Effect of adding *Moringa oleifera* leaf powder with or without probiotic on growth performnce, carcass characteristics and some biochemical blood characteristics for broiler

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- **Date of research received 2022/8/7 and accepted.2022/8/24**
- **Part of MSc. Dissertation for the first author.**

Abstract

A study conducted at poultry field/Animal Production Department/College of Agriculture, Kirkuk University, Iraq. The experiment aimed to study the effect of adding *Moringa oleifera* leaf powder with or without probiotic on growth performnce, carcass characteristics and some biochemical blood characteristics for broiler. 288 chicks of Ross 308 broilers (unsexed) were bred from one-day old until 42 days, and the average weight for chicks were 41.9 g. The chicks were randomly distributed to 6 treatments, with 4 replicates each treatment, (12chicks/replicate). The experimental treatments include: - T1: control, T2: standard diet + addition of probiotic 3 g/kg feed, T3: addition of *Moringa oleifera* leaf powder 2.5 g/kg feed, T4: addition of *Moringa oleifera* leaf powder 5 g/kg feed, T5: addition of *Moringa oleifra* leaf powder 2.5 g/kg feed + probiotic 3 g/kg feed and T6: addition of *Moringa oleifera* leaf powder 5 g/kg feed + probiotic 3 g/kg feed. The results showed a significant increase ($P<0.05$) in T5 in live body weight, weight gain rate and feed intake rate compared with other treatments. The feed conversion ratio was significantly improved in T4 and T5 compared to the other treatments. The average empty carcass weight was significantly increased in T4 compared to the other treatments, and the results also showed that the pieces (breast and thigh) and (wing, neck and back) were not affected by the study parameters. The relative weight of the liver and heart recorded a significant value in T2 compared to the other treatments. T3, T5 and T6 had a significant effect on the relative weight of gizzard, but the relative weight of abdominal fat was the lowest in T3 and T5. A significant decrease was found in the total protein concentration of T6 compared to the rest of the treatments, and there was a significant superiority of T4 and T5 compared to the other treatments in the concentration of glucose, and the total cholesterol concentration which was lower in T1, T3 and T5 compared to the rest of the treatments. The concentration of triglycerides decreased in T3 and T5, and T3 recorded the lowest concentration in uric acid compared to the rest of the treatments.

Key words: broiler, *Moringa oleifera* leaf powder, probiotic, carcass characteristics, blood biochemical.

تأثير إضافة مسحوق أوراق شجرة البان مع أو بدون معزز الحيوي على أداء النمو وصفات الذبيحة وبعض صفات الدم الكيموحيوية لفروج اللحم

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- **تاريخ استلام البحث 7/8/2022 وقبوله24/8/2022**
- **البحث مستل من رسالة ماجستير للباحث الاول .**

الخلاصة

أجريت الدراسة في حقل الدواجن/ قسم الإنتاج الحيواني/ كلية الزراعة جامعة كركوك-العراق. هدفت التجربة إلى دراسة تأثير إضافة مسحوق أوراق شجرة البان مع او بدون المعزز الحيوي على أداء النمو وصفات الذبيحة وبعض صفات الدم الكيموحيوية لفروج اللحم. تم تربية 288 فرخاً من فروج اللحم نوع Ross 308 (غير مجنسة) من عمر يوم واحد لغاية 42 يومًا، وكان متوسط الوزن 41.9 غم للفرخ الواحد. وزعت الافراخ عشوائياً على 6 معاملات بواقع 4 مكررات لكل معاملة (12 فرخ/مكرر). وكانت المعاملات التجريبية كالاتي:- T1: السيطرة، T2: عليقة قياسية + إضافة المعزز الحيوي بتركيز 3 غم/كغم علف، T3: إضافة مسحوق أوراق شجرة البان بتركيز 2.5 غم/كغم علف، T4: إضافة مسحوق أوراق شجرة البان بتركيز 5 غم/كغم علف، T5: إضافة مسحوق أوراق شجرة البان بتركيز 2.5 غم/كغم علف + المعزز الحيوي بتركيز 3 غم/كغم علف وT6: إضافة مسحوق أوراق شجرة البان بتركيز 5 غم/كغم علف + المعزز الحيوي بتركيز 3 غم/كغم علف. أظهرت النتائج تفوق معنوي ($P < 0.05$) في T5 في متوسط وزن الجسم الحي، ومعدل الزيادة الوزنية ومعدل استهلاك العلف مقارنة مع المعاملات الأخرى. تحسن معامل تحويل العلف معنويا في T4 وT5 مقارنة بالمعاملات الأخرى. وتفوق متوسط وزن الذبيحة الفارغ معنويا في T4 مقارنة مع المعاملات الأخرى، وأظهرت النتائج عدم وجود فروقات معنوية بين المعاملات في الوزن النسبي للقطعيات الرئيسية (الصدر والفخذ) والثانوية (الاجنحة والرقبة والظهر). تفوق وزن النسبي للكبد والقلب معنويا في T2 مقارنة بالمعاملات الأخرى. وتفوق T3 وT5 وT6 معنويا على باقي المعاملات في الوزن النسبي للقانصة، اما وزن النسبي لدهن البطن فقد انخفض معنويا في T3 وT5 مقارنة بالمعاملات الاخرى. ولوحظ وجود انخفاض معنوي في تركيز البروتين الكلي في T6 مقارنة بباقي المعاملات، وكان هناك تفوق معنوي في T4 وT5 مقارنة بالمعاملات الأخرى في تركيز الكلوكوز، وكان تركيز الكوليسترول الكلي أقل معنويا في T1 وT3 وT5 مقارنة ببقية المعاملات. انخفض تركيز الدهن الثلاثي في T3 وT5، وسجل T3 أقل تركيز في حامض اليوريك مقارنة بباقي المعاملات.

الكلمات المفتاحية: فروج اللحم، مسحوق أوراق شجرة البان، المعزز الحيوي، صفات الذبيحة، كيموحيوية الدم.

Introduction

Poultry production remains the most widespread of all livestock enterprises, and constitutes an important pillar for improving food security in most countries (Alders, 2005; Dieye et al., 2010). Antibiotics have been used as growth stimulants as feed additives used in the poultry industry to improve gut health and control sub-clinical diseases. With growing public concerns about bacterial resistance to antibiotics, the European Union has proactively banned the use of antibiotics as growth promoters since 1 January 2006 (Catala-Gregori et al., 2008). Therefore, alternatives to antibiotics as growth promoters should be proposed to livestock producers in order to maintain animal health, productivity and carcass quality. Thus, interest in safe and natural alternatives such as plants to replace antibiotics is on the rise. *Moringa oleifera* leaves also have the effects of prebiotics and antioxidant phytochemicals, such as chlorogenic acid and caffeic acid (Siddhuraju and Becker, 2003). *Moringa oleifera* leaves, widely available in many tropical countries, are a good source of antioxidant compounds such as ascorbic acid, flavonoids, phenols and carotenoids (Teixtra et al., 2014). *Moringa oleifera* is very high in antioxidants and anti-inflammatory compounds (Yang et al., 2006). Leaves, flowers, and pods are good sources of vitamins A, B, and C, riboflavin, nicotinic acid, folic acid, pyridoxine, ascorbic acid, beta-carotene, calcium, iron, and alpha-tocopherol (Dahot, 1988). The leaves and pods of *Moringa oleifera* also have a positive effect in reducing blood cholesterol (Ghasi et al., 2000). *Moringa oleifera* is a plant that can be used to boost immune responses and improve the gut health of broilers. Yang et al. (2006) reported that dried *Moringa oleifera* leaves in broiler diets significantly enhanced immune responses, reduced E.coli and increased Lactobacillus in ileums. Thus, *Moringa* oleifera has great potential in improving nutrition and strengthening immune functions in Meat chicken. Researchers believe that ensuring the safety of birds' immune systems is the most effective way to solve this difficult equation in order to avoid diseases and improve poultry products without the use of drugs. This can be achieved through appropriate biosecurity measures, the use of medicinal herbs and plants, and the use of a probiotic. To contribute to restoring the microbial balance of the intestinal flora when birds are exposed to stress due to disease and high temperature. It also covers the receptors on the surface of the intestinal epithelial cells, preventing dangerous germs from sticking to them and expelling them outside the body (Zinedine et al., 2005).

Therefore, this study aimed to find out the effect of using *Moringa oleifera* leaf powder with or without probiotic on growth, carcass and some biochemical blood characteristics for broiler.

Materials and methods

place and management of the experiment:

This experiment was conducted in the poultry field of the Department of Animal Production at the College of Agriculture, Kirkuk University for the period 42 days. 288 chicks (unsexed) were reared from Ross-308 broiler at 1 day old. The average weight was 41.9 grams per chick. Chicks were purchased from a private hatchery in Kirkuk governorate. Chicks were randomly distributed into 6 treatments, 48 birds for each treatment, 4 replicates for each treatment, each replicate contained 12 birds.

Experimental treatments:

Moringa oleifera leaf were obtained from a field in Chamchamal city of Sulaymaniyah governorate in Iraq, where the leaf were dried in a dark room for a week away from sunlight, and then the leaf were crushed by an electric mixer to become a powder ready for use. Baan tree leaf are harvested from the tree and washed thoroughly to remove dust and dirt. The leaf are dried in the shade to avoid damaging their phytonutrients. The dried leaf are crushed, sieved and stored in an airtight container for future use (Chukwuebuka, 2015). The probiotic Anova (Vietnamese origin) was purchased from the local markets and 1 kg of probiotic consists of the ingredients listed in Table (1).

Table (1) Components of the probiotic used in the experiment

Ingredients	Concentration
Lactobacillus acidophilus	18×10^9 - 22×10^9 CFU
Bacillus subtilis	18×10^9 - 22×10^9 CFU
Saccharomyces cerevisiae	18×10^9 - 22×10^9 CFU
Aspergillus oryzae	18×10^9 - 22×10^9 CFU
Vitamin A	1,000,000 IU
Vitamin D	150,000 IU
Vitamin B	250 mg
Niacinamide	200 mg
Folic Acid	100 mg

experimental treatments were as follows:

T1: the control treatment.

T2: a standard diet + adding the probiotic at a concentration of 3 g/kg feed (according to the recommendations of the producing company).

T3: Add *Moringa oleifera* leaf powder at a concentration of 2.5 g/kg feed.

T4: Add *Moringa oleifera* leaf powder at a concentration of 5 g/kg feed.

T5: Addition of *Moringa oleifera* leaf powder at a concentration of 2.5 g/kg feed + addition of the probiotic at a concentration of 3g/kg feed.

T6: Addition of *Moringa oleifera* leaf powder at a concentration of 5 g/kg feed + addition of the probiotic at a concentration of 3 g/kg feed**.**

Nutritional needs of ROSS-308 broilers according to the company guide:
As shown in Table (2).

Table (2) composition of the dietes with calculated chemical composition.

Ingredients %	0-10 DAY	11-24 DAY	25-42 DAY
Wheat	**49**	**52.34**	**65.46**
Corn	**10.30**	**10.00**	**0**
Oil	**3.15**	**4.26**	**5.77**
***Animal protein conc. (40%)**	**5.00**	**5.00**	**5.00**
Soybean meal 48%	**30.20**	**26.35**	**21.85**
Lysine	**0.10**	**0.07**	**0.08**
Methionine	**0.12**	**0.08**	**0.09**
Limestone	**1.93**	**1.7**	**1.55**
Salt	**0.10**	**0.10**	**0.10**
****Cholivit-M**	**0.10**	**0.10**	**0.10**
Total	**100.0**	**100.0**	**100.0**
	***Calculated chemical composition**		
Energy Kcal/kg	**3000**	**3100**	**3200**
Crude protein %	**23**	**21.51**	**20**
Lysine %	**1.28**	**1.15**	**1.06**
Methionine %	**0.58**	**0.52**	**0.51**
Met. + Cysteine	**0.95**	**0.87**	**0.83**
Ca %	**0.96**	**0.87**	**0.81**
Available phosphorous %	**0.51**	**0.51**	**0.53**

*Wafi protein concentrate (Dutch origin) contains 40% crude protein, 2117 kcal/kg, 5% crude fat, 3.85% lysine, 3.70% methionine, 4.12 methionine + cysteine, 3.14% calcium and 2.65% phosphorous.
**Mixture of vitamins and minerals.
***Chemical composition calculated according (NRC, 1994).
The nutritional requrment were calculated in the table according to the ROSS-308 (2019) guide.

Studied traits:

A- growth performance:

The following characteristics were studied: birds' live body weight (g), weight gain rate (g), feed intak rate (g), feed conversion ratio g feed/g weight gain, for broilers at 42 days of age, were studied.

B- Carcass characteristics:

The following characteristics were studied: empty carcass weight (g), dressing %, relative weight of the main pieces (breast, thigh) %, relative weight of secondary pieces (wings, neck, back) %, relative weight of the edible internal viscera (liver, heart, gizzard) were studied. % and the relative weight of abdominal fat % in broilers at 42 days of age**.**

C- Characteristics of blood biochemical:

The following characteristics were studied: (total protein concentration mg/dl, glucose concentration mg/dl, total cholesterol concentration mg/dl) were studied Triglycerides (mg/dl) and uric acid (mg/dl) in the blood serum of 42-day-old broiler.

statistical analysis:

The results were analyzed using the Complete Random Design (CRD) and Duncan's multiple range test (Duncan, 1955) to test the significance between the means of the coefficients at the probability level (0.05) using the ready-made statistical program SAS (2002).

Results and discussion

Table (3) showed that there are significant (P<0.05) differences between the treatments for the average live body weight (g), where T5 increase (adding *Moringa oleifera* leaf powder at a concentration of 2.5 g/kg feed + probiotic at a concentration of 3 g/kg feed) significantly on all treatments, T6 (adding *Moringa oleifera* leaf powder at a concentration of 5 g/kg feed + probiotics at a concentration of 3 g/kg feed) recorded the lowest average body weight live (g) compared to the rest of the treatments. As for the average weekly body weight gain (g), the results showed significant (P<0.05) differences between treatments, where T5 significantly increase on all treatments, T6 recorded the lowest rate weight gain (g) compared to the rest of the treatments. As for the feed intak (g), the results showed that there were significant (P<0.05) differences between the treatments, where T5 significantly increase on all treatments, T4 (adding Moringa leaf powder at a concentration of 5 g/kg feed) and T6 recorded the lowest feed intak (g) compared to the rest of the treatments. As for the feed conversion ratio, the results showed that there were significant (P<0.05) differences between the treatments, where T3 (adding Moringa oleifera leaf powder at a concentration of 2.5 g/kg feed) was significantly superior to all treatments. T4 and T5 recorded the lowest feed conversion ratio compared to the rest of the treatments.

The reason for the improvement in the productive traits and growth performance of broilers in this study in the treatments in which *Moringa oleifera* leaf powder was used with the probiotic in the most of studied traits may be attributed to the synergistic effect of *Moringa oleifera* leaf powder with the probiotic as a growth stimulant. According to the studies conducted by (Hsu et al., 2006; Kasolo et al., 2010) on *Moringa oleifera* from a medical point of view, *Moringa oleifera* has been shown to have tremendous therapeutic capabilities because it is very rich in nutrients and vital elements needed by body, such as vitamins (A, B1, B2, B3, B6, folic acid, and C), minerals (calcium, potassium, iron, phosphorous, magnesium, zinc), amino acids, fatty acids, beta-carotene, antioxidants and anti-inflammatory substances. *Moringa oleifera* is a plant that can be used to boost immune responses and improve the gut health of broilers. Yang *et al.* (2006) reported that dried *Moringa oleifera* leaf in broiler diets significantly enhanced immune responses, reduced E.coli and increased Lactobacillus ileum populations. Thus, *Moringa oleifera* has great potential in improving nutrition and strengthening immune functions in chickens. As Ahmad and AL-Neemi (2017) mentioned that the probiotic works by secreting enzymes that birds' digestive system do not possess in order to break down or render ineffective anti-nutritional factors such as phytic and non-starchy polysaccharides. The improvement in growth performance

may be due to the action of the probiotic that was added to the diet, thus it leds to make the digestive system in a state of microbial balance leading to an increase in the amount of beneficial microbes at the expense of pathogenic microbes, which in turn led to an improvement in performance compared to diets that were not equipped with the probiotic (Al-Salihy and Hussaini, 2020; Simon et al., 2001). The decrease in the growth performance that was observed in the sixth treatment in which *Moringa oleifera* leaf powder was used at concentration of 5 gm/kg fodder with the probiotic may be due to the activity of anti-nutrition factors present in *Moringa oleifera* leaf, as Muhammad et al. (2011) indicated that *Moringa oleifera* leaf contents. It contains tannins and saponins which is known to reduce feeding efficiency and thus lower body weight.

Table (3) Effect of adding *Moringa oleifera* leaf powder with or without probiotic on growth performnce of 42-day-old broiler (mean ± standard error)

Traits	Treatments					
	T1	T2	T3	T4	T5	T6
Live body weight (g)	2796.07 ± 4.47 bc	2820.88 ± 9.48 b	2779.21 ± 7.83 cd	2785.87 ± 6.31 bc	2867.79 ± 16.33 a	2747.28 ± 17.21 d
Body weight gain rate (g)	2754.17 ± 4.47 bc	2778.98 ± 9.48 b	277.31 ± 7.83 cd	2743.97 ± 6.31 bc	2825.89 ± 16.33 a	2705.38 ± 17.21 d
Feed intak (g)	3840.35 ± 5.30 b	3882.53 ± 18.32 b	3858.04 ± 8.17 b	3778.4 ± 14.12 c	3933.44 ± 15.58 a	3779.83 ± 16.71 c
Feed conversion ratio	1.394 ± 0.01 ab	1.397 ± 0.01 ab	1.409 ± 0.01 a	1.377 ± 0.00 c	1.392 ± 0.01 bc	1.397 ± 0.00 ab

*Different letters within the same row indicate significant differences (P<0.05) between the treatments.
**T1: Control treatment without additives, T2: Standard diet + Probiotic supplement at concentration (3g/kg feed), T3: Add *Moringa oleifera* leaf powder at concentration (2.5g/kg feed), T4: Add *Moringa oleifera* leaf powder at concentration (5g/kg feed), T5: add *Moringa oleifera* leaf powder at a concentration (2.5g/kg feed) + add a probiotic at a concentration (3g/kg feed), T6: add *Moringa oleifera* leaf powder at a concentration (5g/kg feed) + add a probiotic at a concentration (3 g/kg feed).

The results in Table (4) showed that there were significant differences (P<0.05) between the treatments in the average weight of the carcass without the internal viscera (g) and of dressing %, where T4 increase (adding Moringa oleifera leaf powder at a concentration of 5 g/kg feed) significantly on all treatments in the average empty carcass weight (g). However there was a significant decrease (P<0.05) in the average empty carcass weight (g) in the T3 (adding Moringa oleifera leaf powder at concentration of 2.5 g/kg feed) compared to the rest of the treatments. T2 (adding probiotics at a concentration of 3 gm/kg feed) and T4 were significantly superior to all treatments in the dressing %, while there was a significant decrease (P<0.05) in the dressing % in the T1 compared to the rest of the treatments. The results also showed that there were no significant differences (P<0.05) between the treatments in the relative

weight of the main pieces (breast and thigh) and the relative weight of the secondary pieces (wings, neck and back).

The improvement in carcass weight may be due to the improvement in the digestibility of the feed ingredients through herbal nutritional supplements (Jamroz et al., 2003). It may be due to the effect of another substance such as vitamins that improved the feeding efficiency of broilers (Melesse et al., 2011). *Moringa oleifera* leaves contain some antioxidants such as tocopherol, vitamin C and ascorbic acid which have been known as stress reducer, digestive enhancer and growth stimulator, thus, it can lead to improvement in carcass weight (Qwele et al., 2013; Saini et al., 2014). Also, the effect of the biostimulant, which has a role in improving growth performance, which lead to improvement in the dressing ratio and the weight of the carcass, noted by Gibson and Roberfroid (1995); Chen et al (2005); AL-Taei and AL-Neemi (2019) that strains of beneficial microorganisms in the probiotic improve nutrients in terms of readiness and prevent the presence of harmful pathogenic microorganisms that compete with the bird for nutrients in the digestive system

Table (4) Effect of adding *Moringa oleifera* leaf powder with or without probiotic on carcass characteristics (carcass weight (g), dressing % and relative weight of main and secondary pieces %) (mean ± standard error)

Traits %	Treatments					
	T1	T2	T3	T4	T5	T6
Empty carcass weight rate (g)	2255.00 ± 23.98 ab	2282.50 ± 37.50 ab	2040.00 ± 22.08 d	2322.50 ± 13.77 a	2238.75 ± 16.50 b	2148.75 ± 20.45 c
Dressing %	72.88 ± 0.86 c	79.75 ± 0.79 a	76.55 ± 1.58 b	78.59 ± 0.48 ab	75.79 ± 0.77 b	76.23 ± 0.92 b
Relative weight of the main pieces %						
Breast	37.05 ± 0.56 a	35.29 ± 0.28 a	35.71 ± 0.83 a	36.33 ± 1.18 a	35.35 ± 1.00 a	34.91 ± 0.97 a
Thigh	27.49 ± 0.36 a	27.60 ± 0.42 a	27.57 ± 0.61 a	28.00 ± 0.30 a	28.23 ± 0.58 a	28.30 ± 1.00 a
Relative weight of secondary pieces %						
Wings	9.99 ± 0.36 a	10.56 ± 0.39 a	10.91 ± 0.23 a	10.40 ± 0.24 a	10.62 ± 0.39 a	10.46 ± 0.46 a
Neck	7.09 ± 0.24 a	7.18 ± 0.22 a	6.99 ± 0.10 a	7.07 ± 0.44 a	7.42 ± 0.16 a	7.62 ± 0.23 a
Back	18.38 ± 0.18 a	19.37 ± 0.20 a	18.82 ± 0.40 a	18.20 ± 0.54 a	18.38 ± 0.47 a	18.71 ± 0.70 a

*Different letters within the same row indicate significant differences (P<0.05) between the treatments.
**T1: Control treatment without additives, T2: Standard diet + Probiotic supplement at concentration (3g/kg feed), T3: Add *Moringa oleifera* leaf powder at concentration (2.5g/kg feed), T4: Add *Moringa oleifera* leaf powder at concentration (5g/kg feed), T5: add *Moringa oleifera* leaf powder at a

concentration (2.5g/kg feed) + add a probiotic at a concentration (3g/kg feed), T6: add *Moringa oleifera* leaf powder at a concentration (5g/kg feed) + add a probiotic at a concentration (3 g/kg feed).

As for the relative weight of the edible internal viscera and abdominal fat %, the results in table (5) showed significant differences ($P<0.05$) between the treatments, where T2 (adding probiotic at a concentration of 3 g/kg feed) superior significantly on all treatments in relative weight for the liver and heart, while there was a significant decrease ($P<0.05$) in the relative weight of the liver in the T3 (adding Moringa oleifera leaves powder at a concentration of 2.5 g/kg feed) and T5 (Adding Moringa oleifera leaf powder at a concentration of 2.5 g/kg feed + probiotic at a concentration of 3 g/kg feed) compared to the rest of the treatments, and there was a significant decrease ($P<0.05$) in the relative weight of the heart in T5 Compared to the rest of the treatments, the treatments T3 (adding Moringa oleifera leaf powder at a concentration of 2.5 g/kg feed) and T5 and T6 (adding Moringa oleifera leaf powder at a concentration of 5 g/kg feed + probiotic at a concentration of 3 g/kg of feed) was significantly superior to the rest on the treatments in the relative weight of the gizzard, there was a significant decrease ($P<0.05$) in the relative weight of gizzard in T2 (adding probiotic at a concentration of 3 g/kg feed) compared to the rest of the treatments. there was a Significant superiority ($P<0.05$) in the relative weight of abdominal fat in T1 (control) compared to the rest of the treatments, and there was a significant decrease ($P<0.05$) in the relative weight of abdominal fat in T3 (Adding Moringa oleifera leaf powder at a concentration of 2.5 g/kg of feed), and T5 compared to the rest of the treatments.

The decrease in abdominal fat may be attributed to the properties of *Moringa oleifera* leaf in reducing fat (Cui et al., 2018) and they confirmed that feeding on *Moringa oleifera* leaf reduces the percentage of abdominal fat for broilers. Other researchers suggested that feeding *Moringa oleifera* leaf reduced lipid biogenesis resulting in reduced abdominal fat deposition in broilers. It can also be attributed to the presence of phenolic antioxidants in *Moringa oleifera* leaf powder and ethanol extract which improve the oxidative stability of abdominal fat in birds (Bartov and Bornstein, 1981; Abou Sekken et al., 2013).

Table (5) Effect of adding *Moringa oleifera* leaf powder with or without probiotic on the relative weight of edible viscera and abdominal fat % (mean ± standard error)

Relative weight %	Treatments					
	T1	T2	T3	T4	T5	T6
Liver	2.02 ± 0.03 b	2.28 ± 0.06 a	1.90 ± 0.03 c	2.13 ± 0.04 b	1.82 ± 0.03 c	2.07 ± 0.04 b
Heart	0.50 ± 0.02 bc	0.57 ± 0.03 a	0.51 ± 0.02 bc	0.52 ± 0.01 abc	0.47 ± 0.01 c	0.54 ± 0.02 ab
Gizzard	1.84 ± 0.04 b	1.61 ± 0.03 c	2.08 ± 0.05 a	1.78 ± 0.04 b	2.01 ± 0.06 a	2.04 ± 0.06 a
Abdominal fat	1.08 ± 0.06 a	0.81 ± 0.03 bc	0.77 ± 0.05 c	0.85 ± 0.04 bc	0.79 ± 0.04 c	0.95 ± 0.05 ab

*Different letters within the same row indicate significant differences (P<0.05) between the treatments.
**T1: Control treatment without additives, T2: Standard diet + Probiotic supplement at concentration (3g/kg feed), T3: Add *Moringa oleifera* leaf powder at concentration (2.5g/kg feed), T4: Add *Moringa oleifera* leaf powder at concentration (5g/kg feed), T5: add *Moringa oleifera* leaf powder at a concentration (2.5g/kg feed) + add a probiotic at a concentration (3g/kg feed), T6: add *Moringa oleifera* leaf powder at a concentration (5g/kg feed) + add a probiotic at a concentration (3 g/kg feed).

The results in Table (6) showed a significant decrease (P<0.05) in the concentration of total protein (mg/dl) in T6 (adding *Moringa oleifera* leaf powder at a concentration of 5 g/kg feed + the probiotic at a concentration of 3 g/kg feed) Compared to the rest of the treatments, there were no significant differences between the remaining treatments. The decrease in protein in the sixth treatment (T6) in which *Moringa oleifera* leaf powder was used at a concentration of 5 gm/kg fodder with the probiotic could be attributed to the harmful effect of the phytotoxins of *Moringa oleifera* such as lecithin, moringaine, moringenin, glucosinolates, tannins, nitrites, oxalates and phytates (Odetola, 2012). The decrease in total protein is always due to a decrease in the level of albumin (Melesse et al., 2013). Albumin deficiency may be due to primarily decrease in synthesis by the liver and secondly to decrease protein consumption which also confirms liver damage (Luskova et al., 2002; Jyotsna et al., 2003). Low levels of protein in the blood is an indication that toxic substances such as isothiocyanates and glycoside cyanide may cause the protein to be triggered by stress to deal with a harmful condition (Das and Mukherjee, 2000).

In addition, it was found that there were significant differences (P<0.05) between the treatments in the concentration of glucose (mg/dl), there was a significant superiority in favor of the T4: adding Moringa oleifera leaf powder at a concentration (5 g/kg feed), and T5: the addition of Moringa oleifera leaf powder at a concentration of (2.5 g/kg feed) + the addition of the probiotic at a concentration of (3 g/kg of feed), compared to the rest of the treatments, T1 (control) recorded a significant decrease in glucose concentration mg/dl compared to the rest of the treatments, High glucose concentration in the blood serum of broilers by using *Moringa oleifera* leaves powder with or without the probiotic may be due to the fact that the birds used carbohydrates in the ration efficiently, it may be due to the active substances in *Moringa oleifera*

leaves. Teixeira et al. (2014) reported that quercetin, zeatin, apigenin and kaempferol (phenolic components) in *Moringa oleifera* leaves had a key role in reducing digestive problems, and the growth of birds, thus leading to efficient feed consumption for growth. It may be attributed to the use of the probiotic, which leads to a change in the absorption and excretion of steroids, a decrease in the concentration of bile salts, or an increase in the activity of amylase enzyme in the small intestine of broilers (Jin et al., 2000; Kalavathy, 2003).

It was also noted that there were significant ($P<0.05$) differences between the treatments in the concentration of total cholesterol mg/dl, where T4 and T6 increased on the rest of the treatments, and the total cholesterol concentration decreased in T1 (control) and T3 (adding Moringa oleifera leaf powder at a concentration of 2.5 g/kg feed) and T5 compared to the rest of the treatments. *Moringa oleifera* leaves powder has anti-cholesterol effects in broilers. Moreover, the increase in cholesterol concentration in treatments in which *Moringa oleifera* leaf powder was used at concentration of 5 g/kg feed may be due to the increase in HDL cholesterol concentration. In a study conducted by (Alnidawi et al., 2016), the use of *Moringa oleifera* leaf powder in broiler diet reduces the concentration of low density lipoprotein (LDL) cholesterol and increases the concentration of high density lipoprotein (HDL) cholesterol. Therefore, the observed increase in blood cholesterol in broiler broilers fed with *Moringa oleifera* leaf powder may be indicative of a large proportion of high density lipoprotein (HDL) cholesterol.

The results also showed significant differences ($P<0.05$) between treatments in the concentration of triglycerides mg/dl, where T1 (control) was significantly superior to all treatments, and the concentration of triglycerides decreased in T3 and T5 compared to the rest of the treatments. The decrease in triglycerides in treatments containing *Moringa oleifera* leaves powder may be due to the effectiveness of the active substances, especially the phenolic compounds in *Moringa oleifera* leaves. *Moringa oleifera* leaves contain a high amount of polyphenols (Moyo et al., 2011) flavonoids, alkaloids and phenolic compounds (Verma et al., 2009) and these compounds have a hypolipidemic effect. In this study, the decrease in serum triglyceride concentration of broilers could be attributed to the above mentioned phytochemical components in *Moringa oleifera* leaf powder. During digestion in the intestine, cholesterol is the main component of the bile acids secreted. The fiber coats the bile acids in the intestine and is excreted in the body, which cause the body to withdraw cholesterol from the blood to form bile acids and thus lower the level of cholesterol in the blood (Olugbemi, 2010).

The results also showed significant differences ($P<0.05$) between treatments in the concentration of uric acid mg/dl, where T1 (control) was significantly superior to all treatments, T3 recorded the lowest concentration in uric acid compared to the rest of the treatments. Uric acid is the form of protein excreted through the urine that often occurs when extra protein is available in the circulation. However, a decrease in the serum uric acid concentration of broilers feeding on *Moringa oleifera* leaf powder in the ration may occur with increased in protein consumption, which may indicate better absorption and effective utilization of the broiler protein (Alnidawi et al., 2016).

Table (6) Effect of adding *Moringa oleifera* leaf powder with or without a probiotic on some blood biochemical characteristics (mg/dl) (mean ± standard error)

Traits (mg/dl)	**Treatments**					
	T1	**T2**	**T3**	**T4**	**T5**	**T6**
Total Protein	2.68 ± 0.08 a	2.70 ± 0.12 a	2.68 ± 0.09 a	2.85 ± 0.06 a	2.68 ± 0.05 a	2.38 ± 0.06 b
Glucose	234.63 ± 1.97 c	243.15 ± 1.11 ab	239.48 ± 0.93 b	246.13 ± 1.52 a	246.30 ± 1.55 a	243.35 ± 1.27 ab
Total Cholesterol	125.08 ± 0.89 c	135.95 ± 0.98 b	124.65 ± 1.03 c	143.60 ± 1.64 a	126.35 ± 1.49 c	140.43 ± 0.81 a
Triglycerides	34.08 ± 1.48 a	28.60 ± 1.32 b	19.93 ± 0.77 d	27.53 ± 1.06 bc	21.18 ± 0.19 d	24.85 ± 0.67 c
Uric Acid	4.51 ± 0.17 a	2.47 ± 0.21 bc	2.32 ± 0.06 c	2.85 ± 0.07 b	2.84 ± 0.07 b	2.57 ± 0.21 bc

*Different letters within the same row indicate significant differences (P<0.05) between the treatments.
**T1: Control treatment without additives, T2: Standard diet + Probiotic supplement at concentration (3g/kg feed), T3: Add *Moringa oleifera* leaf powder at concentration (2.5g/kg feed), T4: Add *Moringa oleifera* leaf powder at concentration (5g/kg feed), T5: add *Moringa oleifera* leaf powder at a concentration (2.5g/kg feed) + add a probiotic at a concentration (3g/kg feed), T6: add *Moringa oleifera* leaf powder at a concentration (5g/kg feed) + add a probiotic at a concentration (3 g/kg feed).

Conclusion

The study conclude that use of 2.5 g/kg feed of *Moringa oleifera* leaf powder with the probiotic in broilers diets led to an improvement in the productive characteristics of broiler. The carcass weight improved by using 5 g/kg feed of *Moringa oleifera* leaf powder, also improvement in dressing ratio and a decrease in abdominal fat when using *Moringa oleifera* leaf powder at different levels with or without probiotic. The use of *Moringa oleifera* leaf powder at different levels with or without the probiotic led to an improvement in some blood biochemical characteristics of broiler.

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