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Effect of *Moringa oleifera* Aqueous Seed Extract on Some Productive Indicators of Broiler Chickens

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Abstract

Background: The research aims to study the effect of the *Moringa oleifera* aqueous seeds extract (MSE) on some productive indicators of broiler chickens. The experiment was conducted using 300 broiler chicks of the Ross 308 strain. Starting from one day of age until 42 days. The broiler chickens were allocated into four equal groups: T1 (control), T2, T3 and T4, each of which included 75 broiler chickens. They were fed balanced and uniform diets according to their age. Drinking water was ad libitum provided, with the addition of the MSE at a rate of 0, 80, 100 and 120 ml/liter of water for T1, T2, T3 and T4, respectively.

Results: The results showed a significant improvement ($P<0.05$) in the growth rate, and feed conversion ratio, with a decrease ($P<0.05$) in the percentage of dead broiler chickens, for the groups treated with MSE compared to the control group T1.

Conclusions: The study suggests that adding the aqueous of MSE to the drinking water of broiler chickens results in the improvement of the studied productivity indicators.

Keywords: *Moringa oleifera, Seed extract, Productive indicators, Broiler chickens*

Background

The poultry industry is one of the most important sectors of animal production, contributing to the provision of high-quality animal protein in large quantities to meet the growing nutritional needs of humans [1]. With increasing production, it has become necessary to rely on feed additives to improve growth, increase feed conversion efficiency, and enhance immunity against diseases. Antibiotics have been used for many years to achieve this goal [2], but their extensive use has led to the emergence of health problems, most notably the development of bacterial resistance to antibiotics and the accumulation of drug residues in poultry meat and eggs, which negatively impacts consumer health [3]. Therefore, recent studies have focused on safe and effective natural alternatives, with medicinal plants and their derivatives, such as oils and extracts, playing a prominent role in this field [4]. *Moringa oleifera* is a medicinal plant rich in active compounds such as phenols, flavonoids, antioxidants, amino acids, and minerals [5]. It is used as a plant-based supplement to improve health and immunity and increase production efficiency in poultry. Phenolic compounds and flavonoids are key factors in increasing the activity of antioxidant enzymes, reducing oxidative stress caused by free radical formation, and supporting the bird's immune system by stimulating the production of antibodies and increasing the number of white blood cells [6]. Isothiocyanates and other plant compounds also act as antimicrobials, helping to reduce bacterial infections and disease, and improving the integrity of the intestinal mucosa, which positively impacts nutrient absorption and reduces mortality rates [7]. Several studies have indicated the important role of using Moringa in poultry nutrition to improve health and productivity [8]. Ali *et al.,* [9] found that adding MSE to drinking water can lead to lower mortality rates and increased growth, which enhances production efficiency, as found by Rehman *et al.,* [10]. Adding MSE to poultry drinking water has significant effects on improving growth rates, weight gain, meat quality, and its vitamin, mineral, protein, and fat content. Verma *et al.,* [11] found that when studying the effect of adding an aqueous extract of *Moringa oleifera* leaves to the drinking water of four groups of broiler chickens, the first group received drinking water devoid of the extract, the second group received 60 ml of the extract per liter, the third group received 90 ml per liter, and the fourth group received 120 ml per liter. The results showed a significant increase ($P<0.01$) in the weights of broiler chickens and an improvement in the feed conversion ratio in the groups treated with the extract, with the highest increase recorded in the group receiving 90 ml per liter. Given the recent trend toward using medicinal plants and their extracts as a natural alternative to antibiotics to enhance chicken production efficiency, which enhances the safety of animal products and reduces reliance on chemicals that may negatively impact human health and the environment, the aim of this study was to study the effect of adding different levels of aqueous MSE to drinking water on some production indicators (weight gain, feed consumption, feed conversion ratio, and mortality rate) in broiler chickens.

Materials and Methods

Animals, Treatments and Experimental Design

The study was conducted using 300 one-day-old chickens of Ross 308 strain, in a private farm on the outskirts of Hama city, which relies

on a semi-closed breeding system and a bedding of sawdust. The experiment lasted for 42 days during the period from 01/09/2024 to 11/10/2024. The broiler chicks were distributed into four groups, each containing 75 broiler chickens. Each group contained three replicates, each containing 25 broiler chickens, according to a completely random design. The broiler chickens were placed in mesh cages with dimensions of 2 x 1.5 m, with a density of 8 chickens /m^2. The broiler chickens of each replicate were placed in a place equipped with a feeder and a drinker, and all groups underwent the same treatment in terms of heating, ventilation, and everything related to the management and care system. The broiler chickens were cared for from one day old until 42 days old, and the temperature was controlled when receiving the broiler chicks at around 33°C during the first three days, then it was gradually reduced at a rate of 1°C daily for all the studied treatments to be fixed at 21°C, while light was provided 24 hours a day during the first three days of caring for the broiler chicks, then the lighting was gradually reduced at a rate of one hour a day until the age of one week, to fix the lighting program according to (20L: 4D) until the end of the fattening period [12]. The broiler chickens were also vaccinated according to a unified preventive vaccination program followed in the breeding area (Table 1), in addition to giving them vitamins to resist the stress caused by the used vaccine.

The broiler chickens were fed with balanced protein and energy pellet feed mixtures produced by Feedmix (Hama, Syria). The care period was divided into three phases: the starter phase (1-14 days), the grower phase (15-25 days), and the finisher phase (26-42 days). The feed mixtures were provided in accordance with their needs according to the age phase (Table 2) according to the recommended nutritional requirements tables for the breed Aviagen [13]. The feed mixtures and water were ad libitum provided.

Preparation of the Aqueous Extract of Moringa Seeds

Moringa seeds were obtained from private shops selling medicinal herbs in Hama Governorate. They were cleaned, leaves and foreign bodies were removed, dried, and then ground using a special mill for medicinal plants until a fine powder was obtained. Then 100 g of the powder were collected and mixed with 1000 ml of distilled water (at a ratio of 10: 1) using an electric mixer. The mixture was then left for 24 hours at room temperature. After that, the mixture was filtered using several layers of medical gauze to get rid of suspended particles. Then, the mixture was placed in a centrifuge (Bio-Rad- USA) at a speed of 3000 rpm for 10 minutes. After that, the extract was filtered using Whatman No. 101 filter papers to obtain a clear solution. Then, the extract was diluted with clean drinking water to obtain the doses that were provided to the broiler chickens daily [14] as follows:

Group T1: Drinking water only (control group).

Table 1: Immunization program followed during the period of care.

Today'S	Method of giving the vaccine	Type of vaccine given
1	Eye Drop	Newcastle and bronchitis
10	Drinking Water	ND Clone 30
14	Drinking Water	Gumboro
25	Drinking Water	ND Clone 30

Table 2: Composition of feed mixtures used in feeding experimental broiler chickens.

Ingredients(g/kg)	Starter Mixture (1-14 days)	Grower Mixture (15-25 days)	Finisher Mixture (26-42 days)
Yellow corn	556.4	594.3	624.3
Soybean meal, 48%	320	280	231.3
Corn gluten, 60%	59.8	55.7	65.7
Soybean oil	20	30	40
Calcium carbonate	13	12	10.5
Calcium dibasic Phosphate	15	13	13
Common salt	1.5	1.5	1.5
Premix*	3	3	3
DL-Methionine, 98%	2.3	2	1.8
Lysine, Hcl, 78%	4.7	4.2	4.6
Choline	0.7	0.7	0.7
Threonine	1	1	1
Phytase	0.1	0.1	0.1
NaCo3	2.5	2.5	2.5
Chemical composition (g/kg)**			
ME kcal/kg diet	3012.65	3108.199	3213.92
Crude Protein%	23.48	21.57	20.14
Calcium	9.7	8.7	8.1
Available P	4.8	4.3	4.1
Lysine	14.4	12.9	11.9
Methionine	5.6	5.1	4.8
Threonine	9.7	8.8	8.1

*Premix per kg of diet: vitamin A, 1500 IU; vitamin D3, 200 IU; vitamin E, 10 mg; vitamin K3, 0.5 mg; thiamine, 1.8 mg; riboflavin, 3.6 mg; pantothenic acid, 10 mg; folic acid, 0.55 mg; pyridoxine, 3.5 mg; niacin, 35 mg; cobalamin, 0.01 mg; biotin, 0.15 mg; Fe, 80 mg; Cu, 8 mg; Mn, 60 mg; Zn, 40 mg; I, 0.35 mg; Se, 0.15 mg

**According to Ross manual Guide, Aviagen [12].

Table 3: Phytochemical content (mg/L) of moringa seed extract (MSE) treatments.

Phytochemicals	T2	T3	T4
Alkaloids	8.53	8.89	9.16
Carbohydrates	2.79	3.35	3.54
Flavonoids	3.98	4.23	4.52
Phenols	17.96	18.41	18.99
Protein	32.77	33.32	34.12
Saponins	5.87	6.18	6.63
Steroids	4.12	4.73	5.34
Tannins	47.63	53.2	55.32
Terpenoids	18.24	18.97	19.48

Group T2: 80 ml of MSE/L of drinking water.

Group T3: 100 ml of MSE/L of drinking water.

Group T4: 120 ml of MSE/L of drinking water.

Chemical Analysis of Moringa Seed Extract Treatments

The MSE treatments (T2, T3, and T4) were analyzed for alkaloids, carbohydrates, flavonoids, glycosides, phenols, proteins, saponins, steroids, tannins, and terpenoids using the standard method by Ijarotimi *et al.* [15] and Nathaniel *et al.* [16], as shown in Table 3.

The calcium, magnesium, phosphorus, potassium, zinc, iron, and sodium content of MSE treatments was determined according to the

methods described by Liang *et al.* [17]. The MSE treatments (T2, T3, and T4) were analyzed for vitamin A, B1, B2, B3, B6, B12, C, D3, E, K3, and *β*-carotene (Table 4) using the methods described by Sami *et al.* [18].

Studied Indicators

The production indicators were studied during 42 days of the chickens ' life, as follows:

Weight of hatched broiler chickens (g): The broiler chickens were weighed at one day of age in each replicate separately using a scale with an accuracy of 0.1 g.

Weekly live weight (g): The individual weight of the broiler chickens was recorded weekly for all chickens in the studied groups.

Weight gain (g): Live weight at the end of the period - live weight at the beginning of the period [19].

Table 4: Mineral and vitamin composition (mg/L) of moringa seed extract (MSE) treatments.

Micronutrients	T2	T3	T4
Calcium	601.3	621.7	637.8
Magnesium	38.47	41.20	43.50
Phosphorus	356.0	396.4	405.8
Potassium	69.00	74.00	77.10
Zinc	1.067	1.170	1.243
Iron	6.260	6.490	6.750
Sodium	243.8	262.7	275.7
Vitamin A	4.040	4.480	4.640
Vitamin B1	0.140	0.170	0.250
Vitamin B2	0.230	0.310	0.350
Vitamin B3	0.230	0.320	0.390
Vitamin B6	0.280	0.320	0.360
Vitamin B12	0.110	0.130	0.170
Vitamin C	4.650	4.800	4.940
Vitamin D3	ND	ND	ND
Vitamin E	546.0	597.0	630.0
Vitamin K3	ND	ND	ND
β-carotene	ND	ND	ND

ND = not detected.

Average feed intake of the broiler chickens (g): According to the average weekly feed intake, by weighing the amount of feed provided to each group at the beginning of the week, then weighing the amount of feed remaining in the feeders for each group at the end of the week, and according to the difference in weight. The average feed intake of each chicken was calculated according to the following equation:

Average feed intake (g) = Amount of feed given (g) - Amount of feed remaining (g).

Feed conversion ratio: According to the conversion ratio for each group weekly according to the following relationship:

$$\text{Feed conversion ratio} = \frac{\text{Average feed intake (g)}}{\text{Average weight gain (g)}}$$

Mortality rate: The number of dead broiler chickens was recorded daily from each replicate, and their percentage was recorded during the care period extending up to 42 days of age.

Statistical Analysis

The results of all studied indicators were subjected to statistical analysis using analysis of variance according to the completely random design using the statistical program SPSS26, and the significant differences between the averages of the coefficients were compared using the LSD test at a significance level of $p < 0.05$.

The mathematical model was as follows: $Y_{ij} = \mu + T_i + e_{ij}$

Where:

Y_{ij} = Individual observation.

μ = The overall mean for the trial under consideration.

T_i = The effect of the i^{th} treatment.

e_{ij} = Random residual error. [20]

Results

Live Weight

The results in Table 5 show the effect of adding the aqueous of MSE to drinking water on the average live weight of the experimental broiler chickens. As it is noted, there is a significant increase (P<0.05) in the average weights of the broiler chickens in the treatment groups

Table 5: The Effect of adding aqueous of MSE to drinking water on the average live weight of experimental broiler chickens. (g)

The age	Experimental groups (Mean ± SD)				
	T1	T2	T3	T4	P- value
Day 1	4.12 ± 43.25^{ns}	4.97 ± 43.32 ^{ns}	4.55 ± 43.46 ^{ns}	5.32 ± 43.37 ^{ns}	0.531
Week 1	8.74 ± 171.75 ^{b}	9.93 ± 181.64^{a}	8.35 ± 185.46^{a}	± 187.479.27^{a}	0.046
Week 2	12.54 ± 446.86^{c}	13.01 ± 480.75^{b}	12.89 ± 500.65^{a}	13.42 ± 512.68^{a}	0.039
Week 3	19.71 ± 915^{c}	22.34 ± 967.92^{b}	23.45 ± 993.26^{a}	24.98 ± 1018.87^{a}	0.042
Week 4	26.52 ± 1428.15^{c}	26.05 ± 1513.42^{b}	27.34 ± 1544.58^{b}	28.54 ± 1582.28^{a}	0.040
Week 5	31.10 ± 1990.85^{b}	2099.62 ± 30.25^{a}	31.21 ± 2137.08^{a}	32.18 ± 2184.38 ^{a}	0.043
Week 6	34.13 ± 2499.2^{8}b	31.02 ± 2626.8^{9}a	35.73 ± 2669.9^{6}a	39.52 ± 2725.66 a	0.041

T1: Drinking water only (control group). T2: 80 ml of MSE/liter of drinking water.
T3: 100 ml of MSE/liter of drinking water. T4: 120 ml of MSE/liter of drinking water.
ns indicates no significant differences within the same line between the experimental groups (P>0.05).
Different letters a, b, c within the same line indicates significant differences between groups at a level of (P≤0.05).

T2, T3, T4, as they reached 2626.89, 2669.96, and 2725.66 g at the end of the experiment for the three groups, respectively, compared to the control group T1, which reached 2499.28 g.

Weight Gain

The results in Table 6 show the effect of adding the aqueous of MSE to drinking water on the average weight gain of broiler chickens during the experimental stages. A significant increase (P<0.05) was observed in the average weight gain of broiler chickens in the treatment groups T2, T3, T4, which reached 2582.57, 2626.5, and 2682.29 g at the end of the experiment, respectively, compared to the control group T1, which reached 2456.03 g.

Feed Intake

The results in Table 7 show the effect of adding the aqueous of MSE to drinking water on the average amount of feed consumed by the experimental broiler chickens. It is noted that there was no significant effect (P>0.05) of the MSE on the amount of feed consumed by the treatment groups T2, T3, T4, as the average reached 4530.4, 4556.86, and 4572.47 g, compared to the control group, as the average reached 4518.19 g.

Feed Conversion Ratio

The results in Table 8 show the effect of adding the aqueous of MSE to drinking water on the average feed conversion ratio of the

Table 6: Effect of adding aqueous of MSE to drinking water on the average weight gain of experimental broiler chickens. (g)

The age	Experimental groups (Mean ± SD)				
	T1	T2	T3	T4	P- value
Week 1	4.12 ± 128.5 ns	4.55 ± 138.32ns	3.95 ± 142 ns	4.56 ± 144.1 ns	0.121
Week 2	5.10 ± 275.11b	6.40 ± 299.11ab	6.70 ± 315.19a	6.32 ± 325.21a	0.045
Week 3	12.70 ± 468.14b	13.30 ± 487.17a	14.11 ± 492.6a	14.10 ± 506.19a	0.043
Week 4	22.30 ± 513.15b	20.35 ± 545.5a	21.45 ± 551.32a	22.57 ± 563.41a	0.034
Week 5	19.16 ± 562.7b	18.67 ± 586.2ab	19.87 ± 592.5a	19.47 ± 602.1a	0.031
Week 6	7.62 ± 508.43b	8.42 ± 527.27ab	9.71 ± 532.88a	9.32 ± 541.28a	0.042
Full experience	31.02 ± 2456.03b	± 2582.5727.78a	2626.5 ± 22.6a	32.1 ± 2682.29a	0.041

T1: Drinking water only (control group). T2: 80 ml of MSE/liter of drinking water.
T3: 100 ml of MSE/liter of drinking water. T4: 120 ml of MSE/liter of drinking water.
ns indicates no significant differences within the same line between the experimental groups (P>0.05).
Different letters a, b within the same line indicates significant differences between groups at a level of (P≤0.05).

Table 7: Effect of adding aqueous of MSE to drinking water on the average amount of feed intake of experimental broiler chickens. (g)

The age	Experimental groups (Mean ± SD)				
	T1	T2	T3	T4	P- value
Week 1	5.17 ± 188ns	5.20 ± 189.12ns	4.90 ± 190.34ns	5.88 ± 191.52ns	0.131
Week 2	5.80 ± 414.21ns	6.25 ± 416.34ns	6.98 ± 419.74ns	7.22 ± 420.61ns	0.081
Week 3	10.72 ± 732.14ns	12.14 ± 733.44 ns	14.19 ± 734.67ns	13.35 ± 735.41ns	0.075
Week 4	24.35 ± 813.15ns	22.30 ± 816.41 ns	25.37 ± 827.42ns	23.50 ± 835.81ns	0.053
Week 5	29.46 ± .1129.2ns	31.26 ± .1131.1 ns	34.21 ± .1139.24ns	35.56 ± .1141.21ns	0.068
Week 6	37.32 ± 1241.49ns	35.72 ± 1243.99ns	± 1245.4937.51ns	36.75 ± 1247.91ns	0.094
Full experience	35.72 ± 4518.19nS	4530.4 ± 30.52nS	4556.86 ± 33.8 nS	4572.47 ± 40.12nS	0.055

T1: Drinking water only (control group). T2: 80 ml of MSE/liter of drinking water.
T3: 100 ml of MSE/liter of drinking water. T4: 120 ml of MSE/liter of drinking water.
ns indicates no significant differences within the same line between the experimental groups (P>0.05).

Table 8: Effect of adding aqueous of MSE to drinking water on the average feed conversion ratio of experimental broiler chickens. g/g

The age	Experimental groups (Mean ± SD)				
	T1	T2	T3	T4	P- value
Week 1	5.17 ± 1.463b	5.20 ± 1.397a	4.90 ± 1.340a	5.88 ± 1.329a	0.047
Week 2	5.80 ± 1.505b	6.25 ± 1.392a	6.98 ± 1.332a	7.22 ± 1.293a	0.045
Week 3	10.72 ± 1.564b	12.14 ± 1.505a	14.19 ± 1.491a	13.35 ± 1.453a	0.031
Week 4	24.35 ± 1.585b	22.30 ± 1.517a	25.37 ± 1.501a	23.50 ± 1.483a	0.042
Week 5	29.46 ± .2.007b	31.26 ± .1.929a	34.21 ± .1.923a	35.56 ± .1.895a	0.033
Week 6	37.32 ± 2.442b	35.72 ± 2.359a	37.51 ± 2.337a	36.75 ± 2.306a	0.035
Full experience	35.72 ± 1.840b	1.754 ± 30.45a	1.735 ± 33.8a	1.705 ± 36.12a	0.024

T1: Drinking water only (control group). T2: 80 ml of MSE/liter of drinking water.
T3: 100 ml of MSE/liter of drinking water. T4: 120 ml of MSE/liter of drinking water.
Different letters a, b within the same line indicates significant differences between groups at a level of (P≤0.05).

Table 9: Effect of adding aqueous of MSE to drinking water on the Average total mortality rate of broiler chickens in the experimental groups (%).

Groups	Total number of broiler chickens in the group	Number of live broiler chickens at the end of the experiment	Mortality %
T1	75	69	8[b]
T2	75	72	4[a]
T3	75	73	2.66[a]
T4	75	74	1.33[a]
P- value			0.043

T1: Drinking water only (control group). T2: 80 ml of MSE/liter of drinking water. T3: 100 ml of MSE/liter of drinking water. T4: 120 ml of MSE/liter of drinking water. Different letters a, b within the same line indicates significant differences between groups at a level of (P≤0.05).

experimental broiler chickens. As indicated, there is a significant improvement (P<0.05) in the average feed conversion ratio of the broiler chickens of the treatment groups T2, T3, T4, as it reached 1.754, 1.735, and 1.705 g/g for the three groups, respectively, compared to the control group T1, as it reached 1.840 g/g.

Mortality

The results in Table 9 show the effect of adding the aqueous of MSE to drinking water on the mortality rates of the experimental broiler chickens. A significant decrease (P<0.05) is observed in the percentage of dead broiler chickens in the treatment groups T2, T3, T4, as it reached 4, 2.66, and 1.33% at the end of the experiment for the three groups, respectively, compared to the control group T1, which reached 8%.

Discussion

The results of the present study show the important role of MSE in improving the growth and weight gain of broiler chickens. These findings are consistent with that of Alabi *et al.* [21] when providing the aqueous extract of *Moringa oleifera* leaves to broiler chickens, as they noted that the average daily weight gain and final body weight were higher in the groups that received the extract at 120 ml/liter compared to the control group. Khan *et al.* [22] also recorded a significant increase in body weight when Moringa leaf powder was added at a rate of 1.2% to broiler chickens feed mixtures. In addition, adding *Moringa oleifera* leaves at a level of 5% to 20% to feed mixtures showed a significant improvement in the growth of broiler chickens [23]. The reason for the improved growth and weight gain may be explained by the richness of Moringa seeds in proteins rich in sulfur amino acids and their high content of oil and beneficial unsaturated fatty acids [24]. The results of the study show that there was no significant effect of MSE on the amount of feed consumed. This is consistent with previous researchers [25,26], who did not observe any effect of Moringa on the amount of feed consumed, while it contradicts the results reached by other authors [27,28,29], who found an increase in the amount of feed consumed. The results of the study also indicate an improvement in the feed conversion rate in broiler chickens in the treatment groups compared to the control group. These results are consistent with what was reached by previous researchers [28,29,30], who explained that Moringa leaves have an effect in improving the feed conversion rate, while the results differed from that of Naga *et al.* [31], who did not observe any effect of Moringa leaves on the feed conversion rate, while Cui *et al.* [25] found a significant increase in the feed conversion rate in Moringa leaf treatments. The improvement in the feed conversion rate may be attributed to the fact that MSE improves intestinal health, as it works to increase the length of the villi in the digestive tract [32], which in turn leads to better absorption of the nutrients available in Moringa leaves [33]. The results show a significant decrease in the percentage of dead broiler chicks during the experiment in the groups treated with MSE. This is consistent with the results of Alnidawi *et al.* [34] and contradicts that of other researchers [26,35,36]. The reason for the decrease in the mortality rate in the treatment groups may be attributed to the Moringa seeds containing a high percentage of antioxidants, vitamins and nutrients that contribute to enhancing the broiler chickens' immunity and resistance to diseases.

Conclusions

The study concludes the positive effect of using the aqueous of MSE with drinking water in improving the productive performance of broiler chickens, as the live weight increased with stability in the amount of feed consumed, and the feed conversion ratio and the percentage of dead broiler chickens decreased.

Author Contributions

Researcher dr. Mohamed Alrez wrote the research, conducted the experiments, statistically analyzed the results, tabulated them, reviewed the research, and prepared it for publication.

Declarations

Ethics Approval and Consent to Participate: Approval was obtained from the Institutional Animal Care and Use Committee (IACUC) and informed consent was obtained from the animal owner for the experiments and publication of the results, with a commitment to applying the best veterinary practices for animal care

Consent for publication: Not applicable.

Availability of data and materials: The data obtained and analyzed during the current study are available from the corresponding author upon request and are also available on the website: https: //orcid.org/0009-0003-0735-1807.

Competing interests: The authors declare no competing interests.

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