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Evaluation of the Nutritional Effectiveness of Nano-Alcoholic Extract of *Moringa oleifera* Leaves added to Drinking Water on the Productive Traits of Broilers

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ABSTRACT: This experiment was conducted in the poultry farm of the Department of Animal Production at the College of Agriculture / Al-Qasim Green University to evaluate the high nutritional effectiveness of the nano-alcoholic extract of *Moringa oleifera* leaves added to drinking water on the productive characteristics of broiler chickens. 180 one-day-old Ross broiler chicks, unsexed, were used. They were randomly divided into four treatments, 45 birds for each treatment, and each treatment consisted of three replicates (15 birds for each replicate). The experimental treatments were as follows: the first treatment (control) without adding the nano-alcoholic extract of *Moringa oleifera* leaves to the drinking water. The second treatment: adding the nano-alcoholic extract of *Moringa oleifera* leaves at a dose of 10 ml/liter of drinking water at a concentration of 0.01%. The third treatment: adding the extract Nano-alcoholic extract of *Moringa oleifera* leaves, at a dose of 10 ml/liter of drinking water, at a concentration of 0.02%. The fourth treatment: adding the nano-alcoholic extract of *Moringa oleifera* leaves, at a dose of 10 ml/liter of drinking water, at a concentration of 0.03%. The experiment included studying the following characteristics: average live body weight, weight gain, feed consumption, feed conversion factor, Percentage of losses, production index, Villus length, crypts depth, and the ratio of villus length to crypts depth. The results indicated that adding the nano-alcoholic extract of *Moringa oleifera* leaves led to a significant improvement in all the productive traits studied. It can be concluded from the current experiment that adding the nano-alcoholic extract of *Moringa oleifera* leaves to drinking water can lead to improving the productive traits of broiler chickens.

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INTRODUCTION

The poultry industry is of great importance in the agricultural sector and in raising the standard of living for humans because of the white meat, eggs, and other by-products it produces. Poultry is characterized by excellent food conversion efficiency compared to other farm animals, and this is reflected in the amount of feed consumed and the rate of body weight gain.

Recently, we have witnessed the introduction of many medicinal plants into the feed of broilers and laying hens, including mint leaves (Ali et al; 2016), moringa leaves (Aqeel et al; 2018; Oraibi and Ali, 2021; Nihad and Dakhil, 2022) and white tea leaves (Ali et al; 2019), and among these plants is the moringa plant, its scientific name is Moringa oleifera. It is called by the Arabs the miracle tree or the tree of life because a single seed gives a tree that reaches a height of five meters in its first year, and it is widely spread throughout the tropical regions (Olugbemi et al; 2010), and its effectiveness lies in it containing Flavonoids, Saponins, Tannins, Terpenoids and Sterol glycoside (Nazmy et al; 2016). It tolerates drought and salinity and is characterized by rapid growth (Donkor et al; 2013). Its leaves are considered edible and have great nutritional and therapeutic value due to their rich content. It contains vitamins (A and C) and minerals, especially calcium and potassium, and contains many antioxidants, amino acids and carotenoids (Nihad et al; 2016). As for toxic metals such as mercury, arsenic, and cadmium, they are absent from Moringa oleifera leaves (Murro et al; 2003). Likewise, alcoholic extracts of Moringa leaves are characterized by having important biological properties, and these properties vary according to the type of solvent used to extract the active substances contained in these leaves (Doughari et al. (2007), where Bukar and others (2010) showed that the alcoholic extract of moringa leaves has a significant and more effective effect on pathogenic bacteria compared to the aqueous extract.

In recent years, the poultry industry has witnessed multiple technologies, the most important of which is nanotechnology, which is a promising and emerging technology that has enormous potential to revolutionize the poultry sector around the world. This technology has been widely used in the field of poultry nutrition (Nbras and Nihad, 2019), and nanoparticles in general have dimensions between approximately (1-100) nanometers, these nanoparticles can bypass the physiological methods of distributing nutrients and transporting them across tissues and cell membranes. Nanotechnology works to develop new products and the possibility of reformulating and reformulating traditional materials to give effective results (Troncarelli et al; 2013), while The volume of the material is very reduced, which leads to the formation of new physical properties, and these properties allow nanomaterials to be used in wide fields, including health, pharmacy, industry and other unlimited fields (Feynman, (1959). Given the lack of studies on adding nano-alcoholic extract to *Moringa oleifera* leaves For broiler drinking water, this study was intended to determine and evaluate the efficiency of the nano-alcoholic extract and to study the extent of its effect on productive performance, as well as to know the effective compounds and nutritional value of *Moringa oleifera* leaves.

In view of the above, the aim of this study was to know the effect of the nano-alcoholic extract of *Moringa oleifera* leaves added to drinking water on the productive characteristics of broilers and to know the best proportions that can be added to drinking water.

MATERIALS AND METHODS

This study was conducted in the poultry farm of the Department of Animal Production at the College of Agriculture / Al-Qasim Green University for the period from 22/4/2022 until 27/5/2022, which lasted 35 days. 180 unsexed Ross broiler chicks were used, with an average weight of 40 gm/chick. The chicks were raised in floor cages, and the chicks were randomly distributed into 4 treatments, each consisting of 3 replicates, with each replicate containing 15 chicks. Feed was provided to the birds freely, as two diets were provided, a starter diet from the ages of 1-21 days and a finishing diet from the ages of 22-35 days (Table 1). The nano-alcoholic extract of *Moringa oleifera* leaves was added to the drinking water starting from one day old, as follows: The first treatment (control) without adding the nano-alcoholic extract of *Moringa oleifera* leaves to the drinking water. The second treatment: Adding the nano-alcoholic extract of Moringa oleifera leaves at a dose of 10 ml. / liter of drinking water, at a concentration of 0.01%. The third treatment: adding the nano-alcoholic extract of *Moringa oleifera* leaves, at a dose of 10 ml / liter of drinking water, at a concentration of 0.02%. The fourth treatment: adding the nano-alcoholic extract of *Moringa oleifera* leaves, at a dose of 10 ml / liter of drinking water, at a concentration of 0.03%. The experiment included studying the following characteristics: average live body weight, weight gain, feed consumption, feed conversion factor, Percentage of losses, production index, villus length, villus depth, and villus length ratio to villus depth. . A completely randomized design was used to study the effect of different parameters on the studied traits, and the significant differences between the means were compared using the Duncan multinomial test (Duncan, 1955), and the ready-made statistical program SAS (SAS, 2016) was used to analyze the data.

Table (1) The percentages of feed materials included in the composition of the starter diet and the final diet used in the experiment, with the calculated chemical composition of both diets

Feed material	Starter diet (1-21) % days	%Finished diet (22-35) days
yellow corn	48.2	58.7
Local wheat	8	7.5
Soybean meal (44% protein)	28.5	20.5
Protein concentrate*	10	10
Vegetable oil (sunflower)	4	2.5
limestone	1	0.5
Table salt	0.3	0.3
total summation	%100	% 100
		Calculated chemical analysis**
Representative energy (kcal/kg)	3079.85	3102.6
Crude protein (%)	21.56	18.87
Lysine (%)	1.04	0.85
Methionine+Cycine (%)	0.455	0.42
Crude fiber %	3.54	3.2
Calcium (%)	1.28	1.07
Ready phosphorus (%)	0.42	0.41

* A protein concentrate of Belgian origin, one kilogram of which contains: 2200 kilocalories of representative energy, 40% crude protein, 8% fat, 3.5% fiber, 25% ash, 8% calcium, 3.1 ready-made phosphorus, 1.2% lysine, 1.2% Methionine, 1.8% Methionine + 70 mg B, 30 mg Vitamin E, 1 300 mg Vitamin D, 2500 IU A, 3 Cysteine, 2% Chlorine, 10,000 IU 12 mg Folic acid, B 250 plus B, 120 mg Pantothenic acid, 400 mg niacin, 50 mg Vitamin B 2, 5000 mg Choline Closed, 450 mg Iron, 70 mg Copper, 600 mg Biotin, 1000 mg Vitamin E, 750 mg Manganese, 5 mg Iodine, 1 gm Cobalt And antioxidants.
** According to the chemical composition according to the analyzes of feed materials mentioned in the NRC (1994).

RESULTS AND DISCUSSION

Table (2) shows the addition of nano-alcoholic extract of *Moringa oleifera* leaves to drinking water in the average weekly live body weight of broilers. It is noted that there are no significant differences between all treatments in the first week of the chicks' life, while in the second week, significant differences appeared, as the treatment excelled. The fourth treatment was significant (P≤0.05) over the second treatment and the first treatment (control), while there were no significant differences between the third treatment and the fourth treatment, which in turn was significantly superior (P≤0.05) over the first treatment (control), as evidenced by the appearance of significant superiority (P≤0.05) during the last three weeks in favor of the fourth treatment compared to the rest of the treatments, and the other treatments (second and third) showed significant superiority (P≤0.05) over the control treatment (first) for the same period.

Table (2). Effect of adding nano-alcoholic extract of *Moringa oleifera* leaves to drinking water on average weekly body weight (g/bird)

Age (weeks)					
Treatments	1	2	3	4	5
First treatment (control)	1.17 ±119.47	3.11 ±327.15 c	7.12 ±701.81 d	11.40 ±1159.12 d	16.72 ±1739.63 d
Second treatment	1.22 ±121.73	2.87 ±350.11 b	6.54 ±768.04 c	11.57 ±1286.70 c	16.88 ±2012.90 c
Third treatment	1.09 ±122.82	2.52 ±355.24 ab	7.03 ±779.52 b	12.01 ±1311.06 b	17.30 ±2064.65 b
Fourth treatment	1.11 ±123.77	2.60 ±365.93 a	6.83 ±796.93 a	11.73 ±1368.17 a	17.51 ±2175.39 a
Significant level	N.S	*	*	*	*

The first treatment (control) was drinking water without any additives. The second, third and fourth treatments were adding the nano-alcoholic extract of moringa leaves at a dose of 10 ml/liter of drinking water and at a concentration of 0.01, 0.02 and 0.03%, respectively. N.S: There is no significant difference between the treatments, * There are significant differences at the level of (P≤0.05)

Table (3) shows the effect of adding the nano-alcoholic extract of *Moringa oleifera* leaves to drinking water on the rate of weekly weight gain of broiler chickens. In the first week, no significant differences appeared between all treatments, but in the second and third weeks, a significant superiority (P≤0.05) was obtained in favor of The fourth treatment outperformed the second treatment and the first treatment (control), while no significant differences were recorded between the fourth treatment and the third treatment, and also between the third treatment and the second treatment. Significant differences appeared (P≤0.05) between the third treatment and the first treatment (control) on the one hand and on the other hand. Between the second treatment and the control treatment on the other hand for the same age, while in the last two weeks of the experiment the fourth treatment outperformed the significance level (P≤0.05) compared to the rest of the treatments, while the third treatment outperformed the second treatment and the control treatment at a significance level (P≤0.05). It is also noted that the second treatment was significant (P≤0.05) over the first treatment at the same age.

Table (3). Effect of adding the nano-alcoholic extract of *Moringa oleifera* leaves to drinking water on the rate of weekly weight gain (g/bird)

Age (weeks)						
Treatments	1	2	3	4	5	Total weight gain
First treatment (control)	0.71±79.47	c 1.90±207.68	c 3.27±374.66	d 4.47±457.31	d 5.75±580.51	1699.63 d 17.03 ±
Second treatment	0.79±81.73	b 1.75±222.38	b 3.18±417.93	c 4.82±518.66	c 6.29±726.20	18.22 1972.90 c ±
Third treatment	0.77±82.81	ab 1.81±232.42	ab 3.33±424.28	b 5.03±531.54	b 5.80±753.59	17.18 2024.65 b ±
Fourth treatment	0.69±83.77	a 2.04±241.16	a 2.96±431.70	a 4.73±571.54	a 5.74±807.22	18.06 2135.39 a ±
Significant level	N.S	*	*	*	*	*

The first treatment (control) was drinking water without any additives. The second, third and fourth treatments were adding the nano-alcoholic extract of moringa leaves at a dose of 10 ml/liter of drinking water and at a concentration of 0.01, 0.02 and 0.03%, respectively. N.S: There is no significant difference between the treatments, * There are significant differences at the level of (P≤0.05)

The significant increase in body weight and weight gain in treatments in which the nano-alcoholic extract was used in drinking water at different concentrations compared to the control treatment is attributed to the role of the active substances present in the leaves, such as Flavonoids, Linalool, and Phenoles, as stimulants for the digestive system and improving digestion (Cabuk et al; 2003). It leads to an increase in the production of digestive enzymes such as chemotrypsin lipase, amylase and trypsin in birds (Muthamma et al; 2008). The digestive process improves and the bird benefits from the food consumed. This is reflected in the growth of the birds, and the final impact is positive on the rate of weight gain and the final weight of the bird (Lee et al; 2004) as there is a positive correlation between the digestibility rate, body weight, and the amount of feed consumed (Abdel Rahman et al; 2013).

As for Table (4), it shows the effect of adding the nano-alcoholic extract of *Moringa oleifera* leaves to drinking water on the weekly feed consumption rate of broiler chickens. The table shows that there are no significant differences between all treatments during the first week of the chicks' life, while in the second week, the moral superiority in The rate of feed consumption in the fourth treatment, which was significantly (P≤0.05) superior to the second and first treatments, while no significant differences were observed between the fourth and third treatments and between the second and third treatments, which were significantly superior to the first treatment (control). However, in the third week of the experiment, it was observed A significant increase (P≤0.05) in the rate of feed consumption for the fourth, third and second treatments over the first treatment (control), while the moral superiority for the last two weeks was in favor of the fourth treatment, which had a significant increase (P≤0.05) over each of the third, second and first treatments (control). While no significant differences appeared between the third and second treatments, their significant superiority (P≤0.05) was noted over the control treatment for the same period.

Table (5) indicates the effect of adding the nano-alcoholic extract of Moringa oleifera leaves to drinking water on the feed conversion factor rate for broiler chickens. It is noted that there are no significant differences between all treatments in the first week of the experiment. However, in the second week, the nano-alcoholic extract parameters recorded an improvement. Significant (P≤0.05) in the food conversion factor compared to the control treatment. As for the third and fourth weeks, the significant improvement was (P≤0.05) in favor of the fourth treatment compared to the first treatment (control) and the second treatment, while there were no significant differences between the third and fourth treatments. On the one hand, the second and third on the other hand, which recorded a significant improvement (P≤0.05) in the feed conversion factor over the first treatment (control), while the improvement was significant (P≤0.05) in favor of the fourth treatment in the feed conversion factor during the last week of the chicks' life. The significant differences were clear in all treatments compared to the control treatment.

Table (4). Effect of adding the nano-alcoholic extract of *Moringa oleifera* leaves to drinking water on the average weekly feed consumption (g/bird)

Age (weeks)						
Treatments	**1**	**2**	**3**	**4**	**5**	Total feed consumption
First treatment (control)	1.20 ± 127.15	c 3.57 ± 342.67	6.58 ± 640.67 b	8.87 ± 827.73 c	c 11.09 ± 1102.97	30.74 ± 3041.19 d
Second treatment	1.30 ± 128.32	b 3.39 ± 358.03	6.72 ± 693.76 a	8.59 ± 912.84 b	11.46± 1327.30 b	29.24± 3418.25 c
Third treatment	1.26 ± 129.20	ab 3.42±371.87	a 6.66± 695.82	8.46 ± 930.20 b	11.39 ± 1363.99 b	30.18 ± 3491.08 b
Fourth treatment	1.22 ± 129.84	a 3.70 ± 383.44	6.46 ±699.35 a	8.77 ± 983.05 a	11.15± 1428.78 a	30.56± 3624.46 a
Significant level	N.S	*	*	*	*	*

The first treatment (control) was drinking water without any additives. The second, third and fourth treatments were adding the nano-alcoholic extract of moringa leaves at a dose of 10 ml/liter of drinking water and at a concentration of 0.01, 0.02 and 0.03%, respectively. N.S: There is no significant difference between the treatments, * There are significant differences at the level of (P≤0.05)

Table (5). Effect of adding nano-alcoholic extract of *Moringa oleifera* leaves to drinking water on the rate of feed conversion ration (g weight / gm feed)

Age (weeks)						
Treatments	**1**	**2**	**3**	**4**	**5**	Cumulative feed conversion factor
First treatment (control)	0.03 ± 1.60	0.03 ± 1.65 b	0.02 ± 1.71 c	0.03 ± 1.81 c	0.03 ± 1.90 d	0.03 ± 1.79 b
Second treatment	0.01 ± 1.57	0.03 ± 1.61 a	0.02 ± 1.66 b	0.02 ± 1.76 b	0.03 ± 1.83 c	0.03 ± 1.73 a
Third treatment	0.03 ± 1.56	0.02 ± 1.60 a	0.01 ± 1.64 ab	0.02 ± 1.75 ab	0.02 ± 1.81 b	0.02 ± 1.72 a
Fourth treatment	0.01 ± 1.55	0.02 ± 1.59 a	0.01 ±1.62 a	0.02 ± 1.72 a	0.01 ± 1.77 a	0.02 ± 1.70 a
Significant level	N.S	*	*	*	*	*

The first treatment (control) was drinking water without any additives. The second, third and fourth treatments were adding the nano-alcoholic extract of moringa leaves at a dose of 10 ml/liter of drinking water and at a concentration of 0.01, 0.02 and 0.03%, respectively. N.S: There is no significant difference between the treatments, * There are significant differences at the level of (P≤0.05)

The significant superiority in feed consumption in favor of nano-alcoholic extract treatments is attributed to the role of active substances present in the leaves, such as phenols and polyphenols, which can be considered natural antibiotics as they have effectiveness against pathogenic bacteria and harmful microorganisms (Botsoglou et al; 2003), and thus the number of microorganisms is reduced. Harmful organisms are compared to beneficial microorganisms and bacteria, which improve the efficiency of food digestion and absorption, which makes the bird consume more feed because there is a positive correlation coefficient between the digestion rate, body weight, and the amount of feed eaten (Abdel Rahman et al; 2013).

As for the significant improvement in the food conversion factor in the nano alcoholic extract treatments, it is attributed to the role of the active substances in improving digestion and the absorption capacity of the digested food as a result of the increase in the

depth of the crypts and the length of the villi, as well as the increase in the process of food analysis by beneficial microorganisms, which increases the benefit from the elements. Nutrition is better and reduces the amount of undigested food inside the digestive system.

Table (6) shows the effect of adding the nano-alcoholic extract of Moringa leaves on the mortality rate (%) and the productive index of broilers. The table shows that all treatments of the nano-alcoholic extract (second, third, and fourth) showed a significant effect in reducing the mortality rate compared to the first treatment (control). with the appearance of a significant increase in the value of the productive index for the fourth treatment compared to the rest of the treatments during the experiment period, and the absence of significant differences between the second and third treatments, which in turn were significantly superior to the first treatment (control) in the value of the productive index.

Table (6). Effect of adding the nano-alcoholic extract of *Moringa oleifera* leaves to drinking water on the mortality rate (%) and the production index of broiler chickens

Treatments	Percentage of losses (%)	production index
First treatment (control)	a 0.37 ±3.33	c 2.84 ±268.43
Second treatment	b 0.18 ±1.67	b 2.63 ±326.88
Third treatment	b 0.16 ±1.67	b 3.02 ±337.24
Fourth treatment	b 0.13 ±1.67	a 2.48 ±359.51
Significant level	*	*

The first treatment (control) was drinking water without any addition. The second, third and fourth treatments were adding the nano-alcoholic extract of moringa leaves at a dose of 10 ml/liter of drinking water and at a concentration of 0.01, 0.02 and 0.03%, respectively. * There were significant differences at the level of (P≤0.05)

The low percentage of losses in nano alcoholic extract treatments is attributed to the fact that the active ingredients, such as tannins, flavonoids, phenolic acids (Li et al; 2006). works as natural antioxidants and antimicrobials . It works to inhibit many pathogenic germs, especially Salmonella typhimurium and Escherichia coli, in addition to working to inhibit or kill pathogenic organisms by inhibiting their internal enzymatic system (Farag et al; 1989). Which reflects positively on the vitality and health of the birds and the decrease in the percentage of deaths, and this improvement in the production characteristics is all reflected positively in the values of the production index, which is one of the important indicators in evaluating the productive performance of broilers, and the increase in the value is attributed to the increase in live body weight and vital ratio in addition to the improvement Food conversion factor in nano alcoholic extract parameters.

Table (7) shows the effect of adding nano-alcoholic extract of Moringa leaves on villus height, crypt depth (micrometers) and the ratio of villus height to crypt depth in the ileum of broilers. It is noted that there is a significant superiority of the fourth treatment in villus height, crypt depth and the ratio of villus height to depth. The environment was superior to the rest of the treatments, and there was a significant superiority of the second and third treatments over the first treatment (control) in the same characteristics.

Table (7). Effect of adding nano-alcoholic extract of *Moringa oleifera* leaves to drinking water on villus height, crypt depth (micrometers) and the ratio of villus height to crypt depth in the ileum of broilers.

Treatments	Ileum		
	Villus height (micrometer)	Depth of the crypts (micrometer)	The ratio of the height of the villus to the depth of the crypts
First treatment (control)	0.93 ± 97.95 d	0.15 ± 14.60 d	0.07 ± 6.71 d
Second treatment	1.05 ± 105.67 c	0.13 ± 14.71 c	0.07 ± 7.18 c
Third treatment	1.11 ± 108.83 b	0.14 ± 14.86 b	0.06 ± 7.32 b
Fourth treatment	1.09 ± 112.75 a	0.13 ± 14.99 a	0.06 ± 7.52 a
Significant level	*	*	*

The first treatment (control) was drinking water without any addition. The second, third and fourth treatments were adding the nano-alcoholic extract of moringa leaves at a dose of 10 ml/liter of drinking water and at a concentration of 0.01, 0.02 and 0.03%, respectively. * There were significant differences at the level of ($P \leq 0.05$)

The appearance of significant superiority in villus height, crypt depth, and the ratio between villus height and crypt depth in the ileum of the nano alcoholic extract treatments over the first treatment (control) is due to the role of the active substances in moringa leaves in stimulating the cells of the digestive system to grow and divide (Cross et al; 2007). Hence improving the morphological characteristics of the intestine, such as increasing the length of the villi and increasing the depth of the crypts of the small intestine (Garcia et al; 2007).

It is also attributed to the contribution of active substances to increasing beneficial bacteria, which are an energy source for intestinal cells and increase cell activity and division, thus increasing the length of the villi. (Ghazanfari et al; 2014).

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