



## Response of adding citrus peels bitter orange (*Citrus aurantium*) to broiler chickens on some production traits

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<b>Received:</b> Mar. 09, 2025	<b>Abstract</b> The study aimed to evaluate the effect of adding citrus peel powder (Bitter Orange) to broiler diets on some production traits, the experiment was conducted on 160 unsexed day-old Ross 308 broilers, divided into 4 groups and each group had 4 replicates with 10 birds per replicate, The birds in each replicate were randomly distributed were T0 (control group) = (no additives) basal feed, T1 = basal feed+ 5g Bitter Orange powder/kg, T2 = basal feed+ 10g Bitter Orange powder/kg, and T3 = basal feed+ 15g Bitter Orange powder/kg, The experiment lasted for 42 days. The results showed that there were significant differences ( $P \leq 0.05$ ) in body weight at different levels compared with the control group and there was no significant effect on the rate of weight gain, and there were significant differences at the level of ( $P \leq 0.05$ ) in feed conversion ratio and feed conversion ratio. There were significant differences ( $P \leq 0.05$ ) in body weight and weight gain, and there was no significant effect on feed consumption and feed conversion ratio. In T1, T2, and T3 groups, there was an increase in body weight, feed intake, and feed conversion ratio compared with the T0 group.
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### Introduction

The livestock production sector is one of the important productive sectors, including poultry production, which has an impact on the national economy in terms of providing animal proteins such as chicken meat with high nutritional content at appropriate prices compared to meat from other animals [1]. Among the major types of meat produced worldwide, poultry has recorded the highest absolute growth rate in recent years and poultry meat is expected to remain the primary leader of meat production in the world [2]. High poultry consumption has been associated with increased oxidative stress mainly caused by oxidized compounds in the body, such as malondialdehyde, 4-hydroxy-nonenal, oxysterols, or protein carbonyls, which can induce free radicals, but are a key source for the introduction of various bioactive compounds that aim to reduce the free radical effects resulting from high poultry consumption [3].

Recently, there has been a great interest in the use of natural antioxidants in feed due to the potential adverse effects associated with the consumption of synthetic antioxidants [4]. A variety of plant resources are known to be natural sources of antioxidants,



such as herbs, fruits and vegetables [5], as they contain many active compounds with diverse chemical and therapeutic properties that are used in the treatment of many bacterial, fungal and other diseases by stimulating and improving the digestive system of domestic birds [6],

Among fruits, citrus fruits are the most abundant, grown all over the world and contain useful and valuable phytochemicals and belong to the family Rutacea, a tree that grows in tropical and subtropical regions [7].

The bitter orange (*Citrus aurantium*) fruit is of great biological and economic importance. A variety of phytochemical constituents found in the bitter orange (*Citrus aurantium*) fruit are closely related to its various biological activities [8]. The properties of citrus peels have attracted the attention of researchers for their medicinal and nutritional attributes. Citrus peels contain various active ingredients such as dietary fiber, pectin, protein, flavonoids, and essential oils [9]. *C. aurantium* has a thick peel rich in pectin, higher amounts of essential oils, phenolic compounds, the most abundant flavonoids, and a higher percentage of limonene than other citrus fruits [10]. It is characterized by its rich content of bioactive compounds such as flavonoids (Bitter orange enin, hesperidin), essential oils (limonene), and vitamin C, which represent important biological activities and antioxidant, antimicrobial, anti-inflammatory, and anticancer effects [11]. Peels are the most important by-products of the fruit, representing about 40-55% of its total weight and are characterized by a high moisture content (80%) and are naturally perishable, causing environmental pollution and because of this nature, they are considered discarded waste and there is no economic cost in collecting them [12].

The aim of our research is to find out the benefits of the effect of the addition of bitter orange peels to broiler chickens and its role in the production characteristics.

### Materials and Methods

This study was conducted in the poultry farm of the Department of Animal Production at the Faculty of Agriculture/Karbala University to study the effect of adding bitter orange peels powder at different levels to the feed and its effect on the productive traits of broilers, In this study, 160 chicks of Ross 308 strain were used at the age of one day from a local hatchery with an initial weight of 40 g. The chicks were randomly distributed into four experimental groups with 40 chicks per group and four replicates per group (10 chicks per replicate) with an area of 1 × 1 meter per cage and the chicks were fed on a diet according to table (1), and feed and water were provided to the chicks freely.

**Table (1):** Composition and chemical analysis of the treatments used during the starter and terminator periods.

Feedstuffs	Starter period from 1 day old	Age 22 Terminal Period
Yellow corn %	53.3	58
Soybean %	35.2	31.5
Bran %	4	3
Limestone %	1	1
Dicalcium %	3	3
Antitoxin %	1	1
Premix %	2.5	2.5
<b>Total</b>	100%	100%
<b>Protein %</b>	21.6	20
<b>Metabolic energy (kcal/kg feed)</b>	2900	3000
<b>Methionine%</b>	0.56	0.54
<b>Lysine %</b>	1.47	1.37
<b>Phosphorus %</b>	0.43	0.43
<b>Calcium %</b>	0.95	0.95
<b>Fat %</b>	2.4	2.6
<b>Fibers</b>	3.2	3.2

\*Feed provided to birds in the form of pellets, produced by Al-Hafez Factory / private sector.

### Animal feeding

the treatments were distributed as follows: T0 control diet, T1 addition of 5 g/kg bitter orange peels powder, T2 addition of 10 g/kg bitter orange peels powder, T3 addition of 15 g/kg bitter orange peels powder. Bitter orange peels were brought from Karbala governorate, dried at a temperature of 50 degrees Celsius by an electric oven for 4-5 hours and milled using a small electric mill to be in the form of powder by mixing a quantity of dry powder with a quantity of feed in proportions and weighed by a sensitive scale and the prescribed proportions were mixed and prepared for the experiment, at the end of the experiment 10 birds from each treatment were treated, and tests were conducted on them.

### Average weekly live body weight:

The chicks were weighed at one day of age, and the birds were weighed weekly for each replicate of the experimental treatments during the experimental period by weighing the birds of each replicate (10 birds/weight) using an electronic balance during the first three weeks, then a balance with a 50 kg capacity pan was used for the last two weeks of the experiment. The following equation was applied to determine the average weight of the live bird within one replicate, which was mentioned by [13].



$$\text{Average live weight (g)} = \frac{\text{Total weight of birds in the replicate}}{\text{Total number of birds in the replicate}}$$

### **Average weekly weight gain:**

The weight gain achieved weekly was calculated according to the following equation provided by [13].

Weight gain (g) = Live body weight at the end of the period - Live body weight at the beginning of the period.

### **Weekly feed consumption:**

The amount of feed consumed each week was calculated by weighing the amount of feed remaining at the end of the period and subtracting it from the total amount provided during the period according to the formula given by [13].

Weekly feed intake (g) = feed provided at the beginning of the period - feed remaining at the end of the period .

### **Food conversion factor:**

According to the weekly nutritional conversion factor as reported by [13] in the following equation:

$$\text{Food conversion factor} = \frac{\text{Average amount of feed consumed per week (g)}}{\text{Average weekly weight gain (g)}}$$

### **Statistical analysis**

The data were statistically analyzed by SAS software following a randomized complete block design (CRBD) with 4 replicates per group, differences between means were examined using L.S.D tests, and statistical significance was performed at the  $P \leq 0.05$  level (SAS, 2012).

### **Results and Discussion**

It was found that the birds that were fed with the addition of bitter orange peels at levels of 5 g, 10 g, and 15 g had a significant superiority ( $p < 0.05$ ). Where the two additions 5g and 10g are the best, and the observed enhancement in body weight is due to the presence of citric acid in the crusts, which has antimicrobial properties, and the low pH of these acids inhibits harmful microbes causing gastrointestinal diseases such as bacteria and reduces the level of toxicity in bacterial products and as a result improves the digestibility of protein and energy, thus improving the weight gain of birds [14].

Or due to the improved performance of the small intestine in digesting feed ingredients and increasing the efficiency of the absorption process of nutrients in a superior ratio as a result of increasing the height of the villi and decreasing the depth of the crypts in the ileum and jejunum, which led to improved digestive performance of the birds [15]. This may be due to the presence of active compounds in the shells at high

levels, especially biodegradable phenolic acids such as flavonoids, which help to improve the digestion of nutrients by stimulating the secretion of digestive enzymes, thereby enhancing the digestion of feed intake, which in turn helps to improve the overall growth of broilers [16].

Or the reason is attributed to the improved digestibility of nutrients and the antioxidant properties of citrus peels, which improved weight gain when orange peel powder was added to the feed [17]. The researcher indicated through his study that adding citrus extract supplements to broiler chicken feed resulted in an improvement in body weight at the age of 35 and a positive effect on final body weight. This may be due to citrus peels, which are mainly composed of fiber, oligosaccharides, and flavonoids [18]. Our results are consistent with the researcher [19]. that adding citrus peels to broiler feed had a significant effect on the live body weight of broilers, weekly weight gain, and feed conversion ratio compared to the control group. The results are also consistent with [20]. in their study that adding orange peel powder to feed improved weekly body weight and final body weight gain in the supplemented groups when compared to the control group. They are also consistent with [21]. that adding 2% dried orange residue to feed increased the final body weight of broiler chickens.

**Table (2):** Effect of adding bitter orange peel powder to broiler chickens on average weekly body weight

Average body weight (g) ± standard error

Treatment	Age in weeks					
	Week1	Week2	Week3	Week4	Week5	Week6
<b>T0</b>	b75.041 ± .330	b 335.62± 1.02	b 644.38± 1.40	b 1164.00± 39.97	b 1702.00± 79.18	a 2396.50 ± 81.63
<b>T1</b>	a 50.149 ± 1.24	a 350.87± 4.90	a 725.88± 8.56	a 1305.38± 9.77	a 1863.00± 13.60	ab 2571.75 ± 74.03
<b>T2</b>	a 1.01 ± 148.10	a 4.95 ± 339.62	a 706.63± 13.67	a 1270.00± 42.02	a 1849.00± 45.73	a 2580.25± 24.08
<b>T3</b>	a 149.22± 0.43	b 338.75± 0.82	a 712.75± 6.18	a 1281.38± 22.75	ab 1838.50± 23.07	ab 2509.50± 18.19
<b>Morale effect</b>	6077.2 Sector impact is significant	10.929 Sector impact is immaterial	26.718 Sector impact is significant	97.163 Sector impact is significant	146.8 Sector impact is immaterial	176.09 Sector impact is immaterial

Treatments: The first treatment T0 is the control treatment (no addition), the second treatment T1 was added 5 g of bitter orange peel powder/kg feed, the third treatment T2 was added 10 g/kg feed, the fourth treatment T3 was added 15 g of bitter orange peel powder/kg feed, and the fourth treatment T4 was added 15 g of bitter orange peel powder/kg feed.

\*Different letters within one column indicate significant differences at the level of ( $P \leq 0.05$ ).

**Table (3):** Effect of adding bitter orange peel powder to broiler chickens on average weekly weight gain.

Weight gain rate (g) ± standard error

Treat ment	Age in weeks						
	Week1	Week2	Week3	Week4	Week5	Week6	cumulatively
<b>T0</b>	100.75± 0.65	194.87± 1.32	± d 0.98	519.63± 39.38	538.00± 49.94	694.50± 30.17	392.75± 13.66
<b>T1</b>	109.50± 0.79	201.37± 3.74	± c 12.15	579.50± 2.15	557.63± 10.30	708.75± 67.01	421.96± 12.37
<b>T2</b>	1.27 ± 107.60	5.25 ± 191.52	b 13.79	563.38± 30.43	579.00± 19.16	731.25± 28.01	423.29± 4.01
<b>T3</b>	109.22± 0.24	189.52± 0.79	a 5.85	568.63± 19.14	575.00± 4.84	671.25± 6.52	414.60± 3.34
<b>L.S.D 0.05</b>	2.5486 Sector impact is intangible	10.221 Sector impact is intangible	29.754 Sector impact is intangible	82.229 Sector impact is intangible	84.263 Sector impact is intangible	121.59 Sector impact is intangible	29.526 Sector impact is intangible

Treatments: The first treatment T0 is the control treatment (no addition), the second treatment T1 was added 5 g of bitter orange peel powder/kg feed, the third treatment T2 was added 10 g/kg feed, the fourth treatment T3 was added 15 g of bitter orange peel powder/kg feed, and the fourth treatment T4 was added 15 g of bitter orange peel powder/kg feed.

\*Different letters within one column indicate significant differences at the level of ( $P \leq 0.05$ ).

Table 3,4 indicates that feeding supplemented with neranium peel powder at different levels in the diet significantly affected ( $p < 0.05$ ) on feed consumption value and total feed conversion factor during the experimental period due to the presence of bioactive receptors in bitter orange peel powder that reduced the growth of pathogenic bacteria *Escherichiacoli* and promoted the growth of beneficial bacteria *Lactobacillus* spp. in the gastrointestinal tract, as beneficial bacteria circulating in the parts of the small intestine are considered an effective center of the mucosal layer. in the small intestine is an effective center for the mucosal layer lining the intestinal cells, as this layer is a suitable environment and nutrient material for beneficial bacteria, thus increasing their vital effectiveness in digestion and absorption, which reflects positively on the improvement of the productive performance of birds [22].

Or the reason is related to the reduction of pathogens in the digestive system, increasing the effectiveness of digesting the ingested feed, which enhances intestinal absorption of nutrients by increasing the thickness of the intestinal lining as well as maximizing the use of digested food [20]. Or due to the presence of an increase in the percentage of fiber and an increase in the percentage of pectin within the crusts powder, which works to slow enzymatic secretion to increase the efficiency of feed digestion, and if the percentage of crusts powder increases, it reduces antibiotic growth stimuli [23]. Or due to the role of antioxidant metabolites in crusts, which are functional nutrients that are highly absorbed at the cellular level to support the immune function of birds, which help protect the lipids in the feed from peroxidation and thus increase the concentration of dietary fat absorbed from the feed, which may explain the reduced amount of feed consumed and increased feed conversion efficiency [17].

This is consistent with the results of a study conducted by researcher [24] when adding 3% of dried sweet orange to the feed reduces feed intake, increases body weight and increases the food conversion rate of broiler chickens for both starter and grower. The results also showed agreement with the results of [25]. Biodegraded sweet orange peels were used in different parameters in experimental diets for broiler chickens, and had a significant effect on increasing feed consumption and feed conversion ratio. The results are consistent with the study conducted by [26] in which the addition of dried orange pulp to the feed improved growth performance parameters such as body weight gain and feed conversion ratio of broiler chickens. They are also consistent with the experiment conducted by [27] in which the feed conversion ratio (FCR) of broiler chickens was increased when orange peel powder was added to the chicken feed.

**Table (4):** Effect of adding adding bitter orange peel powder to broiler feed on weekly feed consumption rate (g) ± standard error

Treatment	Age in weeks						
	Week1	Week2	Week3	Week4	Week5	Week6	cumulatively
T0	± 26.45	± a 2.28	± d 2.98	40.97	d 10.33	14.20	ab 29.31
T1	91.75± 1.08	± c 3.36	± c 2.28	± 0.52	c 2.48	36.93	b 36.33
T2	1.94 ± 93.90	b2.37 ±	b 1.79	1.74	a 13.43	8.27	a 16.65
T3	2.47	bc 0.77	a 1.58	12.33	b 4.58	8.41	a 15.03
Morale level	084.41 Sector impact is intangible	7.3603 Sector impact is intangible	6.854 Sector impact is intangible	65.926 Sector impact is intangible	27.318 Sector impact is intangible	63.621 Sector impact is intangible	79.801 Sector impact is intangible

Treatments : The first treatment T0 is the control treatment (no addition), the second treatment T1 was added 5 g of bitter orange peel powder/kg feed, the third treatment T2 was added 10 g/kg feed, the fourth treatment T3 was added 15 g of bitter orange peel powder/kg feed, and the fourth treatment T4 was added 15 g of bitter orange peel powder/kg feed.

\*Different letters within one column indicate significant differences at the level of (P≤0.05).

**Table (5):** The effect of adding bitter orange peel powder to broiler feed on the feed conversion ratio.

(g feed/g weight increasing) ± standard error

Trea tmen	Age in weeks						
	Week1	Week2	Week3	Week4	Week5	Week6	cumulativel
T0	29.1 ± 0.25	0.01± a 1.32	1.67± a 0.01	1.70± 0.04	1.76± 0.16	1.79± 0.06	1.62± a 0.06
T1	0.007 ±	± c 0.03	± b 0.04	1.56± 0.004	1.71± 0.03	1.70± 0.10	1.42± b 0.02
T2	87.00.02 ±	b 0.03 ±	1.48± b 0.05	1.58± 0.08	1.76± 0.04	1.70± 0.05	1.46± b 0.01
T3	94.± 0.02	b 0.007	1.49± b 0.02	1.60± 0.03	1.78± 0.05	1.81± 0.01	1.50± b 0.01
Mora le	0.4011 Sector impact is intangible	0.0745 Sector impact is intangible	0.1182 Sector impact is intangible	0.1575 Sector impact is intangible	0.2848 Sector impact is intangible	0.208 Sector impact is intangible	0.1029 Sector impact is intangible

Treatments: The first treatment T0 is the control treatment (no addition), the second treatment T1 was added 5 g Bitter orange peel powder/vkg feed, the third treatment T2 was added 10 g/vkg feed, the

fourth treatment T3 was added 15 g Bitter orange peel powder/kg feed and the fourth treatment T4 was added 15 g Bitter orange peel powder/kg feed.

\*Different letters within a column indicate significant differences at the  $P \leq 0.05$  level.

From the above, we conclude that the addition of bitter orange peels powder (bitter orange) in the broiler feed at different levels achieved a highly significant benefit in increasing production performance and had a positive effect on improving production performance (weekly weight gain), and had a positive effect on the rate of nutritional conversion and maximizing the utilization of the feed ingredients consumed .

We recommend the use of bitter orange peels powder (bitter orange) as an economically inexpensive (waste) and add it to the broiler feed.

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