Effect of Nano Arabic Gum Compared to Import Prebiotic on Biochemical Traits of Broiler

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Abstract

Gut health has a direct impact on broiler output, and Nano-Arabic gum is a natural prebiotic that stimulates broiler gut immunity. This was done at the poultry farm of the animal production department, college of agriculture, Al-Qasim Green University. Three hundred chicks were separated into five treatments, with each replica containing three replicas (20 chicks). The study groups were as follows. T1: Control treatment (no additives); T2: Addition of 1 g prebiotic/L to the drinking water. T3: Add 1.5 g prebiotic/L to the drinking water; T4: Add 1 mL of Nano-Arabic gum/L to the drinking water. T5: Add 1.5 mL of Nano- Arabic gum/L to the drinking water. A significant increase ($P \leq 0.01$) in treatment T1 in the concentrations of cholesterol, triglycerides, VLDL (very low-density lipoprotein), and LDL (low-density lipoprotein), while a significant increase ($P \leq 0.05$) in treatments T2, T3, T4, and T5. A significant increase ($P \leq 0.05$) in treatment T1 in the concentration of MDA (Malondialdehyde), and a significant increase ($P \leq 0.01$) in the concentration of AST (aspartate aminotransferase) in the same treatment. A significant increase ($P \leq 0.01$) in treatments T4 and T5 in the concentration of glutathione, and a significant increase ($P \leq 0.05$) in the concentration of catalase in treatments T4 and T5 compared to the control treatment. A significant increase ($P \leq 0.05$) in total protein concentration in treatments T3, T4, and T5. Albumin and globulin concentrations also increased significantly ($P \leq 0.05$) in treatments T4 and T3, respectively. The treatment T4 showed a significant increase ($P \leq 0.05$) in the relative weight of the digestive tract, while treatments T4 and T5 showed a significant increase ($P \leq 0.05$) in digestive tract length .

Keywords: Antioxidant enzymes, Gut health, Lipid profile, Nano-prebiotic, Oxidative stress, Intestinal morphology

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Introduction

The complete ban on the use of antimicrobial growth promoters (antibiotics) in poultry feed in the European Union came into effect on January 1, 2006, due to their intestinal health problems and the disruption they cause to the balance of the microbial community, especially in broiler chickens, and the resulting health problems and reduced growth performance [1]. Moreover, antibiotics directly affect the liver of birds, which weakens the metabolic level of chickens .[2] In recent years, numerous attempts have been made to modify the gut microbiome through dietary or management interventions with the aim of improving intestinal health in poultry [3]. Enzymes, probiotics, prebiotics, synbiotics, and postbiotics have been used in many different studies with the aim of supporting biotic balance and avoiding biotic imbalance in poultry. The effects of prebiotics and probiotic enhancers may not be limited to poultry intestinal health[4,5,6] but may also include general health effects, including improved growth performance, bird immunity, and improved bone metabolism [7].Gum Arabic, also known as acacia gum, is secreted from Acacia seyal and Acacia senegal trees, sometimes called the shooting star tree. It is a naturally occurring, nutritious compound obtained when the outer bark of the stems or branches is removed, or when insects attack. The gum is secreted as a defense mechanism, emerging in teardrop-shaped sacs. Upon exposure to air, it dries and forms a spherical shape. Gum arabic contains a complex mixture of molecules of varying sizes, primarily

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composed of proteins and carbohydrates [8]. It is a natural compound rich in polysaccharides, along with amino acids and minerals. Gum Arabic possesses potent antioxidant effects, both directly and indirectly, through its active compounds [9].The polysaccharides Arabinogalactan, rhamnose, and glucuronic acid neutralize free radicals by donating electrons to oxidized compounds. For their stability, they also prevent the initiation or continuation of lipid peroxidation reactions in cell membranes [10]. Furthermore, phenolic acids act as free radical scavengers and inhibit lipid peroxidation [11] . Therefore, the current study aims to investigate the effect of Nano-formulated gum Arabic compared to its biological counterpart on certain biochemical properties of broiler chickens.

Materials and Methods

Ethical Approval

The research received approval from the Research Ethics Committee at Al-Qasim Green University, as certified (qgee/29/2025 .(

The experiment took place in the Department of Animal Production/College of Agriculture/Al-Qasim Green University for 35 days, from September 18 to October 23, 2025. During this time, the effect of adding Nano-gum Arabic and prebiotic to broiler chickens' drinking water on their productive and physiological performance was investigated. The chicks were randomly assigned to 15 cages and divided into five treatments (60 birds each). The experiment consisted of three replicates of 20 chicks in each treatment and a total of 300 Ross-308 broiler chicks. The experimental treatments consisted of adding imported Nano-gum Arabic and a precursor to the drinking water beginning on the first day of the trial, as follows: T1; without addition, T2 and, T3; adding 1 and 1.5 g prebiotic/ L, T4 and, T5 adding 1 and 1.5 ml Nano Arabic gum/L. The chicks were fed a super diet (23.18% protein and 3253 kcal/kg feed) until they were four days old, at which point they were switched to a beginning diet (23.33% protein and 3233 kcal/kg feed) for four to ten days. This was followed by a grower diet (21.86% protein and 3304 kcal/kg feed) from 11 to 22 days, and then a finisher diet (21.86% protein and 3304 kcal/kg feed) from 23 to 35 days. Food and drink were provided ad libitum (table 1.(

Table 1: study diets ingredients and chemical analysis

Ingredients	Super diet (1-3 d)	Starter diet (4-10 d)	Growth diet (11-22 d)	23.Finisher diet (23-35 d)
Yalow corn	23.25	43.25	39.00	38.25
Soybean	35.00	37.50	33.00	33.00
Wheat	15.00	0.00	0.00	0.00
Wheat flour	20.00	15.00	20.00	20.00
Oil	3.25	3.00	4.00	4.75
Premixes	2.00	0.00	2.50	2.50
Milestone	1.50	1.15	1.40	1.40
Salt	0.00	0.10	0.10	0.10
Total	100	100	100	100
Chemical analysis				
Crude protein %	23.18	23.33	21.86	20.79
Metabolic energy (kacl)	3253.00	3233.00	3304.00	3347.00
Lysine %	1.17	1.24	1.11	1.11
Methionine %	0.34	0.35	0.33	0.32
Methionine + cysteine	0.74	0.76	0.70	0.70
Available phosphor	0.18	0.16	0.14	0.14

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The Nano-sized gum Arabic was prepared according to a specific method [12] and tested at the Iraqi Ministry of Science and Technology to examine product quality, the Nanoparticle size was found to be (31.57 - 51.97 nm) according to (letter 2583/3 in 11/6/2025). As for the prebiotic, he obtained it from local markets in Babylon Governorate.

Traits studied

The biochemical characteristics of the blood were studied at 35 days of age in broiler chickens by collecting two blood samples per replicate. Glucose, cholesterol, triglycerides, liver enzymes, antioxidant enzymes, and protein profile were studied according to [13,14,15. [

Statistical analysis

The [16] and [17] were used to analyze the data and demonstrate significant differences between the studied treatments according to model: $Yij = \mu + Ti + eij$

Results and discussion

Glucose, Lipid Profile, and AST and ALT Enzymes

Table (2) shows the effect of the experimental treatments on some biochemical parameters. No significant difference was observed between the treatments in glucose concentration. A significant increase ($P < 0.01$) was observed in cholesterol concentration in treatment T1 compared to the other treatments, which did not show a significant difference. A significant increase ($P < 0.01$) was also observed in triglyceride concentration in treatment T1 compared to the other treatments, which did not show significant differences. High-density lipoprotein (HDL) concentration increased significantly ($P < 0.01$) in all treatments except the control treatment, which did not show a significant difference. Low-density lipoprotein (LDL) concentration increased significantly ($P < 0.05$) in the control treatment T1 compared to the other treatments, which did not show significant differences. A significant increase ($P < 0.01$) was observed in very low-density lipoprotein (VLDL) concentration in the control treatment T1 compared to the other treatments, which did not show significant differences. A significant increase ($P < 0.05$) was observed in the concentration of malondialdehyde in the control treatment T1 compared to the other treatments, which showed no significant differences. No significant difference was recorded in the ALT enzyme. A significant increase ($P < 0.01$) was observed in the concentration of the AST enzyme in the control treatment T1 compared to the other treatments, which showed no significant differences.

Table2: Effect of adding different levels of Nano-gum Arabic to drinking water and comparing it to the previous imported prebiotic on lipid profiles and liver enzymes

Treatments	mean± stander error					Significant
	T1	T2	T3	T4	T5	
Glucose (mg/dl)	290.37± 33.95	259.62± 21.05	237.27± 3.06	248.82± 4.49	244.87± 1.56	N.S
Cholesterol (mg/dl)	154.38± 2.24 a	144.67± 0.46 b	134.35± 0.83	135.05± 3.34c	131.64± 3.55c	**
Triglyceride (mg/dl)	96.88± 0.35 a	88.50±0.97 b	81.69±1.41c	77.34± 1.82 cd	73.60± 1.51d	**
HDL (mg/dl)	86.81± 2.53b	95.46± 2.05a	97.56± 1.92a	98.23± 1.04 a	97.52± 0.70a	*
LDL (mg/dl)	48.20± 0.36a	31.50± 2.71b	20.44± 1.36bc	21.34± 4.74bc	19.40± 3.95c	**
VLDL (mg/dl)	19.37± 0.07a	17.69± 0.20b	16.34± 0.28c	15.46± 0.36cd	14.72± 0.31d	**

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MDA (µ mol/mol)	208.25± 9.25 a	176.87± 1.46 b	173.37± 4.42 b	155.94± 10.56 b	161.89± 9.65 b	*
ALT (IU/L)	18.72± 0.97	16.46± 0.96	16.44± 0.82	15.44± 0.07	15.69± 1.03	N.S
AST (IU/L)	32.47± 1.09 a	24.81± 0.46 b	26.16± 1.57 b	23.86± 1.44 b	26.42± 0.91 b	**

Means with different letters within the same row differed significantly, * (P≤0.05), ** (P≤0.01), N.S. not significant. Treatments: T1: Control treatment with no addition; T2 and T3: Addition of 1 and 1.5 g of imported prebiotic/L of drinking water, respectively; T4 and T5: Addition of 1 and 1.5 ml of Nano-gum Arabic/L of drinking water, respectively.

The concentration of AST increased significantly (P < 0.01) in the control treatment T1 compared to the other treatments, which showed no significant differences. The improvement in lipid profile in gum arabic treatments may be attributed to gum Arabic's role as a dietary fiber component and a natural prebiotic that improves blood lipid profiles [18]. When gum Arabic is converted to Nanoparticle form, these effects are amplified by its increased solubility and higher ability to interact with beneficial microorganisms in the intestines of birds [19] . [18] found that adding gum Arabic at a rate of 0.12-1% reduced total cholesterol and LDL levels and increased HDL concentration. This is attributed to gum Arabic acting as a prebiotic, increasing the number of beneficial bacteria and reducing harmful bacteria by increasing the production of short-chain fatty acids, thus lowering the intestinal pH. Furthermore, the polysaccharides in gum Arabic act as a nutrient for beneficial bacteria, while an increase in harmful bacteria leads to impaired lipid absorption and metabolism[20], and gum Arabic is characterized by being primarily soluble fibers, especially in Nano-forms. These fibers slow the passage of food through the digestive tract and trap harmful cholesterol within lipid micelles, leading to a greater portion being excreted with feces. Even if it doesn't bind to harmful cholesterol, improving the intestinal microbiome and lowering the pH will reduce the reabsorption of bile acids and fats [21,22] . Furthermore, the fermentation of gum Arabic by beneficial bacteria in the intestines increases the production of propionate, butyrate, and acetate. Propionate is absorbed and reaches the liver, where it inhibits enzymes responsible for the synthesis of harmful cholesterol. Butyrate and acetate serve as an energy source for intestinal cells and improve intestinal health, thus reducing intestinal inflammation, which contributes to lipid metabolism disorders [23,24] . In addition to this, gum Arabic also has other beneficial effects. Arabic gum acts as an antioxidant, improving liver function and reducing fat accumulation [25,26] . This also explains the decrease in MDA and AST enzyme concentrations in treatments involving the addition of Nano-sized Arabic gum.

Antioxidant Enzymes

Table (3) shows the effect of different treatments on antioxidants. Glutathione peroxide showed a significant increase (P>0.01) in treatments T4 and T5 compared to the other treatments, which did not show a significant difference. Catalase showed a significant increase (P>0.05) in treatments T5 and T4 compared to the control treatment T1. No significant increase was recorded in SOD. The significant increase in the concentration of glutathione peroxidase and catalase enzymes in treatments T4 and T5 may be attributed to the antioxidant activity of gum Arabic [27]. This activity occurs through the scavenging of free radicals and the enhancement of the antioxidant system. Gum Arabic extracts contain phenols and sulfur-containing amino acids such as cysteine,

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methionine, and tyrosine, which play a significant role in improving oxidative stress and supporting avian immunity [28] . Gum arabic also stimulates the gene expression of antioxidant enzymes (Nrf2/ARE) [18] . Furthermore, gum Arabic contains minerals such as iron, zinc, copper, and manganese, which directly stimulate antioxidant reactions and support the activity of glutathione and catalase enzymes. Treatment with Nano-formed gum Arabic will increase the availability of these elements to the bird (Kong). [29] Furthermore, the action of gum Arabic as a prebiotic improves intestinal health and reduces inflammation, thereby decreasing oxidative stress in the body and improving the level of antioxidant enzymes[20. [

Table 3: Effect of adding different levels of Nano-gum arabic to drinking water and comparing it to the previous imported prebiotic antioxidants

Treatments	mean± stander error		
	GSH (µ mol/mol)	Catalase (µ mol/mol)	SOD (µ mol/mol)
T1	321.66±4.55 d	131.67±5.44b	183.25±4.25
T2	391.02±5.53c	145.82±2.72ab	196.87±1.46
T3	423.56±6.04b	144.12±4.41ab	193.37±7.57
T4	452.41±6.06a	162.72±8.72 a	190.94±5.57
T5	451.07±6.23a	155.71±2.54a	200.88±8.65
Significant	*	*	N.S

Means with different letters within the same row differed significantly, * (P≤0.05), N.S. not significant. Treatments: T1: Control treatment with no addition; T2 and T3: Addition of 1 and 1.5 g of imported prebiotic/L of drinking water, respectively; T4 and T5: Addition of 1 and 1.5 ml of Nano-gum Arabic/L of drinking water, respectively.

Total Protein, Albumin, and Globulin

Table (4) illustrates the effect of different treatments on the biochemical properties of blood serum. A significant increase ($P < 0.05$) in total protein concentration was observed in treatments T3, T4, and T5 compared to the control treatment. Albumin concentration also increased significantly ($P < 0.05$) in treatment T4 compared to the control treatments T1 and T2. In globulin concentration, a significant increase ($P < 0.05$) was observed in treatment T3 compared to the other treatments, except for treatment five, with which the increase was similarly significant. The improvement in total protein concentration in the treatment with the prebiotic (T3) and gum Arabic (T4 and T5) may be attributed to their role as prebiotics in improving the digestibility of consumed feedstuffs and feed availability, thus increasing protein digestibility and the availability of absorbable amino acids in the intestine [30]. The improved microbial community also plays a significant role, with some bacteria secreting protease enzymes that enhance protein digestion, thereby increasing the level of amino acids available to the bird [31,32] . This improvement extends to albumin and globulin levels in the T4 and T3 treatments, respectively. Furthermore, gum Arabic contains certain types of protein [33]. [34] also indicated that gum Arabic improves protein synthesis in the body, which improves the level of total protein, albumin, and globulin.

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Table 4: Effect of adding different levels of Nano-gum Arabic to drinking water and comparing it to the imported prebiotic on the biochemical traits

Treatments	mean± stander error		
	Total protein (gm/100 ml)	Albumin (gm/100 ml)	Globulin (gm/100 ml)
T1	18.24±6.08b	10.16±1.41 b	8.07±4.67 b
T2	20.27±4.05 ab	9.46±2.58 b	10.79±1.47
T3	40.13±11.05 a	12.79±4.23ab	27.33±13.29 a
T4	32.43±12.16 a	20.33±3.88 a	12.09±8.28 b
T5	32.02±0.41 a	14.87±2.63 ab	17.14±3.04 ab
Significant	*	*	*

Means with different letters within the same row differed significantly, * (P≤0.05), N.S. not significant. Treatments: T1: Control treatment with no addition; T2 and T3: Addition of 1 and 1.5 g of imported prebiotic/L of drinking water, respectively; T4 and T5: Addition of 1 and 1.5 ml of Nano-gum Arabic/L of drinking water, respectively.

Anatomical Characteristics of the Digestive Tract

Table (5) shows the effect of adding different levels of Nano-gum arabic to the drinking water of broiler chickens on the anatomical characteristics of the digestive tract. A significant increase ($P < 0.05$) was observed in the relative weight of the digestive tract, with treatment T4 showing a significant advantage over the other treatments. A significant increase ($P < 0.05$) was also observed in the length of the digestive tract for treatments T4 and T5 compared to treatment T2. No significant differences were recorded in the pH measurement of the jejunum and ileum. One of the most telling indicators of digestive tract health and activity is the increase in intestinal length and weight. This leads to greater digestion and absorption of feedstuffs due to increased exposure to digestive enzymes, which positively impacts the birds' productive performance [35 ،36 ،37 ،38] . The improvement in intestinal weight and relative length following treatment with Nano-gum arabic may be attributed to the role of gum arabic as a prebiotic. Gum arabic enhances the regeneration of intestinal cells and replaces cells damaged by digestion and friction [39،40،41،42،43]. Furthermore, the fermentation of gum arabic fibers in the birds' intestines, converting them into short-chain fatty acids, promotes intestinal tissue development and increases intestinal weight and length [44،45،46]. Additionally, gum arabic increases the length and width of villi, which translates to increased weight and length, resulting from improved gut health microbiome in the intestinal flora of birds [47،48،49. [

Table 5: Effect of adding different levels of Nano-gum Arabic to drinking water and comparing it to the imported prebiotic on anatomical traits

Treatments	mean± stander error					
	T1	T2	T3	T4	T5	Significant
Digestive tract relative weight (%)	8.28±0.57 d	9.23± 0.56 b	9.09± 0.71 c	9.44± 0.56 a	9.18± 0.59 b	*
Digestive tract length (cm)	230.50± 2.50 ab	215.00± 5.00 b	238.00± 10.00ab	248.50± 3.50 a	243.50± 7.50 a	*

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Jejunum PH	5.85± 0.09	5.34± 0.18	5.15±0.24	5.01± 0.39	5.03±0.95	N.S
Ileum PH	5.73± 0.14	5.79± 0.11	5.62± 0.11	5.49± 0.11	5.58±0.05	N.S
Means with different letters within the same row differed significantly, * (P≤0.05), N.S. not significant. Treatments: T1: Control treatment with no addition; T2 and T3: Addition of 1 and 1.5 g of imported prebiotic/L of drinking water, respectively; T4 and T5: Addition of 1 and 1.5 ml of Nano-gum Arabic/L of drinking water, respectively.						

Conclusion

The current study concludes that Nano-sized gum Arabic improved the physiological performance of the treated broilers, enhancing antioxidant levels and intestinal anatomical traits, the fourth and fifth treatments achieved the best results .

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