U. of K. J. Vet. Med. Anim. Prod., Vol. 5, Issue 2 (2014) p 58-65
ISSN: 243456

UNIVERSITY OF KHARTOUM
Journal of Veterinary Medicine and Animal Production

Performance and Blood Chemistry as Affected by Inclusion of *Moringa Oleifera* Leaf Meal in Broiler chicks Diet

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Abstract

The effect of *Moringa oleifera* leaf meal (MOLM) on the performance and blood chemistry of broiler chicks' diets were investigated. A total of one-hundred and sixty one-day old, unsexed (Ross) broiler chicks were randomly divided into four experimental groups. Each group was further subdivided into five replicates at the rate of eight chicks per pen in randomized complete block design. Four levels of *Moringa oleifera* leaf meal (0.0, 3, 5 and 7%) were fed during the experimental period for 7-weeks duration. Birds fed on MOLM gained significantly (P<0.05) higher weight and superior feed conversion ratio than birds fed the control diet. No significant difference between birds fed on 3% & 5% (MOLM) diets regarding final body weight or body weight gain .Birds fed on (5% MOLM) diet showed the heaviest body weight, highest total feed intake with the best feed conversion ratio. There were significant (P<0.05) differences among groups in packed cell volume (PCV) and red blood cell (RBC) of the birds. The haemoglobin (HB), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) counts showed no significant (P>0.05) difference among treatments. There were significant (P<0.05) differences in the values of total protein supplementary serum, while there were no significant (P>0.05) differences in the values of serum albumin and globulin. Birds fed on (5% MOLM) diet showed the highest values of (PCV), (RBC) and serum total protein as compared to other experimental treatments. The highest profitability ratio (1.47) was obtained by the diet with 5% (MOLM). *Moringa oleifera* leaf meal could be included at 5% dietary level without any deterious effect on performance and blood characteristics of broilers.

المستخلص

أجريت هذة التجربة لدراسة أثر تغذية الدجاج اللاجم على مستويات مختلفة من مسحوق أوراق المورنجا على الاداء الانتاجي وكيمياء الدم بالإضافة الى المردود الإقتصادي .استخدم نظام المربع العشوائي الكامل في تصميم هذة التجربة حيث أستخدم مائة وستون (160) كتكوت لاحم غير مجنس من سلالة الروس في عمر يوم ،قسمت عشوائيا إالى 4 مجاميع تجريبية متساوية تقريبآفي الوزن الإبتدائي . كل مجموعة ضمت 5 مكرارات وبكل مكرر8 كتاكيت. تمت تغذية الكتاكيت على أربعة علائق تحتوى على مستويات مختلفة من مسحوق المورنجا شملت 0% ،3%،5% ،7% لتكوين أربعة مجموعات (A،B،C وD) على التوالي . غذيت الكتاكيت على العلائق التجربية لمدة سبعة أسابيع . تم تسجيل قياسات الأداء الانتاجي، ثم الذبح بنهاية فترة الاعلاف وأخذ عينات

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الدم لدراسة كيمياء الدم وتسجيل قيم الذبيحة ومن ثم التقييم الإقتصادي . أثبتت النتائج المتحصل عليها أن أضافة مسحوق اوراق المورنجا الى العلائق التجريبية أدى معنويا (P<0.05) الى افضل المعدلات بالنسبة لقيم الوزن المكتسب ،إستهلاك العلف ، معدل الكفاءة التحويلية للغداء مقارنة مع العليقة الضابطة.أشارت النتائج المتحصل عليها أن المجموعة التي تغذت على مسحوق اوراق المورنجا بمستوى 5% قد تحصلت معنويا (P<0.05) على أعلى الأوزان وإستهلاك العلف وأفضل كفاءة تحويلية للغذاء مقارنة مع المجموعات التجريبية الأخرى . وأشارت التجارب أن هنالك فروقات معنوية بين المجموعات التجريبية في حجم الخلية المعبأ (PCV) ،وكريات ادم الحمراء (RBC) في الدجاج اللاحم . لم توجد فروقات معنوية بين المجموعات فيما يخص الهيموقلوبين (HB)ومتوسط حجم الخلية الحمراء (MCV)، ومتوسط تركيز الهيموقلوبيين (MCH) ، ومتوسط تركيز الهيموقلوبيين الجسمي (MCHC) . اثبتت التجارب ان المجموعة التي تغذت علي 5% مسحوق ورق المورنجا قد سجلت أعلى القيم لكل من حجم الخلية المعبأ (PCV)، وكريات الدم الحمراء (RBC) و البروتين الكلي في بلازما الدم مقارنة بالمجموعات التجريبية الأخرى. أشارت الدراسة الأقتصادية للتجربة أن مجموعة مسحوق أوراق المورنجا 5% قد تحصلت على أعلى ربحية نسبية 1.47% بالمقارنة مع بقيه المجموعات التجريبيه الأخرى. وقد خلصت نتائج هذة التجربة الى انه يمكن استخدام مسحوق اوراق المورنجا بنسبة 5% في علائق الدجاج اللاحم بدون اي اثر ضار على الأداء الإنتاجي ،خصائص الذبيح و كيمياء الدم.

Key words: Moringa Oleifera, broiler chicks, Performance, blood haematology

Introduction

Recently, the rising cost of the protein rich feeds has encouraged search for protein sources to formulate adequate-least-cost diets for broiler which can satisfy the bird's requirements for maintenance and production. The incorporation of protein from leaf sources in diets for broilers is fast gaining grounds because of its availability, abundance and relatively reduced cost (Onyimonyi and Onu, 2009). According to Opara (1996) leaf meal do not only serve as protein sources but also provide some necessary vitamins, minerals and also oxycarotenoids which causes yellow colour of broiler skin, shank and egg yolk. *Moringa oleifera* is one of the plants that can be utilized in the preparation of poultry feeds. The plant apart from being a good source of vitamins and amino acids, it has medicinal uses (Makkar and Becker, 1999; Francis *et al*., 2005). *Moringa oleifera*, otherwise regarded as a "miracle tree" has been used in the treatment of numerous diseases (Gbasi *et al*., 2000 and Matthew *et al*., 2001) including heart disease, and obesity due to its hypocholesterolemic property (Gbasi *et al*., 2000; Olugbemi *et al*., 2010a). The leaves and green pods are rich in carotene and ascorbic acid with good profile of amino acids (Makkar and Becker, 1996). Kakengi *et al*. (2003) observed that, *Moringa oleifera* leaves meal contains 86% DM, 29.7l% C.P., 22.5% CF, 4.38% EE, 27.9 mg/100g calcium, 0.26% phosphorus and negligible amount of tannin (1.23g/kg). In addition, Oduro *et al*. (2008) reported that *Moringa oleifera* leaves contain crude protein 27.51%, crude fiber 19.25%, crude fat 2.23%, ash 7.13%, moisture 76.53%, carbohydrate 43.88% and caloric value 1296.00 Kj/g (305.62 cal/g). Calcium and iron content in mg/100g (DM) are 20.09 and 28.29, respectively. Foidl and Paull (2008) reported that, the protein content of leave is high (20-35% on a dry weight basis) and most important is that, the protein is of high quality having significant quantities of all essential amino acids. Murro *et al*. (2002) reported that, the leaves are highly nutritious containing significant quantities of vitamin A, B and minerals such as C, Ca, Fe, P and protein. However, despite the high nutrient content of *Moringa oleifera* leaf meal, there are few reports in the literature on feeding trials with broilers. Therefore, the objective of this study is to evaluate the effect of feeding diets containing different levels of *Moringa oleifera* leaf meal on productive performance and blood chemistry of broiler chicks.

Materials and Methods

A total of one hundred and sixty, one-day old unsexed (Ross) broiler chicks were randomly distributed into 4 groups of 40 chicks. Each group was further subdivided into 5 replicates with 8 chicks per each. The chicks of each replicate were housed in a pen (1 square meter) in an open-sided deep litter house. Four levels of *Moringa oleifera* leaf meal (MOLM) 0.0, 3, 5 and 7% (treatments A, B, C and D) were fed during the experimental period for 7-weeks duration. The experimental diets were formulated to meet the nutrient requirements of broiler chicks according to NRC (1994) which were formulated from the local feed ingredients commonly used for poultry feed in the Sudan. The *Moringa oleifera* leaves were harvested and air dried under shade for 4 days and milled using a hammer mill to produce *Moringa oleifera* leaf meal which is suitable for incorporation into the experimental diets. Calculated analysis of the experimental diets were done according to feedstuff analysis outlined by Ellis

(1981), while determined chemical analysis was conducted by the method of AOAC (1995). Formulation, proximate analysis and calculated analysis for the experimental diets are shown in Tables (1 and 2) respectively, while chemical composition of the super concentrate used in the diets is shown in Table (3). Feed and water were offered ad-libitum. The light was continuous throughout the experimental period. The performance of the experimental birds in term of feed intake, live weight gain and feed conversion ratio were recorded weekly. Health of the experimental stock and mortality rate were closely observed and recorded daily.

Six birds from each treatment were taken randomly at the end of the 7th week from the start of the experiment, their legs were banded and individually weighed after overnight fast (except for water) then slaughtered without stunning. They were then scalded, manually plucked, washed and allowed to drain on wooden tables. Evisceration was performed by a ventral cut. The head, shanks, visceral, thoracic organs and internal parts (heart, liver and gizzard) were removed.

The eviscerated carcasses were chilled in a refrigerator for 24 hours at 4°C and then used for dissection. The breast and thigh of the left side of each carcass were dislocated, deboned and minced twice then kept frozen for determination of their chemical composition. Random samples of two thighs from each treatment were thawed and used for the determination of colour using Hunter Lab Tristimulus Colorimeter Model D25 M.2.20219 (L= 91.93, a=
-0.8, b= 1.0). Hunter Lightness (L), redness (a) and yellowness (b) were recorded. Blood samples were taken from jugular veins during slaughtering; three birds from each replicate (12 birds/ treatment) and collected into tubes treated with ethylene diamine tetra acetic acid (EDTA) for haematological assay.The remainder of each blood sample were allowed to clot, and sera separated by centrifugation at 3000 rpm for 5 minutes. Clear serum was stored at 20°C pending analysis for total protein.

Table (1): Formulation and proximate analysis of the experimental diets (percent as fed)

Treatments / Ingredients		A	B	C	D
A	**Formulation:**				
	Grain sorghum	65.00	65.00	65.00	65.00
	Wheat bran	5.00	2.00	-	-
	Groundnut meal	11.00	11.00	11.0	9.00
	Sesame meal	9.00	9.00	9.00	9.00
	Moringa oleifera leaf meal (MOLM)	0.00	3.00	5.00	7.00
	Super concentrate	5.00	5.00	5.00	5.00
	Oyster shell	2.75	2.75	2.75	2.75
	Common salt	0.25	0.25	0.25	0.25
	Vegetable oil (corn)	2.00	2.00	2.00	2.00
	Total	100	100	100	100
B	**Determined analyses**				
	Dry matter	95.00	94.82	94.60	94.00
	Crude protein (N%×6.25)	20.43	20.62	21.11	21.31
	Ether extract	6.72	6.74	6.77	6.73
	Crude fibre	4.40	4.46	4.48	5.42
	Ash	8.74	8.73	8.73	8.74
	Nitrogen free-extract	53.71	53.72	53.74	53.76

Table (2): Calculated analysis of the experimental diets (dry matter basis)

Item	A	B	C	D
Metabolizable energy (Kcal/kg)	3027	3035	3063	3050
Crude fat%	6.57	6.51	6.52	6.53
Crude protein%	20.09	20.41	21.01	21.22
Lysine%	1.03	1.05	1.08	1.09
Methionine%	0.44	0.54	0.54	0.54
Cystine%	0.29	0.28	2.29	2.28
Methionine + cystine%	0.73	0.75	0.76	0.77
Calcium%	0.97	1.00	1.10	1.10
Available phosphorus%	0.65	0.64	0.64	0.63
Caloric-protein ratio	151	150	150	150
ME Kcal/kg: protein %				

Metabolizable energy: calculated according to Ellis (1981)

Table (3): Chemical composition of the super concentrate used in the experimental diet formulation (Hendrix broiler concentrate)

Metabolizable energy	1900 (Kcal/kg)
Crude protein	32.00%
Lysine	11.00%
Methionine	2.80%
Methionine + cystine	2.25%
Calcium	8.00%
Available phosphorus	5.00%

Hematological and chemical analysis of blood:

Haemoglobin concentration (Hb) was determined using Hemoglobin-Drabkin Kit. The packed cell volume % (PCV) of Erythrocytes of whole blood was measured using a microhaematocrict centrifuge (Hawksley, London). The erythrocytes (RBC) were counted using Hayems solution. Mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) % also were calculated. Plasma total protein was determined as shown by King and Wootton (1965). Albumin concentration was determined by the Bromocresol Green Method (Peters *et al*., 1982). Globulin (Gb) concentration was computed as the difference between total protein and albumin concentrations.

Statistical analysis:

Statistical analysis was made by analysis of variance for randomized complete block design and differences of means determined by the Dancan's Multiple Range Test according to Steel and Torrie (1986).

Results

The effect of feeding different levels of Moringa oleifera leaf meal (MOLM) is shown in Table (4). Body weight gain, feed intake and feed conversion ratio were improved significantly (P<0.05) with the inclusion of MOLM in the broiler's diet. The diet supplemented with 5%

Table (4): Performance of broiler chicks fed on different levels of *Moringa oleifera* leaves meal

Parameter	A	B	C	D	SEM
Initial live weight (g/chick)	45.10	45.50	45.39	45.21	-
Final live weight (g/chick)	1742.0^{c}	1940.00^{ab}	1976.50^{a}	1873.00^{b}	46.50
Body weight gain (g/chick)	1696.90^{c}	1894.50^{ab}	1931.11^{a}	1827.79^{b}	43.20
Total feed intake (g/chick)	3480.00^{c}	3617.54^{b}	3669.10^{a}	3491.07^{c}	41.20
Feed conversion ratio	2.05^{b}	1.91^{a}	1.90^{a}	1.91^{a}	0.50
Mortality %	1.00	1.00	1.00	1.00	0.001^{NS}

A: Control (without MOLM)
B: 3% MOLM
C: 5% MOLM
D: 7% MOLM
SEM: Standard error of the mean
N.S. Not statistically significant (P>0.05)
Means on the same raw with the same superscripts are not significantly different (P>0.05).

yellowness which differed significantly (P<0.05). The diet with MOLM showed significantly the heaviest body weight gain and the highest total feed intake with better feed conversion ratio as compared to the other experimental diets. The experimental treatments had no significant (P>0.05) effect on the mortality rate.

Table (5) shows the effect of feeding different levels of MOLM on some haematological and blood biochemical parameters. There were significant (P<0.05) differences among groups in packed cell volume (PCV) and red blood cell (RBC) of the birds. The haemoglobin (Hb), MCV, MCH and MCHC counts showed no significant difference (P>0.05) among treatments, the values for (PCV) and (RBC) were significantly (P<0.05) higher for 5% MOLM diet as compared to other experimental diets. For serum biochemical compositions, there were significant (P<0.05) differences in the values of total protein while there was no significant (P>0.05) difference in the value of serum albumin and globulin. The diet with 5% MOLM showed significantly (P<0.905) higher value of total protein compared to other experimental diets.

Table (6) shows the thigh meat colour of the experimental birds on the different dietary treatments. The differences between lightness and redness were not statistically significant (P>0.05) among the experimental treatments except the
5% MOLM showed significantly (P<0.05) the higher yellowness score compared to other experimental diets.

Table (7) shows the effect of feeding different MOLM levels on chemical composition of breast and thigh muscles of the broilers. There were no significant differences (P>0.05) in the percentage of fat, **Table (5): Haemological parameters and serum biochemical compositions of broiler chicks fed different levels of *Moringa oleifera* leaves meal**

Parameters	A	B	C	D	SEM
Packed cell volume (%)	31.30^{c}	34.02^{b}	35.73^{a}	31.00^{c}	1.01
White blood	32.01	33.01	33.07	32.6	1.05^{NS}

cell ($x10^3/mm^3$)				3	
Red blood cell ($x10^6/mm^3$)	6.42^{c}	8.00^{b}	8.26^{a}	6.35^{c}	0.21
Haemoglobin (g/dl)	10.77	11.03	11.15	10.72	0.28^{NS}
MCV (fl)	134.91	135.05	135.30	134.13	0.73^{NS}
MCH (Pg)	58.90	57.33	58.31	58.73	0.64^{NS}
MCHC (%)	33.82	34.82	34.91	35.03	0.66^{NS}
Serum biochemistry					
Total protein	5.40^{bc}	5.71^{b}	6.39^{a}	5.20^{c}	0.15
Albumin	1.79	2.02	2.40	1.72	0.13^{NS}
Globulin	3.61	3.69	3.99	3.48	0.26^{NS}

A: Control (without MOLM)
B: 3% MOLM
C: 5% MOLM
D: 7% MOLM
SEM: Standard error of the means
NS: Not statistically significant (P>0.05)
Means on the same raw with the same superscripts are not significantly different (P>0.05).

Table (6): Determination of broiler meat colour using Hunter Lab Tristimulus Colorimeter

	A	B	C	D	SEM
a	6.20	6.19	6.22	6.23	0.15^{NS}
b	9.00^{c}	10.00^{b}	10.95^{a}	9.12^{c}	0.33
L	55.0	55.6	55.8	56.01	0.17^{NS}

a: Redness +, Grey O, Green -;
b: Yellowness +, Grey O, Blueness -;
L: Lightness
SEM: Standard error of the means
NS: Not statistically significant (P>0.05)
Means on the same raw with the same superscripts are not significantly different (P>0.05).

Table (7): Chemical composition of breast and thigh muscles of broiler chicks

Parameters	A	B	C	D	SEM
Breast					
Fat %	10.87	10.73	10.62	10.72	0.23^{NS}
Protein %	21.16^{c}	22.07^{b}	23.20^{a}	21.95^{c}	0.33
Moisture %	62.53	62.39	62.27	62.74	0.16^{NS}
Ash %	2.03	2.06	2.07	2.03	0.13^{NS}
Thigh:					
Fat %	11.90	11.85	11.83	11.89	0.21^{NS}
Protein %	20.03^{c}	21.86^{b}	22.35^{a}	20.52^{c}	0.32
Moisture %	63.81	63.90	63.72	63.83	0.14^{NS}
Ash %	1.68	1.62	1.65	1.59	1.16^{NS}

Means on the same raw with the different superscripts are significantly different (P<0.05)

moisture and ash for both breast and thigh muscles of the broilers among the different experimental treatments except the protein percentage. Birds fed on 5% MOLM level produced significantly the highest carcass protein percentage compared to other experimental treatments.

Table (8): Total cost, revenues and net profit of broiler chicks fed on different levels of (MOLM).

Item	A	B	C	D
Cost (SDG)				
Chick purchase	6.0	6.0	6.0	6.0
Management	4.0	4.0	4.0	4.0
Feed	11.20	11.15	11.10	11.00
Total cost	21.20	21.15	21.10	21.00
Revenues:				
Average eviscerated carcass weight (kg)	1.19	1.35	1.37	1.34
Price (SDG/kg)	23.00	23.00	23.00	23.00
Total revenues	27.37	31.05	31.51	30.82
Net profit				
Total revenues	27.37	31.05	31.51	30.82
Total cost	21.20	21.15	21.10	21.00
Net profit/bird	6.17	9.90	10.41	`9.82
Net profit/kg meat	5.18	7.33	7.59	7.32
Profitability ratio	1.00	1.41	1.47	1.41

Total cost calculated according to 2014 current (2014) price of meat 23(SDG)/kg.

Table (8) shows the calculations of total cost, revenues and net profit for the experimental groups. The results obtained from the economic study indicated that, treatment (C) with 5% MOLM showed the highest profitability ratio (1.47) compared to the control group.

Discussion

The effect of feeding different levels of *Moringa oleifera* leaf meal (MOLM) is shown in Table (4). The inclusion of MOLM in diet of broilers significantly (P<0.05) enhanced the weight gain as compared to control group. The improved weight gain of birds fed on MOLM based diets could be attributed to higher protein content and protein quality of the diets which were efficiently metabolized for growth. This result was in line with the finding of Kakengi *et al.* (2003); Olugbemi *et al*. (2010) and Banjo (2012) who mentioned that the inclusion of Moringa oleifera leaf meal in the diet of the broilers significantly (P<0.05) enhanced their weight gain at 1% level which was significantly higher than the control. The birds fed on the diet that contained 5% MOLM obtained significantly (P<0.05) higher weight gain as compared to those fed on the diet that contained 7% MOLM. This result may be attributed to higher crude fiber content which may impair nutrient digestion and absorption (Aderemi, 2003; Onu and Otuma, 2008; Onu and Aniebo, 2011). The lower weight gain of birds fed on 7% MOLM diet despite its higher crude protein content might also be due to the negative effect of the anti-nutritional factors present in MOLM on the birds. Moringa oleifera contain 1-23g of tannin in every 1 kilogram of leaves (Kakengi *et al*., 2003).Tannin has been reported to interfere with the biological utilization of protein and to a less extent available carbohydrate and lipids (Esonu *et al*.,2001). The depressed weight gain of birds fed on control diet may be due to the lower crude protein content of the diets which have been inadequate to enhance growth of the birds.

There were significant (P<0.05) differences in the feed intake of the birds among the treatments. The feed intake increased significantly (P<0.05) with the increasing level of MOLM. However, there was a marked reduction in the feed consumption of birds fed on 7% MOLM diet. This reduction could be due to reduced palatability of the diet (Kakengi *et al*., 2003).

There was a significant (P<0.05) improvement in the feed conversion ratio of the birds fed on MOLM based diets as compared to control group. This may be attributed to the fact that, birds fed MOLM based diets adequately utilized the nutrients they consumed. The results coincided with the finding of Ebenebe *et al*. (2012) who reported that, chicks fed on Moringa based diets performed significantly (P<0.05) better than the birds of control group in terms of higher weight gain and better feed conversion ratio. This improvement in body weight gain and feed conversion ratio may be attributed to rich content of nutrients in MOLM (Sarwatt *et al*., 2004; Kakengi *et al*., 2003) and antimicrobial properties of Moringa (Fahey *et al*., 2001).

As shown in Table (5) the packed cell volume (PCV) and red blood cell(RBC) of the birds were significantly (P<0.05) different among treatment groups. The values of (PCV) and (RBC) were significantly (P<0.05) higher for 5% MOLM diet as compared to other experimental diets. The (RBC) values were higher than the range of 3.07 to 7.50 x 10^6/mm^3 which was reported by Fudge (1999) but within 5-8 x 10^6/mm^3 reported by Anon (1980). The higher values of (RBC) recorded for birds fed on 5% MOLM diet indicate a higher protein quality of this diet and MOLM diets increased the blood quality. Hackbath *et al.* (1983) reported that, increased RBC values were associated with high quality dietary protein and with disease free animals. Red blood cells (RBC) are responsible for the transportation of oxygen and carbon dioxide in the blood as well as the manufacture of haemoglobin, hence higher values indicate a greater potential for this function and a better state of health (Olugbemi *et al*., 2010b). The significantly ((P<0.05) lower values of (RBC) and (PCV) recorded by 7% MOLM diet may be due to the higher concentration of tannin. Tannin has been reported to negatively affect feed intake as well as dry matter and protein digestibility (Gualitieri and Rapaccini, 1990). The packed cell volume (PCV) values obtained in this study though they differed significantly (P<0.05) among the groups were within the normal range (Merck Veterinary Manual, 1979). The values obtained for all the treatment groups indicate nutritional adequacy of all diets and presence of a toxic factor, since values did not indicate mal-nutrition (Church *et al*., 1984). PCV is an index of toxicity reduction in the blood usually and suggest the presence of toxic factor which has adverse effect on blood formation (Oyawoye and Ogunkunle, 1998). The values of white blood cell (WBC), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were similar (P>0.05) among treatment groups. The comparable (WBC) of the birds suggests that the animals were healthy because a decrease in number of (WBC) below the normal range is an indication of allergic condition, anaphylactic shock

and certain parasitism or presence of foreign body in circulating system (Ahamefule *et al*., 2008). The general non significance of the (WBC|) across treatments indicates that the experimental diet neither impaired nor enhanced the birds ability to wade off infection (Olugbemi *et al*., 2010b).

For serum biochemical indices, there were significant ($P<0.05$) differences in the values of total protein while there was no significant ($P>0.05$) difference in the values of serum albumin and globulin (Table 5). According to Eggum (1970) total serum protein is usually a reflection of the protein levels. The non significant ($P>0.05$) values for serum albumin and globulin obtained in this study suggests nutritional adequacy of the dietary proteins of the experimental diets. Additionally, it suggests that the diet did not influence the serum albumin and globulin.

As shown in Table (6) the thigh meat colour of the experimental birds was not d significantly different ($P>0.05$) for lightness and redness except the yellowness which was significantly ($P<0.05$) affected by the experimental diets. The diet with 5% MOLM produced significantly ($P<0.05$) higher score compared to other experimental diet. These may be due to oxycarotenoids that found in MOLM diets which cause yellow colour of broiler skin, shanks and egg yolk (Opara, 1996).

The chemical composition of the breast and thigh muscle were showed in Table (7). There were no significant differences in all parameters used except the protein percentage which was significantly different ($P<0.05$) for both breast and thigh muscles. The carcass protein content increased significantly ($P<0.05$) with increasing level of MOLM. However, there was a marked reduction in carcass protein content for diet 7% MOLM which resulted from the reduction in the feed consumption of birds fed on this diet (7% MOLM). This reduction could be attributed to reduced palatability of the diet (Kakengi *et al*., 2003). Additionally, to the higher tannin concentration which has a negative effect on dry matter and protein digestibility (Gualitieri and Rapaccini, 1990).

As shown in Table (8), the economical evaluation of the experimental diets indicated that the diet with 5% level MOLM showed the highest profitability ratio (1.47) which might be due to highest return of the weight gain recorded by this group in comparison to other experimental groups.

Conclusion

It could be concluded that, 5% *Moringa oleifera* leaf meal (MOLM) has successfully improved the broiler chicks performance and has no negative adverse effects on their blood characteristics.

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