 2009). On the other hand, blood glucose level was not affected when fish meal was replaced by MOLM in broilers (Zanu et al., 2012). However, in the present study, blood glucose level was increased in birds fed MOLM but within the normal range (Hazelwood, 2000).Glucose and triglycerides are the major metabolites that are firmly identified with the sustainability of energy supply for the usage of the physiological and biochemical functions in the body (Klasing, 2000). Accordingly, increasing blood glucose level accompanied by increasing in cholesterol and triglycerides level implies that inclusion of MOLM in the diet of broilers may increase glycogenolysis which in turn supports body cells with energy required for bioactive processes.

Conclusions

It can be concluded that addition of MOLM to the diet of broiler chicks improved growth performance. The best growth performance was observed in broilers fed on diets containing 3% MOLM. Moreover, the addition of MOLM increased cholesterol and glucose levels in the blood of broiler chickens which may have a positive effect on supplying energy to the body cells and may beneficially contribute to energy supply in broilers.

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