CHITOSAN EFFECT ON MEAT QUALITY IN LOCAL QUAILS MALE

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ABSTRACT

The aim of this study is to know the effect of different percentages of chitosan added to drinking water on the weight and quality of quail meat, physical anatomy in terms of (the body of the long carcass, the girth of the chest, the length of the thigh bones, the thigh racket, the fullness of the chest), chemical analysis (protein, moisture, fat and ash) and sensory evaluation of quail meat. It was purchased 320 Iraqi-origin birds of quail and one day old. Chicks were randomly distributed to three equal groups' treatments and treated with chitosan and added to the drinking water: the first treatment (0.1 gm./L water only as a control treatment), the second treatment (0.2 gm./L of chitosan was added to the drinking water) and the third treatment (0.3 gm./L of chitosan was added to the drinking water).The results showed a significant difference (p≤ 0.05) between groups in carcass cutting, physical anatomy, measurement of carcass parts and chemical analysis, as well as a significant and clear improvement in the sensory characteristics of quail meat with a concentration of 0.2 gm./L chitosan. We conclude from this that adding low concentrations of chitosan to the drinking water of quail birds showed a significant difference in growth performance, meat quality, chemical composition, carcass weights and physical anatomy, as well as improving sensory characteristics and quality of quail meat.

Keywords: Quails, chitosan, meat quality, physic-chemical composition, sensory evaluation.

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تأثيره الكايتوسان على جودة اللحوم في ذكور طيور السمان المحلي

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الخلاصة

هدفت هذه الدراسة الى معرفة تأثير النسب المختلفة من الكايتوسان المضافة إلى مياه الشرب على أوزان وجودة لحوم طيور السمان، من خلال التشريح (جسم الذبيحة الطويلة ومحيط الصدر وطول عظام الفخذ وحجم الفخذ وامتلاء الصدر) والتحليل الكيميائي (بروتين ورطوبة ودهون ورماد) والتقييم الحسي، اذ تم شراءه 320 طيرا عراقي المنشأ من السمان وذو عمر يوم واحد، وتم توزيعهم عشوائيا إلى ثلاث مجاميع متساوية وتم معاملتها بمادة الكايتوسان وإضافته الى ماء الشرب: المعاملة الأولى (0.1 غم/ لتر ماء فقط كمعاملة سيطرة)، المعاملة الثانية (أضيف 0.2 غم/لتر من الكايتوسان إلى ماء الشرب) والمعاملة الثالثة (أضيف 0.3 غم/ لتر من الكايتوسان إلى ماء الشرب)، وأظهرت النتائج فرقا معنويا بين المجموعات في قطع الذبيحة والتشريح الفيزيائي وقياس أجزاء الذبيحة والتحليل الكيميائي، وكذلك أظهرت تحسنا معنويا واضحا في الصفات الحسية للحم طيور السمان للتركيز 0.2 غم/ لتر من الكايتوسان، اذ شكلت إضافة تراكيز منخفضة من الكايتوسان إلى ماء الشرب لطيور السمان فرقا معنويا في أداء النمو وجودة اللحوم والتركيب الكيميائي وأوزان الذبيحة والتشريح الفيزيائي وكذلك تحسين الصفات الحسية للحوم طيور السمان وجودتها.

الكلمات المفتاحية: السمان، الكايتوسان، جودة اللحوم، التركيب الفيزيو-كيميائي، التقييم الحسي.

INTRODUCTION

Among the meat products, quail meat is currently one of the most desirable poultry meat products, and quail birds are the smallest halal poultry and the most nutritionally expensive compared to chicken because it contains different percentages of important vitamins and low levels of cholesterol and low fats, making these birds more healthy nutritionally **(Moawad *et al.*, 2018; Waterlander *et al.*, 2018)**. It has been known for centuries and used as a source of meat for human food with no religious restrictions against its consumption **(Genchev *et al.*, 2008)**. Iraqi quail is used in four ways: of laboratory animals, breeding, and for egg production and meat production. Nowadays, it is more attention and increase the production and consumption of meat from pheasants, partridges, Japanese quails and other non-commercial bird species **(Ribarski & Genchev 2013)**. Also, the interest of many poultry breeders to produce quails and increase the consumption of their meats by many consumers due to its nutritional benefits, so it can be increased the Iraqi public health **(Al-Hajo *et al.*, 2012)**. Meat quality is determined by two extremely important traits, the appearance and meat consistency **(El-Ashram *et al.*, 2020; Hamdia *et al.*, 2020)**. Meat tenderness is more important in the final qualification determination, and it depends on the thickness of muscle fibers and the ratio between the main metabolic types of muscle fibers forming muscle bundles **(Mateo *et al.*, 2018)**. Dietary value of meat is mostly defined by the composition and ratio among the different groups of nutrients, one criterion for meat evaluation is its protein and fat content **(Ribarski *et al.*, 2013**). Manually deboned Japanese quail meat contains 72.5-75.1% moisture, 20-23.4% protein, 1.0-3.4% fat and 1.2-1.6% ash **(Genchev *et al.*, 2008)**. Medicinal plant showed positive effects on the performance and meat quality parameters in broiler **(Tamires *et al.*, 2020; Kumari *et al.*, 2017)**. Some medicinal plants were found to have natural vital components for example, Chitosan characterized by their content of vital compounds such as phenolic substances which acts as antioxidant and antimicrobial effect **(Babak 2012; Udo *et al.*, 2017)**. Chitosan is a natural product extracted from chitin and is widely spread in nature, including the exoskeletons of shrimp, crabs, krill and other crustaceans are good sources of chitosan, and its extraction methods are relatively cheap, easy to prepare and economical that does not require a lot of equipment and chemicals **(Tamires *et al.*, 2020)**. A number of studies have been conducted on effective utilization of Chitosan as an animal drink and feed supplement, but they have given variable results, but there were no study about meat quality when using Chitosan. So that, the aim of the present study was conducted to perform a detailed analysis of the meat quality and its composition of the Iraqi quail's meat using Chitosan supplementation with drinking water.

MATERIALS AND METHODS

The experiment design

All quail delivery protocols in this study were conducted by poultry research station, department of animal production, college of agriculture, Tikrit university, Iraq. A total of 320 male quail chicks aged one day were purchased. Then chicks were randomly distributed as a complete randomized block design into three equal treatments, each with three replicates (15 chicks/ replicate). Chicks were raised in special cages furnished with sawdust and placed in special poultry houses; the area of each pen was (2 m×1.5 m) until they are healthy and have a similar body weight (1.09 ± 0.02 kg) were randomly divided into 3 groups (control groups without any addition as control, 0.2 g. Chitosan/ Liter water and 0.3 g. Chitosan/ Liter water). Each group includes 3 replicates with 20 quails per replicate.

The diet

The basic diet has been developed to meet the requirements imposed by National Research Council **(NRC 1994)** nutritional requirements for quail development. All birds were fed for one day, then, fed basil diet lasted for 4 weeks (from 28 to 56 day of age), and the composition and nutrient levels of the basal diet is presented in (Table 1). All birds were bred for the same situation and have an announcement of the arrival of the libitum was then fed an experimental diet and water was drunk via the nipple. The Chitosan was supplemented with water for the three treatments: T1 (The control, without Chitosan); T2: (0.2g. Chitosan /Liter water) and T 3: (0.3g. Chitosan /Liter water).

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Table (1): Composition and main characteristics of diets.

Composition	(%)
Corn	53.10
Soybean meal (48% protein)	33.10
Oil plant(Sun flower oil)	4.00
Premix[1]	2.50
$CaCO_3$	7.00
NaCl	0.30
Nutrient Concentrations	
Metabolizable energy ($MJ.kg^{-1}$)	2832.73
Crude protein ($g.kg^{-1}$)	20.50
Crude fiber ($g.kg^{-1}$)	3.62
Ca ($g.kg^{-1}$)	2.89
P ($g.kg^{-1}$)	0.40
Lysine ($g.kg^{-1}$)	1.12
Methionine ($g.kg^{-1}$)	0.47
Methionine+cystine	0.80

Premix (WAFI) provided the following per kilogram of diet: Vitamin A,440000 IU; vitamin D_3, 120000 IU; vitamin E (DL-α-tocopheryl acetate), 1200 mg;K_3 100 mg; B_1/ Thiamin 120mg ; B_2 / Riboflavin280mg; B_6 /Pyridoxine160mg ;B_{12} 1400 mg;Folic acid 40mg; Biotin/Vitamin H 100 µg ; Iron 2000 µg; Copper 400µg;Mg 3200 µg; Zinc 2400 µg; Selenium 10 µg; Colin Chloride 1200mg. And provided Lysine 1.6%; Methionine 6%; Methionine+cystine 6%;Ca 23.2%; Available phosphorous 9.3%; Na 4.9%.

Slaughter and carcass measurements

At the age of 66 day, total of 24 quail (8 quail males per group) were 5 bird randomly assigned from each group were first weighed and then slaughtered Islamic ally (cutting the carotid arteries) after fasting 12 hr. Slaughtering was performed according to the methods of **(Huoyan *et al.*, 2020; Geldenhuys *et al.*, 2013)**. All of the heads, both feet, the ends of the wings and the skin were discarded from carcasses of quail birds, and then the weights of each bird were measured separately. After that, the belly of the birds was incised longitudinally from the chest area, the internal entrails were removed, and the weight was measured in order to determine the percentage of the netted meat produced for the quail birds. After that, all of the abdominal fat was isolated and left aside for weighing after that, the muscles of the chest, thighs were removed and weighed to calculate the percentages of the breast, thigh muscle, abdominal fat, the percentage of eviscerated carcass, half of the eviscerated carcass percentage, respectively **(Ribarski & Genchev 2013)**. After slaughter and weighing, all meat samples were cooled for 24 hr at 4°C.

Physicochemical composition

At 66 day of age, birds were weighed individually at 0.1 g accuracy of an electronic balance. After each weighing, five males whose body weight was close to the median value were selected. Then birds were slaughtered and physic-chemical analysis was done after 4 hr fasting period, as per the protocol described by **(Udo *et al.*, 2017)**. Carcasses were identified by individual numbers and weighed on an ACB plus-300 balance. Weighed labeled carcasses were arranged in polystyrene foam plates, packed with stretch wrap film and placed at -40^{o}C for 24 hr **(Ribarski & Genchev 2013)**. After slaughter, plucking and evisceration each carcass was separated into, breast, leg, wings, back and neck, then the weight of cuts were measured and recorded. Then, the carcasses were dissected according to the method described by **(Ewa & Lidia 2007)**. The measured carcass: long carcass body, circumambient of breast & thigh, long of bones thigh & drumstick and breast repletion was estimated according to **(AL-Hajo 2005)**. Chemical analysis (moisture protein, fat and ash) was determined according **(AOAC 2005)**.

Sensory evaluation of cooked quail's meat

Before starting the sensory evaluation of the studied models in order to ensure the safety of the residents later, 2 randomly slaughtered quails were taken and washed with running tap water, then cleaned and dried well and placed in a plastic container and evaluated by 10 residents who specialize in the quality of fresh meat in the laboratory in terms of color, smell and appearance using 9-point pleasure scales. Then, three carcasses of whole quail birds from each treatment were picked randomly,slaughtered,cleaned and cooked thoroughly until maturity as well as the control treatment in an electric oven 130^{o}C/ 15 min **(Genchev *et al.*, 2010; Wilkanowska & Kokoszyńsk 2011)**. Then, cooked meat of breast and thighs quail were selected and cut in the form of slices of equal diameter and were placed in plastic containers marked with numbers for all treatments under study and presented a random arrangement with sterile cups of water for rinsing between the evaluations of treatments.Participants were asked to gives score of each color, flavor, taste, mouth-feel and overall acceptance using a 9 point Hedonic scale (1= dislike extremely; 2= I don't like it very much; 3= I don't like it moderately; 4= I don't like it; 5= dislike and dislike; 6= like a little pit; 7= like a moderate;8= I like it; 9= I like it very much). While, score less than 5 indicating that quail meat is not accepted and must be rejected **(Moawad *et al.*, 2018)**.

Statistical analysis

The data were analyzed using complete randomized design. The calculation was performed by the SAS package programmers **(SAS 2012**). Duncan (1955) was used to determine significant differences.

RESULTS AND DISCUSSION

Estimation the main parts weights of quail meat

The weight of main parts of carcass parts was presented in (Table 2). There was no significant difference between treatments for the weight of breast. While, Whole Thigh, Wings, Back and Neck part increased significantly by increasing the chitosan add ($P \leq 0.05$)**.** Also, **(Huoyan *et al.*, 2020)** founded drumstick and breast size were increased significantly in all treatments of dietary Chitosan supplementation compared with control treatment. While another study found that the parts removed from slaughtered pharaoh quail, especially the weight of the neck and wings, increased significantly **(Kluczek 2009)**.

Table (2): Effect of different Chitosan treatments (g/L) on weight of main parts of quail meat (gm).

Treatments	Breast	Whole Thigh	Wings	Back	Neck
T1	43.70 ± 5.40	14.21 ± 0.12 ab	4.85 ± 0.10 ab	29.56 ± 1.37 ab	7.32 ± .30 b
T2	49.04 ± 1.36	16.54 ± 0.41 a	5.72 ± 0.04 a	32.56 ± 38 a	8.93 ± 0.56 a
T3	39.94 ± 0.36	12.90 ± 0.51 b	4.17 ± 0.01 b	27.83 ± 1.03 b	8.18 ± 0.51 ab
LSD value	6.822 NS	2.607 *	0.794 *	3.922 *	1.037 *
Means having with the different letters in same column differed significantly. * (P≤0.05).					

Also, there was no significant difference between treatments of Chitosan addition in drinking water on bones weight. While, there were a significant difference between treatments (P≤0.05) with Lean and skin as shown in (Table 3). This result comes close with **(Moawad *et al.*, 2018)**.

Table (3): Effect of different Chitosan treatments (g/L) on physical dissection weight in g.

Treatments	Lean	Bone	Skin
T1	67.08 ± 0.92 b	22.86 ± 4.43	19.89 ± 5.71 ab
T2	75.98 ± 4.45 a	25.08 ± 0.65	23.01 ± 2.23 a
T3	69.85 ± 6.88 ab	21.43 ± 0.67	16.34 ± 1.96 b
LSD value	6.837 *	5.163 NS	5.052 *
Means having with the different letters in same column differed significantly. * (P≤0.05).			

Quail's physical dissection

It has been observed that there are large amounts of fat and meaty materials encasing the inner wall of the quail birds' skin after rearing birds for more than 42 day of feeding. Also, an earlier study **(Baeza *et al.*, 2013)** with broiler chickens, the proportions of skin with subcutaneous fat 7.9-10.9% and remainders of the carcass 26.5-27.3% were higher than quails birds. Also, results of this study presented the effect of Chitosan addition on quail's physical dissection (Carcass body length, chest circumference, thigh circumference, bone length and Breast repletion) as in (Table 4). It was founded there was a significant difference (P≤0.05) between treatments shown in all of the measurements of carcasses, just chest circumference and breast repletion were showed no significant differences. These results were similar to what was found **(Clarias *et al.*, 2017; Huoyan *et al.*, 2020)**.

Table (4): Effect of different Chitosan treatments (g/L) on weight of quail physical anatomy (g).

Treatments	The measure of carcass			Bone length		Breast repletion
	Carcass body length	Chest circumference	Thigh circumference	Thigh	Drumstick	
T1	11.75 ± 0.25 b	11.30 ± 1.20	16.55 ± 0.45 b	8.00 ±0.37 b	10.30 ±0.44 b	0.964 ±0.18
T2	13.25 ± 0.75 a	13.30 ± 0.80	18.50 ± 0.00 a	10.00 ±0.75 a	12.35 ±0.63 a	1.28 ±0.07
T3	11.00 ± 0.00 b	12.50 ± 0.00	16.65 ± 0.05 b	8.56 ±0.41 ab	11.45 ±0.48 ab	1.08 ±0.07
LSD value	1.227 *	2.188 NS	1.562 *	1.784 *	1.733 *	0.442 NS
Means having with the different letters in same column differed significantly. * (P≤0.05).						

Chemical composition of quails meat

The results of chemical analysis of quail meat were presented in (Table 5). The results were showed that the percentage of fat and ash of quail meat supplemented with 0.2 g/L of drinking water for birds increased significantly (P≤0.05). These results came close to what was found by each of the following studies **(Genchev *et al.*, 2010; Facolad *et al.*, 2015)**. While, moisture, protein were increased a little but not significantly (P≥0.05). We conclude from the results of the chemical composition and the differences in the approximate composition clearly for each of the moisture and fat in the meat of quail fed on high percentages of chitosan had a direct relationship to nutrition, living place, slaughter age, season and sex and that's what to changes in quality marks as mentioned by **(Aminzare *et al.*,2016; Clarias *et al.*, 2017; Hartigh 2019)**. Moreover, soaking quail carcasses in cold saline solutions for 10 min almost had no effect on their proximate chemical composition so it did not register here **(Udo *et al.*, 2017; Moawad *et al.*, 2018; Hartigh 2019)**.

Table (5): Effect of different Chitosan treatments (g/L) on chemical analysis percentage of quail meat.

Treatments	Moisture	Protein	Fat	Ash
T1	73.45 ±2,84	22.00 ±1.16	3.02 ±0.09 b	1.04 ±0.04 b
T2	75.31 ±2.07	23.61 ±1.74	4.01 ±0.15 ab	1.87 ±0.02 ab
T3	74.19 ±3.17	23.95 ±1.68	5.92 ±0.26 a	2.30 ±0.07 a
LSD value	4.926 NS	2.489 NS	1.427 *	1.066 *
Means having with the different letters in same column differed significantly. * (P≤0.05).				

Sensory evaluation

Tenderness, juiciness and flavor are major determinant and also an important sensory characteristic of meat. Meat tenderness mainly depends on muscle fiber size, collagen content, solubility, water and lipid content **(Baeza *et al.*, 2013)**, and It depends on the thickness of muscle fibers and the ratio between the main metabolic types of muscle fibers forming muscle bundles **(Cavittet *et al.*, 2005; Genchev *et al.*, 2008)**, postmortem (PM) deboning time can have a large influence also. The results of sensory characteristics analysis of cooked quail meat samples are represented in (Figure 1 and 2). The results showed that all the cooked quail samples under investigation were acceptable and significantly (P≤0.05) compared to control. The results of this study were similar that was investigated by **(Hernandez *et al.*, 2017; Pavelkova *et al.*, 2013)**.

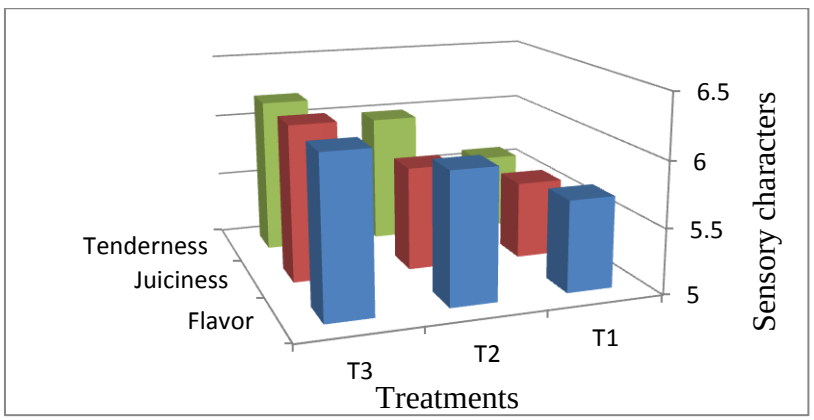

Figure (1): Effect of use chitosan in drinking water on sensory evaluation

The meat appearance depends on the color of skin and meat, the presence of defects is largely motivated consumer's choice (**Genchev*et al.*, 2008**; **Moawad*et al.*, 2018**). Other sensory characteristics such as acceptability, tenderness and appearances were demonstrated in (Figure,2). Results were showed by increasing the concentration of chitosan addition significantly increased ($P \geq 0.05$) the all sensory characters such as acceptability, tenderness and appearances as showed clearly in (Figure, 2). This result comes close with results by (**Moawad*et al.*, 2018).**

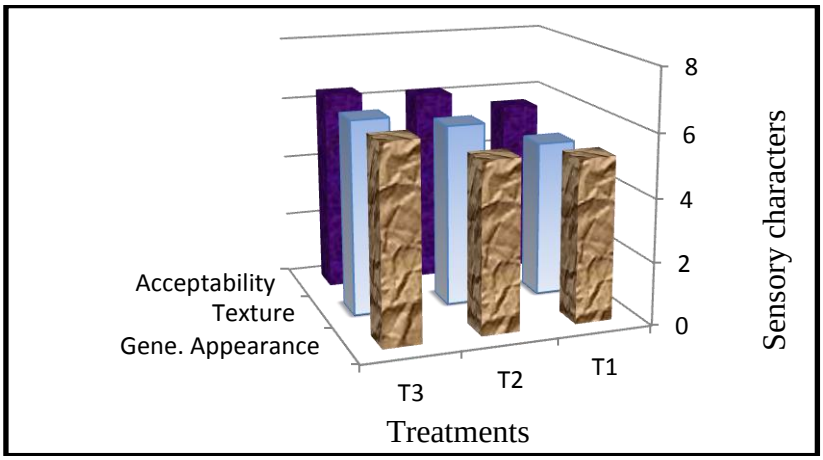

Figure (2): Effect of use chitosan in drinking water on sensory evaluation.

CONCLUSION

A low level of Chitosan in drinking water cannot make a significant difference in growth performance and meat quality, chemical composition, measure of the carcass and physical dissection, but tended to improve sensory evaluation. So that the supplementation of suitable natural agents possessing both antioxidant and antimicrobial activities during poultry's raring could be highly useful for poultry industry.

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