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Meat Physical and Chemical Tests Male Iraqi Wild Ducks (Mallard) Tenderized with Different Levels of Citric Acid

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Abstract: At this study, the meat of male wild ducks (Mallard) was used. After slaughter and cleaning, tenderization treatments were carried out with citric acid, which were as follows; A: Negative control treatment (soaking with distilled water only) for 24 hours. B: Positive control treatment (tenderizing with date vinegar at a rate of 100 ml/ liter of distilled water) for 24 hours. C, D and E were tenderizing treatment with citric acid at a ratio of 100, 200 and 300 ml per liter of distilled water for 24 hours. The results indicate that all tenderizing treatments with citric acid, led to a significant increase in water holding capacity, with a significant decrease on the drip and cooking loss compared to the negative control treatment, in addition to a significant increase on soluble collagen, with a significant decrease on the insoluble collagen and total collagen in the citric acid treatments compared to the two control treatments. A decrease in pH was observed compared to the negative control. In protein, there was a significant increase in citric acid treatments, as for the fat, there was a decrease in the level of significance. As for ash, there were no significant differences between A and B on the one hand, C and D on the other hand.

Keywords: tenderizing, citric acid, meat characteristics, male Iraqi wild ducks (Mallard)

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1. Introduction

Mallards are one of the most famous wild birds in the world, distinguished by its meat, which has a unique and delicious taste, it is rich in protein and contains a small percentage of fat, which makes it an excellent choice for healthy nutrition and nutrition for the elderly [1, 2].

Tenderizing meat is an important process for improving the quality of meat, extending its shelf life, and improving its flavour. Several materials were used for tenderizing, including natural date vinegar and artificial citric acid [3]. Citric acid or citric acid is a weak organic acid found in citrus fruits. It is a natural preservative, it is used to add an acidic

taste to foods and drinks, in biochemistry it is an important intermediate in the citric acid cycle, it is formed in all metabolism and acts as an antioxidant [4, 5].

Citric acid is a transparent, colorless crystal, but when ground it turns into a fine white powder, highly soluble in water, characterized by its strong, sour, sour taste, it is stored in tightly closed boxes in cool and dry places [6, 7].

This study aims to determine the effect of tenderizing with citric acid on some characteristics of the meat of male Iraqi wild ducks (Mallards).

2. Materials and Methods

The methodology of this study involved the examination of the effects of citric acid tenderization on the meat quality of male Iraqi wild ducks (Mallard). A total of 25 ducks were procured from local markets in Al-Muthanna Governorate, slaughtered, cleaned, and divided into main cuts for the experiment. The main cuts—breast, thigh, and drumstick—were randomly assigned to five treatments, each consisting of five samples. The treatments were: A) negative control (meat soaked in distilled water), B) positive control (meat tenderized with date vinegar at 100 ml/l of distilled water), and C, D, E) meat tenderized with citric acid at 100, 200, and 300 ml/l of distilled water, respectively, all for 24 hours.

Physical tests were conducted to measure water holding capacity, thawing loss, drip loss, and cooking loss. Chemical tests included measurements of pH, protein, fat, ash, and soluble, insoluble, and total collagen. The results were statistically analyzed to determine the significance of differences among the treatments. The study observed significant improvements in water holding capacity and reductions in thawing loss, drip loss, and cooking loss in citric acid-treated samples compared to the control groups. Furthermore, a notable increase in soluble collagen and a decrease in insoluble collagen were recorded. The citric acid treatments also influenced the pH and protein content positively, while affecting fat and ash content variably.

Overall, this methodology provided a comprehensive analysis of the physical and chemical changes in duck meat induced by citric acid, facilitating a better understanding of its potential as a meat tenderizing agent.

3. Results and Discussion

Physical tests

Table 1 shows the effect of tenderization with citric acid on the physical properties of Iraqi wild duck meat, as a significant increase is observed for E treatment compared to A and B, and for D compared to C, there are no significant differences between A and B. At drip loss, there were no significant differences between A and B on the one hand, and B and C on the other hand. There were an increase on the drip loss in E treatment compared to A and B, and the same thing happened with treatment C. A significant increase on the thawing loss in successive treatments for A, B, C, D and E when tenderizing Iraqi wild duck meat with citric acid. At the same table, it was noted that tenderizing wild duck meat with citric acid results in a significant increase on cooking loss for E treatment compared to A, B and C, the same applies to D treatment, and significant differences were noted between B and C.

Table 1. The effect of tenderization with citric acid on the physical characteristics of Iraqi wild duck meat

Treatments	Water Holding Capacity	Drip loss	Thawing loss	Cooking loss
A	0.44 ± 3.16 d	0.37 ± 14.73 a	0.58 ± 17.06 a	0.57 ± 15.00 a
B	0.44 ± 3.16 d	0.23 ± 13.80 ab	0.17 ± 15.13 b	0.44 ± 12.66 b
C	0.92 ± 6.83 c	0.50 ± 11.60 b	0.11 ± 14.00 c	0.08 ± 11.93 b
D	0.60 ± 8.33 b	0.40 ± 8.93 c	0.24 ± 11.66 d	0.18 ± 10.63 c
E	0.44 ± 9.66 a	0.43 ± 6.06 d	0.24 ± 10.33 e	0.34 ± 9.60 d
Sig.	*	*	*	*

Chemical tests

Table 2 indicates how citric acid tenderization affects the pH and percentages of protein, fat, and ash in Iraqi wild duck flesh. There were no significant differences in pH between the A, B, and E treatments, as well as the B, C, and D treatments. However, the E treatment had a noticeable significant decrease in pH value when compared to the negative control (A), and the C and D treatments had a significant decrease when compared to the negative control (A). In terms of protein tenderization with citric acid, E treatment had a higher level of significance than D treatment, D treatment had a significant rise over C treatment, and C treatment compared to A. It demonstrates that the percentage of protein increases as the concentration of citric acid increases (100, 200, and 300 ml per litre of distilled water for 24 hours) for C, D, and E treatments, but there were no significant differences between A and B treatments or B and C treatments.

In fat percentage, there was a decrease in the level of the significant value in tenderising with citric acid at different concentrations for A treatment compared to B treatment, in turn, in B treatment, there was a decrease in the level of morality compared to treatment (C), it was noted that there was a significant increase in the two treatments (C and E) compared with D treatment, which shows that D treatment has an average significant value between E and C, and In terms of ash, a considerable increase was seen following tenderising with citric acid in the D treatment compared to the E treatment. It was noted that there was a significant increase in E treatment compared to A and B treatments, which showed that there were no significant differences between them.

Table 2. The effect of tenderizing citric acid on the pH, and the percentage of protein, fat, and ash of Iraqi wild duck meat

Treatments	pH	Protein (%)	Fat (%)	Ash (%)
A	0.03 ± 5.92 a	0.48 ± 61.12 d	0.25 ± 5.79 a	0.15 ± 0.83 c
B	0.02 ± 5.79	0.46 ± 62.16	0.07 ± 4.97	0.18 ± 1.13

	ab	cd	b	c
C	0.07 ± 5.68	0.26 ± 63.24	0.10 ± 3.88	0.02 ± 1.90
	b	c	c	ab
D	0.12 ± 5.56	0.37 ± 63.97	0.12 ± 2.80	0.15 ± 2.15
	bc	b	cd	a
E	0.12 ± 5.43	0.55 ± 66.62	0.19 ± 2.05	0.02 ± 1.68
	a	a	d	b
Sig.	*	*	*	*

Table 3 shows the effect of tenderizing Iraqi wild duck meat in the experiment with citric acid. The soluble collagen in E treatment increased significantly compared to C treatment. No significant differences were observed between the two E and D treatments, it can be said that there was a decrease in the significance of A treatment compared to C treatment, it was noted that there were no significant differences between A and B treatments. Table 3 shows that there was a significant decrease in the insoluble collagen for A treatment compared to C treatment, and the last treatment showed a decrease in the level of significance with respect to E treatment. However, the significant value for B treatment was observed to be neutral between A treatment, and C treatment, and the same thing applied to D treatment in relation to C and E treatments. Total collagen did not show any significant differences for all treatments.

Table 3. Effect of tenderizing with citric acid on both soluble and insoluble collagen and total collagen of Iraqi wild duck meat

Treatments	Collagen		
	Soluble	Insoluble	Total
A	0.052 ± 3.19	0.04 ± 8.97	0.02 ± 12.16
	c	a	
B	0.04 ± 3.42	0.10 ± 8.69	0.15 ± 12.12
	bc	ab	
C	0.05 ± 3.70	0.06 ± 8.21	0.02 ± 11.91
	b	b	
D	0.05 ± 3.93	0.02 ± 8.01	0.05 ± 11.94
	ab	bc	
E	0.03 ± 4.14	0.03 ± 7.87	0.04 ± 12.03
	a	c	
Sig.	*	*	N.S

The reason for the improvement in the physical characteristics of Iraqi wild duck meat is when it is tenderized using a citric acid solution, for high ionic strength [10-17]. The ease of dissociation of proteins due to water binding sites and their lack of association with a significant increase in the ratio of charges between proteins, it results in water being trapped between the muscles, especially the muscle fibers, therefore, the amount of fluid exuded decreased, which increases the water binding sites and thus increases the percentage of moisture content [18-20].

4. Conclusion

The findings of this study reveal that citric acid tenderization significantly enhances the meat quality of male Iraqi wild ducks (Mallard) by improving water holding capacity, and reducing drip loss, thawing loss, and cooking loss. Additionally, citric acid treatments led to a significant increase in soluble collagen and a decrease in insoluble collagen, while pH and protein content were also positively affected. These results imply that citric acid is an effective meat tenderizer that can improve both the physical and chemical properties of duck meat, making it more suitable for consumption and processing. The study's outcomes suggest potential applications in the poultry industry for enhancing meat quality through natural and safe methods. Further research is recommended to explore the long-term effects of citric acid tenderization on meat storage and sensory attributes, as well as to evaluate its efficacy across different types of poultry and varying concentrations.

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