Effect of using raw and treated quinoa seeds (*Chenopodium quinoa*) in the diets on some microbial, physical and chemical properties of broiler carcass

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Abstract

The experiment aimed to study the use of different proportions of raw and treated Chenopodium quinoa seeds by soaking in the diet in order to identify the effect in the physical and chemical traits of meat and the numbers of bacteria in the duodenum of 42 days of age. A 336 sexed broilers (Ross 308) were distributed randomly at one day old, with an average initial weight of 39 g/chick, divided into seven treatments, 48 chicks/treatment, each treatment included three replicates, 16 chicks/replicate (8 males and 8 females). The chicks were fed on the starter diet (1-14) days of age, the grower diet of (15-28) days of age, and finisher diet (29-42) days of age, supplemented with raw quinoa seeds and treated by soaking as the first treatment (T_1) was a control treatment without any addition. (T_2) added 0.5% raw quinoa seeds, (T_3) added 1% raw quinoa seeds, (T_4) added 1.5% raw quinoa seeds, (T_5) added 0.5% quinoa seeds treated with soaking, (T_6) added 1% quinoa seeds treated with soaking, (T_7) added 1. 5% quinoa seeds treated with soaking. The results showed a significant ($P<0.05$) increase in the average numbers of Lactobacillus bacteria in favor of treatments T4, T6, T7. In contrast, there was a significant decrease in the numbers of coliform bacteria in favor of the addition treatments T3, T4, T5, T6, and T7 compared to control treatment. As for the results of the physical traits, it achieved a significant decrease in the percentage of each of the drip loss and the weight lost when dissolve for all addition treatments, and in favor of the T4 treatment the percentage of loss during cooking and a significant increase in the water holding capacity in favor of all the addition treatments compared to the control treatment. As for the chemical properties, it was found that there was a significant increase in the pH values and myoglobin pigment for meat in all the addition treatments compared to the control treatment (T1).

Keywords: quinoa seeds, raw, treated, traits, bacteria, physical, chemical , broiler carcass

Introduction

Functional seeds with medicinal roles and continuous technological innovations for their powerful antioxidant activities and nutritional properties are considered as bio-precursors that promote growth, improve final performance and health status, as well as improve meat products accompanied by high-quality meat to meet the desires of consumers [1]. The quinoa Chenopodium quinoa wild is a functional food [2]. and it is a starchy seed belonging to the family Chenopodiaceae of the genus Chenopodium. It is of high nutritional value and contains substances and compounds of technological importance and encouraging factors that are currently used in many countries as an alternative to industrial materials harmful to health, Moreover, it is rich in nutrients that enable it to be used in the production of poultry meat products [3]. Quinoa seeds have a good nutritional value compared to other commonly used seeds. They consist of fiber (5-11%), starch (52-74% rich in amylopectin). Combined with high-quality gluten-free protein (13-17%) that contains all the essential amino acids with abundant and high concentrations, especially methionine and lysine, and fatty compounds (2-9%) fat, of which 90% are unsaturated fatty acids, distributed between 50-56% linoleic acid. Omega-6, 22-25% oleic acid, omega-9, and 5-7% linolenic acid, omega-3 with sufficient of key micro-nutrients including the minerals: calcium, magnesium, iron, potassium, phosphorous, manganese, zinc, copper, and sodium. As well as vitamins, carotenoids, the most important B vitamins, vitamins E and C, bioactive ingredients such as phytosterols, squalene, polyphenols, phenolic compounds, Quercetin, Kaempferol, and Squalene, In addition to other compounds with potent antioxidant activity [4,5,6]. These factors and nutritional components encouraged quinoa seeds to be one of the prebiotics, and this is due to the role of carbohydrates in them, which is rich in fiber and good quality starch [7]. and consists of short-chain polysaccharides [8]. Fiber consists mainly of galacturonic acid, arabinose, lactose, xylose, and glucose, which are soluble dietary fibers [9]. which popularly referred to these seeds as Chenopodium quinoa Polysaccharides [10]. These facts encourage the use of these seeds as one of the components of the broiler's diet, The outer shell of the seeds contains some anti-nutritional substances in small proportions, the most important of which are saponins, phytic acid, and trypsin inhibitors, which pose a concern with the use of raw quinoa seeds, which may affect the metabolism process by reducing the utilization of protein and its good digestion, as well as reducing appetite, destroying intestinal villi and inhibiting the immune system in poultry. Especially young birds[11] .Therefore, studies indicated preparatory treatments to contribute to increasing the use and benefit of the seeds, improving the nutritional value more, eliminating harmful nutritional inhibitors and the taste of soaking seeds. Plus, the contribution of soaking to the germination

process, leads to a high level of protein as well as phenolic compounds and vitamins and an increase in the bioavailability of amino acids inside the seeds[12]. A previous study indicated that washing quinoa seeds before nutrition them or slightly reducing the amount of raw quinoa seeds in the diet will improve the growth and productive performance of birds[13].[14] found when adding quinoa seed extract to food, it worked to delay the activity of E. coli bacteria and staphylococcus bacteria, and[15] confirmed that quinoa seed extract has an inhibitory activity against bacteria that contaminate food, the most important of which are Salmonella typhimurium, Campylobacter jejuni, S.aureus, E.coli and Listeria monocytogens,[16] noticed a decrease in the values of the percentage of loss during cooking with the improvement of Water holding capacity of the beef balls added to it four different levels of quinoa seed flour at an average of 0,2.5,5,7.5% where a functional ingredient for preparing meatballs stored at 4°C for 12 hours compared to the control treatment To which breadcrumbs were added, and between[17] there was a significant decrease in the percentage of loss during cooking for beef when adding 5% quinoa seed flour instead of soybean flour.[18] mentioned that adding ground quinoa seeds to the burger beef mixture as a fat substitute at different levels (0,2.5,5,7.5,10) significantly affected the pH value of meat for all adding treatments compared to the control. The aim of this study is to know the effect of using Different percentage of raw Chenopodium quinoa seeds and soaking treatment in the diet in the physical and chemical characteristics and traits of meat and bacterial numbers in the duodenal region of broilers.

Materials and Methods

Preparation of quinoa seeds and treatments

The white raw quinoa seeds were obtained from the local markets, which were clean and free of impurities, as a quantity was taken from the raw seeds and soaked in water for 48 hours to remove the saponins responsible for the bitter taste. This technique is considered the most used method according to what was [12]. recommended, and it was dried at natural air temperature. Then, the chemical analysis of raw seeds and the treated ones were conducted in the laboratories of the Ministry of Science and Technology - Department of Environment and Water - Department of Food Chemistry according to[19]. as shown in Table 1. These seeds were added to the diets from the chick's first day of age until the end of the experiment at the age of 42 days. Thus, a100 kg of feed was prepared for each treatment and the seeds were added to a small amount of the prepared feed to ensure homogeneity, then this quantity was mixed with a larger amount and so on until got 100 kg of homogeneous feed from the seeds. The experimental treatments were (T_1) which represents the control treatment of the standard diet free of any addition, while (T_2) included the addition of 0.5% raw quinoa seeds to the standard diet, then (T_3) represents the added 1% raw quinoa seeds to the standard diet.

Similarly, (T_4) included added 1.5% raw quinoa seeds to the standard diet, and (T_5) addition of 0.5% quinoa seeds treated with soaking for 48 hours to the standard diet. Finally, (T_6) added 1% quinoa seeds treated with soaking for 48 hours to the standard diet, (T_7) added 1.5% quinoa seeds treated with soaking for 48 hours to the standard diet.

Table (1): The chemical composition of raw and treated quinoa seeds with soaking used in diets

Elements chemical composition %	Seed Soaking treatment	Raw quinoa seeds
protein	15.6	14.7
Fats	6.9	6.2
ash	3.9	3.5
moisture	10.7	10.4
carbohydrate	62.9	65.2
fibers	13.4	14.9
energy	375.1	374.6
(Minerals mg/kg)		
Iron	13.5	12.7
magnesium	196.2	194.0
phosphorous	428.1	423.6
Calcium	145.7	143.1
potassium	92.3	88.5
zinc	24.9	23.1
Fatty acids(%)		
Oleic	24.8	23.8
Palmatic	11.6	10.25
Linoleic	63.0	61.3
Linolenic	2.3	2.0
Stearic	2.5	1.8
Amino acids (mg/gm)		
Methionine	14.2	12.3
Leucine	15.7	14.5
valine	9.5	8.6
Phenylalanine	11.4	10.3
Tryptophan	6.8	5.9
Lysine	6.6	5.3

Glycine	3.9	-
Alanine	5.8	-
Histiden	3.2	-
Total phenols (mg/g)	84.2	68.6
Total saponins (%)	2.8	8.5

Chicks' management and feeding

This experiment was conducted in the poultry field of the College of Agricultural Engineering Sciences - the University of Baghdad for the period from 28-11-2020 to 9-1-2021 (42 days). The current study aimed to study the use of different proportions of raw and treated quinoa seeds in the diet and their impact on production performance, as 336 sexed broiler chicks of Ross308 were used. The chicks were randomly distributed at the age of one day, with an average initial weight of 39 g/chick, distributed over seven treatments, with 48 chicks/treatment, each treatment included three replicates, 16 chicks/replicate (8 males and 8 females),the Chicks were raised from the age of one day up to 42 days in a ground breeding hall divided into pins. The dimensions of one pin were 2 x 2 m^2. Gas incubators were used to heat the hall and obtain the required temperature, as it was 34 °C during the first week of life and then reduced gradually with the use of a ventilation fan at a rate of two degrees per week until reaching 24 °C at the age of marketing. The relative humidity of the hall was 60-65% with the followers of the continuous lighting program. Then, the chicks were fed free ad libitum and crushed feed during the experiment period, knowing that the water was provided in a freeway. The birds were fed on the starter diet from the age of one to 14 days and the grower diet from the age of 15 days up to 28 days and the finisher diet from the age of 29 to 42 days according to the breeding guide for broilers Ross308. It contains on protein and energy ratios as in Tables (2), (3), and (4), which show the percentages of feed materials included in the composition of the diets with the chemical composition calculated for them.

Studied traits

At the end of the experiment period, the birds fasted for 4 hours before the slaughtering process, and then 6 birds from each treatment were randomly taken (male and female) and the weights were close to each other and for the average live weight of the one duplicate bird and weighed using an electronic scale, after slaughter, cleaning, washing and isolating the viscera, follow the following:

Estimation of the logarithmic numbers bacterla in the duodenum

The duodenum contents of each bird were taken in the amount of 10 g and added to the sterile peptone water in a volume of 90 ml under sterile conditions and decimal dilutions were performed on it up to 10^{10} for the purpose of estimating the numbers of microorganisms. The numbers of Lactobacilli and E.Coli bacteria were estimated

according to the method mentioned by[20] using the dish pouring method.From each decimal dilution, 1 ml was transferred to two empty and sterilized Petri dishes and 15 ml was added to each dish of sterilized culture medium (MRS-Agar). It was prepared instantaneously and kept in a water bath at a temperature of 45°C. After the period of solidification of the culture medium in the dishes, it was kept upside down at a temperature of 37°C for a period of 48 hours. The numbers of bacteria were estimated by multiplying the average number of colonies that grew in each dish with the inverted dilution.

Estimation of the physical traits of the carcass

Drip loss percentage:

The exudative fluid loss diet was calculated according to the method referred to by[21] The fresh carcass was weighed and then placed inside nylon bags made of polyethylene and placed in the home refrigerator at a temperature of 5 °C for 24 hours, then the carcass was taken out.It was dried from the resulting oozing liquid using filter paper, and then it was weighed and then the loss percentage of the oozing liquid was calculated using the following equation

$$\textbf{drip loss(\%)} = \frac{\textit{Hot carcass weight} - \textit{cold carcass weight}}{\textit{hot carcass weight}} \times 100$$

Table (2): Components and chemical composition (%) of starter diet (1-14 days)

Components	Treatments						
	T1	T2	T3	T4	T5	T6	T7
yellow corn	45.5	45	45	44.5	45	45	45
wheat	10	10	10	10	10	10	10
Soybean meal (48% crude protein)	34	34	33.5	33.5	34	33.5	33.5
protein concentrate*	5	5	5	5	5	5	5
quinoa seeds**	-	0.5	1	1.5	0.5	1	1.5
oil	3	3	3	3	3	3	2.5
Di Calcium Phosphit***	0.7	0.7	0.7	0.7	0.7	0.7	0.7
limestone	1.2	1.2	1.2	1.2	1.2	1.2	1.2
salt	0.1	0.1	0.1	0.1	0.1	0.1	0.1
methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100
Calculated chemical composition ****							
Represented energy (kilocalories/kg)	3041.2	3043.1	3049.7	3051.6	3043.21	3049.7	3023.5
crude protein	23.34	23.37	23.42	23.33	23.37	23.21	23.29
crude fat	5.57	5.58	5.61	5.62	5.58	5.61	5.15
crude fiber	2.74	2.80	2.86	2.92	2.80	2.86	2.94
methionine + cysteine	1.14	1.14	1.14	1.15	1.14	1.14	1.15
lysine	1.54	1.54	1.53	1.53	1.54	1.53	1.53

Calcium	0.98	0.98	0.98	0.98	0.98	0.98	0.98
available Phosphorous	0.48	0.48	0.48	0.48	0.48	0.48	0.48

* The protein concentrate produced by the Dutch company Wafi, which contains 40% of crude protein and 2107 kcal of metabolic energy / kg of feed, 5% crude fat, 2.81% crude fiber, 5% calcium, 3.7% methionine, 4.12% methionine + cysteine, 3.85% lysine and 4 68% available phosphorous, 0.42% tryptophan, 1.70% threonine, 2.50% sodium and chloride 3.88%.

** Raw Quinoa seeds, metabolic energy 3746 kcal /kg, 14.7% crude protein, 6.2% crude fat, 14.9% crude fiber, soaked quinoa seeds, metabolic energy 3751 kcal /kg, 15% crude protein, and 6.9% raw fat and 15.4% raw fibres.

*** Phosphorous 18%, Calcium 24%.

**** The chemical composition of the diet components as mentioned by [21].

Loss weight when dissolved:

It was calculated according to the method referred to by[22] as fresh carcasses were frozen for each treatment at a temperature of -18°C for a period of three days. Then the weight of the frozen carcasses was taken and left in the refrigerator at a temperature of 5 °C for 24 hours to keep the dissolving process going. After the end of the period, they were dried from the exuded liquid using blotting paper.

Table (3): Components and chemical composition (%) of the grower diet (15-28 days)

Components	Treatments						
	T1	T2	T3	T4	T5	T6	T7
yellow corn	51.5	51	50.5	50	51	51	50.5
wheat	10	10	10	10	10	10	10
Soybean meal (48% crude protein)	28	28	28	28	28	27.5	27.5
protein concentrate*	5	5	5	5	5	5	5
quinoa seeds**	-	0.5	1	1.5	0.5	1	1.5
oil	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Di Calcium Phosphit***	0.5	0.5	0.5	0.5	0.5	0.5	0.5
limestone	1.14	1.14	1.14	1.14	1.14	1.14	1.14
salt	0.1	0.1	0.1	0.1	0.1	0.1	0.1
methionine	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Lysine	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Total	100	100	100	100	100	100	100
Calculated chemical composition ****							
Represented energy (kilocalories/kg)	3140.80	3142.78	3144.01	3146.74	3142.81	3149.36	3151.37
crude protein	20.97	21	21.03	21.06	21	20.84	20.88
crude fat	6.27	6.25	6.26	6.27	6.25	6.28	6.3

crude fiber	2.64	2.70	2.76	2.83	2.7	2.76	2.82
methionine + cysteine	0.96	0.96	0.97	0.97	0.96	0.96	0.97
lysine	1.29	1.29	1.29	1.29	1.29	1.27	1.27
Calcium	0.89	0.89	0.89	0.89	0.89	0.89	0.89
available Phosphorous	0.44	0.44	0.44	0.44	0.44	0.44	0.48

* The protein concentrate produced by the Dutch company Wafi, which contains 40% of crude protein and 2107 kcal of metabolic energy / kg of feed, 5% crude fat, 2.81% crude fiber, 5% calcium, 3.7% methionine, 4.12% methionine + cysteine, 3.85% lysine and 4 68% available phosphorous, 0.42% tryptophan, 1.70% threonine, 2.50% sodium and chloride 3.88%.

** Raw Quinoa seeds, metabolic energy 3746 kcal /kg, 14.7% crude protein, 6.2% crude fat, 14.9% crude fiber, soaked quinoa seeds, metabolic energy 3751 kcal /kg, 15% crude protein, and 6.9% raw fat and 15.4% raw fibres.

*** Phosphorous 18%, Calcium 24%.

**** The chemical composition of the diet components as mentioned by [21].

The percentage of lost weight when dissolve was calculated by following the following equation**:**

$$\textbf{Loss weight when dissolved (\%)} = \frac{Weight\ of\ frozen\ carcass\ (g) - weight\ of\ carcass\ after\ dissolved(g)}{Frozen\ carcass\ weight\ (gm)} \times 100$$

Table (4): Components and chemical composition (%) of the finisher diet (29-42 days)

Components	Treatments						
	T1	T2	T3	T4	T5	T6	T7
yellow corn	55	54.5	54.5	54	54.5	54.5	54.5
wheat	10	10	10	10	10	10	10
Soybean meal (48% crude protein)	24	24	23.64	23.64	24	23.5	23.5
protein concentrate*	5	5	5	5	5	5	5
quinoa seeds**	-	0.5	1	1.5	0.5	1	1.5
oil	4.14	4.14	4	4	4.14	4.14	3.64
Di Calcium Phosphit***	0.4	0.4	0.4	0.4	0.4	0.4	0.4
limestone	1.1	1.1	1.1	1.1	1.1	1.1	1.1
salt	0.1	0.1	0.1	0.1	0.1	0.1	0.1
methionine	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Lysine	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Total	100	100	100	100	100	100	100
Calculated chemical composition ****							
Represented energy (kilocalories/kg)	3228.05	3220.03	3217.38	3219.36	3220.06	3226.61	3200.37
crude protein	19.35	19.38	19.28	19.31	19.38	19.22	19.30
crude fat	6.97	6.98	6.87	6.88	6.99	7.02	6.55

crude fiber	2.56	2.62	2.68	2.74	2.62	2.68	2.76
methionine + cysteine	0.92	0.92	0.92	0.93	0.92	0.92	0.93
lysine	1.18	1.18	1.17	1.17	1.18	1.16	1.16
Calcium	0.84	0.84	0.84	0.84	0.84	0.84	0.84
available Phosphorous	0.42	0.42	0.42	0.41	0.42	0.41	0.41

* The protein concentrate produced by the Dutch company Wafi, which contains 40% of crude protein and 2107 kcal of metabolic energy / kg of feed, 5% crude fat, 2.81% crude fiber, 5% calcium, 3.7% methionine, 4.12% methionine + cysteine, 3.85% lysine and 4 68% available phosphorous, 0.42% tryptophan, 1.70% threonine, 2.50% sodium and chloride 3.88%.
** Raw Quinoa seeds, metabolic energy 3746 kcal /kg, 14.7% crude protein, 6.2% crude fat, 14.9% crude fiber, soaked quinoa seeds, metabolic energy 3751 kcal /kg, 15% crude protein, and 6.9% raw fat and 15.4% raw fibres.
*** Phosphorous 18%, Calcium 24%.
**** The chemical composition of the diet components as mentioned by [21].

Loss during cooking:

It was calculated according to the method referred to by[23] by weighing the fresh carcass before cooking, then the carcass was cooked by barbecue method by placing it in an electric oven at a temperature of 160 °C for a period of 5-6 minutes and then weighing it after cooking, taking into account its drying and disposal of the exuded liquid resulting from the cooking process using blotting paper, according to the following equation:

Loss weight when cooking (%) =

$$= \frac{\textit{weight of the carcass before cooking} - \textit{the weight of the carcass after cooking}}{\textit{weight of the carcass before cooking}} \times 100$$

Water holding capacity (WHC):

It was estimated according to the method presented by[24] in the laboratories of the Ministry of Science and Technology / Department of Environment and Water - Food Chemistry Department by taking 10 g of meat (breast + thigh mixture) and homogenizing it With 50 ml of distilled water for one minute, then centrifuged at 5000 rpm for 10 minutes, and it was estimated according to the following equation:

Water holding capacity% =

$$\frac{\textit{Weight of added water} - \textit{weight of water after centrifugation}}{\textit{sample weight}} \times 100$$

Chemical traits of meat:

Chemical tests for meat (breast + thigh mixture) were calculated for each of the treatments and separated from the bone in the laboratories of the Ministry of Science

and Technology - Department of Environment and Water - Department of Food Chemistry and the following tests were conducted on them:

pH degree:

1 g of meat was homogenized and then mixed with 10 ml of distilled water (pH = 7) and sexed with water well, then the pH was measured directly with a pH meter, according to method [25]

Myoglobin pigment concentration:

measured based on the mentioned method from[26] where 10 g of meat was taken and homogenized with 90 ml of distilled water Then add 10 ml of sodium phosphate (0.04 mol/L) and put it in a centrifuge at 3000 rpm for 10 minutes, then filter it and read the absorbance at a wavelength (525 nm) according to the concentration of myoglobin by the following equation:

Myoglobin concentration (mg/g of meat) = Absorbance x 2.4 / Weight of the sample x 0.452.

The data was analyzed using a complete randomized design (CRD). Duncan's multiple-data test was also conducted to compare the significant differences between the means of the studied traits, and the ready-made statistical program SAS [27] was used in analyzing the data

Results and Discussion

Logarithmic numbers of Lactobacilli and Coliform bacteria in the duodenum

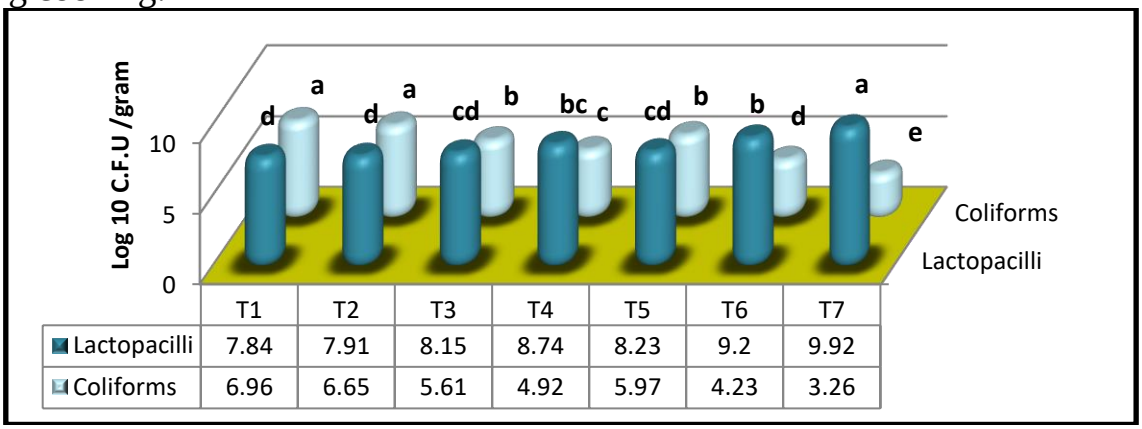
Figure (1) Effect of using raw and treated quinoa seeds with diet on numbers of Lactobacilli and Coliform (Log 10 Cuf/gr) bacteria for duodenal contents of broilers**,** It was noticed that there was a significant improvement ($P<0.05$) in the numbers of lactobacilli bacteria in favor of the T7 in addition to treatment birds, which topped the values compared to the control treatment T1 and the second, third, fourth, fifth, and sixth addition treatments, where the values were recorded 9.92 (Log 10 Cfu/gr) compared to 7.84, 7.91, 8.15 and 8. 74, 8.23, 9.2 (Log 10 Cfu/gr), respectively . As for the T6 adding treatment, it achieved a significant ($P<0.05$) superiority compared to the control treatment T1 and the addition treatments T2, T3 and T5, and it was similar in effect to the T4 treatment, which achieved a significant improvement ($P<0.05$) by comparing with the control treatment T1 and T2 on the one hand and did not differ significantly with the two addition treatments T3 and T5 on the other hand. It was also noted that the experimental treatments T1,T2, T3 and T5 did not differ significantly among them in the numbers of lactobacilli bacteria. From the same figure, the results of the data show that there was a significant ($P<0.05$) decrease in the logarithmic numbers of coliform bacteria in the duodenum of broilers in favor of the birds treated with T7 supplementation, which recorded a significant decrease, which amounted to 3.26 compared to the control treatment T1 and T2, whose values reached 6.96, 6.65, (Log 10 Cfu/gr) and with the addition treatments. T3, T4, T5 and T6, whose values were 5.61,

4.92, 5.97, 4.23, (Log 10 Cfu/gr) respectively. The last addition treatments achieved a significant decrease (P<0.05) between them and the control treatment T1 and in light of the results we note that there are no significant differences between T1 and T2 on the one hand and between T3 and T5 on the other hand in the number of colon bacteria in the duodenum area.

Physical traits

drip loss and loss during cooking

The data of the statistical analysis shown in Table (5) shows the effect of using different levels of raw and treated quinoa seeds with diet on the percentage of drip loss, the loss during cooking, the weight lost when dissolve, and water holding capacity for broiler carcasses. It is noticed that the drip loss decreased significantly (P<0.05) in favor of all addition treatments T2, T3, T4, T5, T6 and T7 compared to the control treatment T1, where the values reached 1.24, 1.37, 1.11, 1.30, 1.19 and 0.97% compared to 2.36 % respectively, The addition treatments did not differ significantly between them, and it was shown from Table (5) that the percentages of loss during cooking decreased significantly (P<0.05) in favor of the T4 addition treatment in which 1.5% of raw quinoa seeds was used compared to the control treatment T1. The values recorded 15.80% compared to 24.22% respectively and the rest of the addition treatments T2, T5, T6 and T7 The values were recorded as 25.82, 23.98, 22.35 and 22.05%, respectively, and were similar in effect to the T3 addition treatment, which recorded 20.41%, which did not differ significantly from all other experiment treatments by the percentage of loss during cooking.



	T1	T2	T3	T4	T5	T6	T7
Lactopacilli	7.84	7.91	8.15	8.74	8.23	9.2	9.92
Coliforms	6.96	6.65	5.61	4.92	5.97	4.23	3.26

Figure (1): Effect of using raw and treated quinoa seeds with ration on numbers of Lactobacilli and Coliform (Log 10 Cfu/gr) bacteria for duodenal contents of broilers

Different letters mean that there are significant differences at the level of probability (P<0.05) between the means of traits treatments:- T1 control treatment without any addition, T2 using 0.5% raw quinoa seeds, T3 using 1% raw quinoa seeds, T4 using 1.5% raw quinoa seeds, T5 using 0.5% quinoa seeds treated, T6 using 1% treated quinoa seeds, T7 using 1.5% quinoa seeds treated .

Weight lost during dissolving and water holding capacity

The results of the statistical analysis in Table (5) showed the effect of using different levels of raw and treated quinoa seeds with the diet on the lost weight when dissolving and the water holding capacity for broiler carcasses, Where it was found that the values of lost weight when thawing decreased significantly (P<0.05) in favor of carcasses of the addition treatments T2, T3 T4, T5, T6, T7, compared to the control treatment T1, the values were 1.25, 1.03, 1.02, 1.79, 1.30 and 1.04% compared to 2.14%, respectively. It was also found that the addition treatments T2, T3, T4, T6, and T7 significantly decreased (P<0.05) in weight loss when dissolving compared to the T5 addition treatment. It is noted from the same table that there was a significant (P<0.05) excelled(P<0.05) in the water holding capacity for carcass meat in favor of the T4 treatment whose birds were fed on rations that contained raw quinoa seeds at an average of 1.5%. Compared to the control treatment T1. Where the values of 24.89 and 25.00 were recorded, compared to 21.60%, and these two treatments achieved a significantly excelled (P<0.05) compared with the other addition treatments T2, T3, T5, and T6, and their values were recorded, respectively, 23.59, 23.93, 23.68 and 23.99%, These last treatments achieved a significantly excelled (P<0.05) compared to the control treatment T1, and it was noted at the same time that the last treatments had a significant improvement (P<0.05), as it was topped by the addition treatment T6 compared to the two treatments T2 and T5, but it did not differ significantly with the treatment of the addition T3, which achieved a significant improvement. (P<0.05) when compared with T2 on one hand and it was significantly similar with T5 treatment on the other hand in the characteristic of water holding capacity of carcasses meat.

Table (5): Effect of using raw and treated quinoa seeds with diet on the percentage of drip loss, loss during cooking, weight lost during dissolving, and water holding capacity (mean ± standard error) of broiler carcasses

traits	Treatments							level of significant
	T1	T2	T3	T4	T5	T6	T7	
drip loss %	^{a}0.22±2.36	^{b}0.12±1.24	^{b}0.15±1.37	^{b}0.03±1.11	^{b}0.18±1.30	^{b}0.17±1.19	^{b}0.11±0.97	*
loss during cooking%	^{ab}0.12±24.22	^{a}0.82±25.82	^{bc}1.52±20.41	^{c}1.60±15.80	^{ab}2.79±23.98	^{ab}1.35±22.35	^{ab}1.56±22.05	*
Weight lost when dissolving %	^{a}0.26±2.14	^{c}0.10±1.25	^{c}0.02±1.03	^{c}0.05±1.02	^{b}0.06±1.79	^{c}0.00±1.30	^{c}0.03±1.04	*
water holding capacity%	^{e}0.15±21.60	^{d}0.07±23.59	^{cb}0.0±23.93	^{a}0.04±24.89	^{cd}0.9±23.68	^{b}0.05±23.99	^{a}0.06±25.00	*

The different letters within the same row indicate a significant difference between the averages of the coefficients

* Indicates that there are significant differences at the level of probability (P<0.05) between the means of the treatments

treatments:- T1 control treatment without any addition, T2 using 0.5% raw quinoa seeds, T3 using 1% raw quinoa seeds, T4 using 1.5% raw quinoa seeds, T5 using 0.5%

quinoa seeds treated, T6 using 1% treated quinoa seeds, T7 using 1.5% quinoa seeds treated.

Chemical traits

pH value of meat

Figure (2) shows the effect of using different levels of raw and treated quinoa seeds with the diet on the pH value of broiler carcasses. It was found that there was a significant (P<0.05) increase in the pH value in favor of the T4 and T7 addition treatments compared to the T1 control treatment, and the values were recorded 5.83 and 5.85 compared to 5.51 respectively , It was noted that these two treatments achieved a significant (P<0.05) excelled compared to the addition treatments T2, T3, T5, and T6, whose values were 5.64, 5.69, 5.66, and 5.71, respectively, and the treatments did not differ.The latter was significantly excelled to each other, although it achieved a significantly excelled (P<0.05) compared to the control treatment T1.

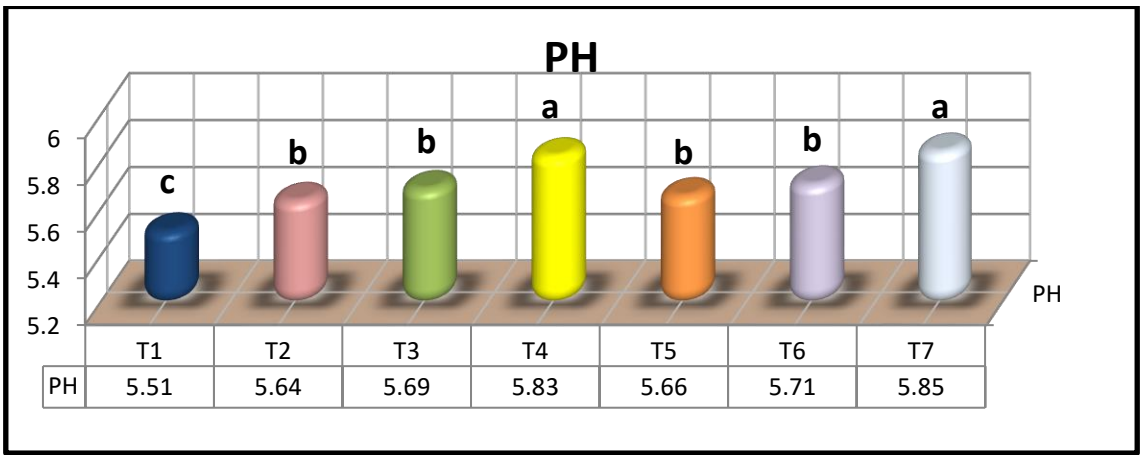


Figure (2): Effect of using raw and treated quinoa seeds with diet on the pH value for meat carcasses of broilers

Different letters mean that there are significant differences at the level of probability (P<0.05) between the means of treatments among them treatments :-) T1) control treatment without any addition, (T2 using 0.5% raw quinoa seeds, (T3) using 1% raw quinoa seeds, (T4) using 1.5% raw quinoa seeds, (T5) using 0.5% treated quinoa seeds (T6) use 1% treated quinoa seeds, (T7) use 1.5% treated quinoa seeds.

Meat myoglobin pigment

Figure (3) shows the effect of using different levels of raw and treated quinoa seeds with diet on the concentration of myoglobin pigment for broiler carcasses. It was found that there was a significantly excelled (P<0.05) in the myoglobin pigment in favor of the addition treatments T4 and T7 compared to the control treatment T1, whose values were recorded at 0.74 and 0.74 compared to 0.49, respectively. It was noted that these two treatments achieved a significant increase (P<0.05) compared to the T2 and T5 addition treatments on the one hand and did not differ significantly with the T3 and T6 addition treatments on the other hand, which recorded their values, respectively, of

0.63, 0.63, 0.66 and 0.67, although the last addition treatments did not significantly different among them, in turn, it achieved a significant improvement (P<0.05) compared to the control treatment T1 in the myoglobin pigment traits of broiler carcasses.

Through the data of the current study of the results obtained in this study, we note that the birds fed on diets in which raw quinoa seeds were used and the treatment had an increase in the values of logarithmic numbers in favor of anaerobic bacteria represented by Lactobacilli in the contents of the duodenum of the intestine, in contrast, the logarithmic numbers of coliform bacteria decreased. This effect may be due to the important role of unsaturated fatty acids contained in the fat content of quinoa seeds in addition to palmitic acid, which works synergistically in improving the intestinal environment through its positive action in reducing the numbers of harmful coliform bacteria Increasing the numbers of beneficial bacteria such as Lactobacilli by enhancing them by increasing the activity of digestion and absorption processes and making more use of the absorbed vitamins and nutrients[28]

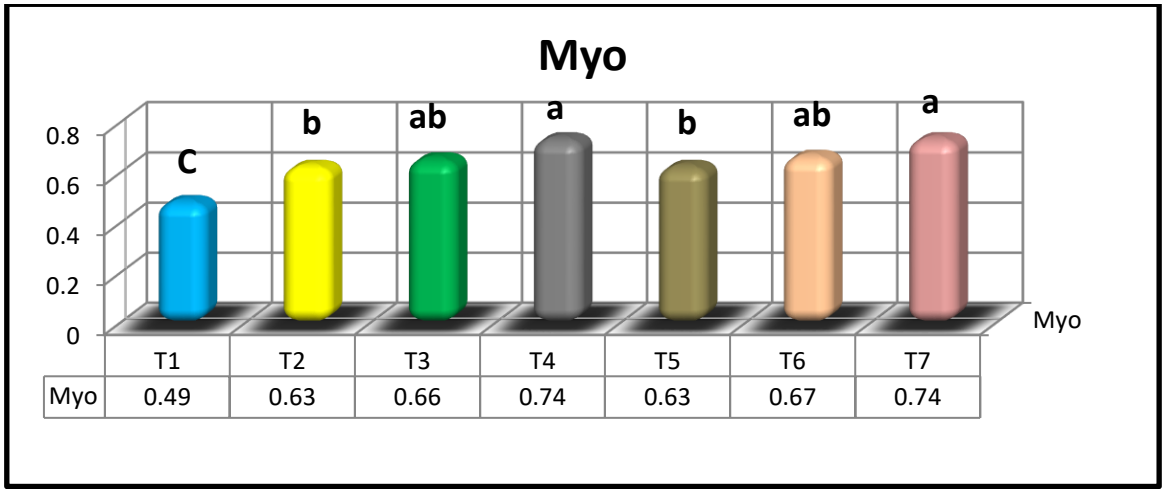


Figure (3): Effect of using raw and treated quinoa seeds with ration on the concentration of myoglobin pigment for meat carcasses of broilers

Different letters mean that there are significant differences at the level of probability (P<0.05) between the means of the coefficients treatments: - (T1) Control treatment without any addition, (T2) using 0.5% raw quinoa seeds, (T3) using 1% raw quinoa seeds, (T4) using 1.5% raw quinoa seeds, (T5) using 0.5% Treated quinoa seeds (T6) use 1% treated quinoa seeds, (T6) use 1.5% treated quinoa seeds.

The improvement is also attributed to the role of the active compounds, tocopherols, polysaccharides, alkaloids, phenolic compounds, and flavonoids found in quinoa seeds through their inhibitory activity and anti-microbial activities and their exclusion, especially gram-positive and gram-negative pathogenic bacteria, and maintaining the microbial balance within the beneficial intestinal flora represented by the selective Lactobacillus lactobacilli represented by Bacto-bacterium. Which is characterized by its ability to settle and adhere to the lining of the alimentary canal[29] Hence, we find that

quinoa seeds have an important role in supporting and enhancing the balance of the microbial community through its work by reducing the numbers of microorganisms and harmful bacteria represented by coliform bacteria due to its killing and exclusion, and thus it will prevail ,The beneficial bacteria represented by Lactobacilli are excelled by strengthening and supporting their activity and balance and increasing their numbers in the intestinal flora. The reason for the improvement is also due to the increase in the numbers of lactobacilli bacteria, mainly to the role of carbohydrates found in quinoa seeds, which are rich in fiber and good quality starch, as they are rich in polysaccharides[30]. Accordingly, these seeds possess the properties of prebiotics due to their possession of fibers consisting mainly of galacturonic acid, arabinose, lactose, xylose, and glucose, which are of the soluble dietary fiber type[9,31] Soluble fiber is food non-starchy carbohydrate compounds that are difficult to digest but are well fermented, which is one of the most important precursors, such as fructooligosaccharide (FOS) and mannanoligosaccharide (MOS), ligosaccharide, oligofructose, xylooligosaccharide and b-glucan, because these sugars are not degradable within the digestive tract, and these sugars are not digestible. Birds do not have the enzymes for their decomposition, but in the opposite direction, they are considered a specialized food material from which beneficial bacteria benefit, Especially Bifidobacterium and Lactobacilli, which feed on them in order to increase, multiply and live and impose their dominance at the expense of pathogenic bacteria, and this is due to the enzymatic compounds present in beneficial bacteria that possess digestive enzymes,Which works to disintegrate and take advantage of these substances, in contrast to harmful bacteria that lose these features and thus increase their numbers and dominance within the intestine, Harmful or pathological bacteria such as salmonella and coliform bacteria that do not possess digestive enzymes and do not benefit from these sugars, and therefore their soluble dietary fibers will contribute to the role of the prebiotic, which will positively affect the increase in the numbers of beneficial and beneficial bacteria inside the intestine, which is a source of energy for intestinal cells[32]. The reason for the decrease of the drip liquid in favor of treatments containing quinoa seeds is due to the fact that these seeds possess chemical compounds represented by phenolics and flavonoids in a large proportion, which worked in their ability to maintain the permanent stability of the cellular structure of meat by not exposing its internal contents such as fluids and its sarcoplasmic components within the membranes to damage caused by the resulting oxidation process from the formation of harmful free radicals to this process, Maintaining cell membranes and their integrity and limiting their rupture processes will prevent the loss of cellular components within the meat membranes, which leads to a lack of drip fluid with an increase in the meat's ability to hold water and bind to it[33,34]. The reason for the decrease in losses during cooking is also due to the addition of the chemical composition of quinoa seeds, which increases the sites that work in turn to hold and bind water with protein molecules, the main component of muscle tissue. The moisture content increases inside the meaty muscles, so when cooking, a decrease in the volume of the separated liquid will be observed [33,35]. While the improvement in

Water holding capacity is due to the role of fiber and carbohydrates found in quinoa seeds and added to the diet in Water holding capacity,[36] confirmed that the improvement in water retention is due to the fact that fatty particles and myofibrils are surrounded and covered with fibers that prevent fluid loss during cooking. The reason for the decrease in the percentage of lost weight when dissolving in favor of the addition treatment birds compared to the T1 control treatment may be due to the possession of quinoa seeds, the chemical compounds that have the main role as an antioxidant. The cell membrane surrounding the muscle fiber exposed. This will encourage its prolongation and preservation, which leads to an increase in the capacity and contribution of the stromal tissues to Water holding capacity and prevent their loss of fluids [33,35]. As the increase in the loss of meat fluids will expose the loss of more nutrients with the necessary components present in the meat tissue, resulting in more dry meat with high hardness and a loss of the natural meat flavor [37]. The reason for the ability of meat to retain water may be due to the role of natural oxidation compounds found in quinoa seeds and their interaction with meat tissues, where these compounds stimulate and increase the meat's Water holding capacity associated with the protein inside the muscle cell that makes up these tissues and keep it. This allows the penetration and entry of water from the outside into the muscle cell, and then the ability of meat protein to absorb and Water holding capacity will increase due to its low solubility[34;35]. The reason for the decrease in the liquid lost when dissolving with the increase of the meat's Water holding capacity is due to the role of quinoa seeds, which have antioxidants, which contributed to raising the pH of the meat of birds of the addition treatment compared to the T1 control treatment. From the data of this study that we obtained, shown in Figure (2), the high pH of the meat of birds of addition treatments and its distance from the electrical equilibrium point will increase the meat's ability to hold water and keep it because the relationship between them is direct [35;38]. Or, the reason may be due to the increase in the amount of water associated with the protein, which leads to a high pH and a move away from the electrical neutralization point, thus improving the solubility and proliferation of protein molecules. between peptide chains with large amounts of water [39]. or, the improvement may be attributed to the dietary fibers possessed by the seeds, which bind the components of the fleshy tissue [40]. as well as the role of proteins and starch in quinoa seeds, which act as a binder, increasing the meat's water holding capacity [41] The reason for the high pH values of meat carcasses of birds fed on rations containing raw and treated quinoa seeds may be due to the increase compared to the control treatment, According to what we believe, this is due to the role of quinoa seeds and their effective compounds and various chemical components that worked to raise the level of protein solubility and spread, which was positively reflected in the water holding capacity and retain water, and then increase the binding of protein molecules to water [35]. As these substances acted in the role that salts play by increasing the electrical repulsion between protein molecules carrying the same charges, which allows to occupy the spaces between the peptide chains and fill them with large quantities of water, which leads to the departure of pH from the electrolytic

equivalence point and its value[42] Therefore, pH is one of the important characteristics that is closely related to the ability to retain water, myoglobin pigment and loss during cooking[43] because its high is one of the good features that indicate improved meat quality in carcasses with high water holding capacity [44;45] or, the reason may be due to the fact that quinoa seeds contain a proportion of the basic amino acids represented by valine, alanine and glycine, which contribute to an increase and work to raise the pH values (Table 1). The reason for the increase in myoglobin pigment for the meat of the carcasses of the treatments that fed their birds on diets containing quinoa seeds is due to the high pH values of the meat of these treatments because the high pH of the meat (pH ≥ 5.8) will increase water holding capacity and give a darker color to the meat while the low pH To the electrolyte point (pH ≤ 5.5) will lead to an opposite process with lower water holding capacity[38] In addition to these seeds possessing carotenoid compounds such as lutein, zeaxanthin and beta-carotene[46]. which worked by accumulating them within muscle tissues according to the proportions of seeds added to rations and took their role as an antioxidant [35;47] Thus, it provided protection to the meat of addition birds and eliminated the factors to which broilers meat is allergic, which leads to its rapid exposure to oxidation processes due to the high levels of unsaturated fatty acids, despite its possession of small amounts of natural antioxidants such as vitamin E,As these agents reduce their storage period due to what they produce from compounds that have a toxic effect such as free radicals, malonaldehyde and hydroperoxides[48,49]. We also believe that quinoa seeds possessing phenolic compounds as in Table (1) that act as antioxidants [50]. contributed to providing protection for myoglobin pigment from oxidation and converting it to Metmyoglobin pigment.In addition to the ability of these compounds to give the pigment myoglobin a hydrogen atom, which helps it protect against the formation of the myoglobin pigment and the occurrence of oxidation processes, according to what was indicated by it[33;34].

We conclude from this study that the use of all levels of raw and treated quinoa seeds in broiler ration worked by affecting the logarithmic numbers of microbial content in the duodenum, represented by reducing the numbers of E.Coli bacteria and the increase in the numbers of Lactobacilli bacteria, as well as the improvement of the physical and chemical traits of carcass meat, which included a decrease in the evaporated liquid, the weight lost when dissolving and the loss during cooking, and the increase in the values of water holding capacity , pH and myoglobin pigment, and the improvement appears better when using the level of 1.5% of treated quinoa seeds.

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