Effect of coating with oat starch enriched with cardamom oil or bay leaf powder on the microbial content of frozen duck breast meat

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Abstract :
The prepare the origin of oats fortified with cardamom oil or crushed bay leaves and study the microbial content of short breast meat exclusively. The study used 72 pieces of fresh breast meat prepared from the central in Basra. The pieces were immersed in solutions of Nashua fortified with cardamom oil or horn leaf powder and divided into stages with three replicates for each selection, as follows: T1 (non-coated negative control treatment) , T2 (positive control treatment coated with polyethylene pressure only) , T3 Duck breast coated in oatmeal only) , T4 Duck breast coated with oat starch enriched with cardamom oil only at a rate of 1%) , T5 (pieces coated with oat starch fortified with clover leaf powder only at a rate of 1%) , T6 (pieces coated with starch fortified with cardamom oil at a rate of 0.5% and monthly leaf powder at a rate of 0.5%) . The treatments were stored in the freezer at a temperature of ¯ 18 C for (0, 30, 60, 90) day s. The microbial content (total bacterial count, cold-loving bacteria and Escherichia coli) was studied and the results of the study modified the bacterial numbers between the intermediate treatments, as treatments T4 and T6 showed significant differences in the total bacterial count , cold - loving bacteria and Escherichia coli compared to multiple treatments from multiple bacterial results with the advancement of the storage period , as the storage period of 0 days showed a modification in the bacterial numbers compared to the storage period of 90 days. The study does not include that the treatments that coated oat starch enriched with cardamom oil or cardamom oil and bay leaf powder together may disappear from the bacterial numbers , which contributes to extending their storage life.

Keywords: - Tennis. Cardamom oil. Autumn leaves. Bacteria

Introduction:

The goal of food preservation is to inhibit or slow down the oxidation processes that occur in meat. During production, processing, storage and distribution, it is necessary to maintain environmental, chemical and microbial food storage standards. Therefore, food should limit interaction with the external environment, which may lead to deterioration and loss of initial properties (Huang et al.,2021). In particular, processed meat products present a high risk of contamination with microorganisms due to high humidity, optimal pH, and features that promote microbial growth (Sivamaruthi et al.,2022). In addition, lipid oxidation can change the concentration of some chemical compounds in the products, affecting nutritional and sensory properties (Wu et al., 2019). However, over the years, many coating innovations have been developed to maintain the quality and safety of food products. One such innovation is the application of edible coatings and films. These

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strategies are cost-effective and environmentally friendly (Khalaf et al., 2019). They are generally obtained from food waste and by-products, thus enabling their reuse in the food chain (Chiralt et al., 2020). The possibility of consuming edible coatings and films with meat, thus avoiding the use of plastic materials and waste generation, is highlighted. The properties of potential components are analyzed Edible coatings and films, their potential and limitations for their widespread food application at present (Chhikara and Kumar, 2022). However, it should also be highlighted that over the years the demand for biodegradable coatings and films with functional plant extracts or essential oils has become a viable alternative to conventional coatings and films (Tafa et al.,2023). Bioactive agents obtained from plants, such as antioxidants and antimicrobial molecules, reduce the risk of microbial proliferation, improve the shelf life and quality of packaged products (Al-Busalimi et al.,2022). Different plant essential oils derived from spices and herbs with antioxidant and antimicrobial activity, added in the formulation of edible coatings and films for the preservation of processed meats, have been tested. (Al-Hilphy et al., 2022). Among these films is cardamom. Elettaria cardamomum is a large perennial herbaceous plant belonging to the Zingiberaceae family and the Cardamomaceae family. Maton contains its biologically active compounds (Castillo et al., 2023). Bay leaf Laurus nobilis belongs to the Laur-aceae family. Bay leaf is consumed as a culinary ingredient and used in many traditional practices for different purposes. Bay leaves are rich in phytochemicals such as phenolic compounds including flavonoids such as quercetin. Moreover, both aqueous and ethanolic extracts of bay leaves have strong antioxidant activity and have effective reducing power, free radical scavenging, superoxide scavenging, and hydrogen peroxide removal (Benli et al.,2024). The study aimed to investigate the effect of using oat starch enriched with cardamom oil or bay leaf powder to coat duck breast meat pieces on the microbial content at different storage periods.

Materials and Methods:

This study was conducted in the Department of Animal Production, College of Agriculture, University of Basra, Iraq, during the period from 1/10/2024 to 1/1/2025, which aims to prepare oat starch fortified with cardamom oil or bay leaf powder in the laboratory and use it in packaging duck breast meat pieces by immersion method and study its microbial properties when stored in freezing at different periods.

Starch extraction:

Oat starch is extracted according to the method (Ahmed et al.,2024) from oat grains after washing the grains well with water to remove dirt and impurities. The oat grains are then crushed into small pieces. The oats are then ground to obtain fine flour using a fine-hole mill. Cellulose enzyme is added, which is essential in the enzymatic process, by mixing a limited amount of the enzyme in water (0.5 g cellulose per 100 g oat flour + 20 ml of water). This enzyme helps in decomposing the cell walls of oat flour and releasing the starch. Cellulose enzyme is added to the oat flour for 5 hours, after which the mixture is mixed well and the enzyme comes into contact with as much oat flour as possible. The mixture is then filtered to separate the solid residue from the starch liquid using a fine mesh strainer, which leads to the complete separation of the liquid from the starch. The filtered liquid can be

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washed with additional water to recover any remaining starch.

Birds used in the experiment:

Seventy-two pieces of breast meat of male Ducks were obtained from local markets in Basra at the age of six months, slaughtered and the duck breast was cut into pieces and these pieces were divided into six treatments. breast meat pieces. Positive control treatment:(T2) Duck breast meat pieces wrapped in vacuum-sealed polyethylene bags only. The third treatment:(T3) duck breast meat pieces coated with oat starch only. The fourth treatment:(T4) duck breast meat pieces coated with oat starch enriched with cardamom oil only at a rate of 1%. The fifth treatment:(T5) duck breast meat pieces coated with oat starch enriched with bay leaf powder only at a rate of 1%. The sixth treatment:(T6)duck breast meat pieces coated with oat starch enriched with cardamom oil and bay leaf powder were stored at a rate of 0.5 ml of cardamom oil and 0.5 g of bay leaf powder. The treatments were stored in the freezer at a temperature of ¯18°C for (0, 30, 60, 90) days. The microbial content was studied (total bacterial count, cold-loving bacteria, and Escherichia coli (E. Coli.(

Methods for calculating the microbial content:

The microbial numbers of the samples were estimated by preparing the decimal dilution by taking 1 g of the samples and adding to 9 ml of sterile peptone water solution 0.1% and mixing well to prepare the first dilution -110. From it, the rest of the decimal dilution was prepared in sterile test tubes, each containing 9 ml of the dilution solution to obtain the appropriate dilution -310 of the samples. After that, the pour plate method was used for all microbial tests, as 1 ml of each dilution was transferred to empty and sterile Petri dishes and the culture medium was added at a temperature of 45 °C and the sample was mixed with The culture medium was mixed well and quietly in the plates, then left to solidify. After that, the plates were placed in the incubator upside down at a temperature of 35 °C for 24 hours. The number of growing microbes was expressed in units (colony forming unit) (g)/ (cfc) colony forming unit, and the number of colonies was multiplied by the reciprocal of the dilution, according to the method described in Public Health, England, 2019.(

-1Total bacterial count

Nutrient Agar culture medium was used with a weight of 28 g of the medium and dissolved in distilled water and the volume was completed to 1 liter and sterilized with an electric autoclave at a temperature of 121 °C and a pressure of 15 pounds / inch2. After cultivation, the plates were incubated at a temperature of 35 °C for 24 hours and the colonies growing in the plates were counted (Heetun et al., 2015.(

-2Counting cold-loving bacteria

The culture medium Nutrient Agar was used at a weight of 28 g/liter and sterilized in an autoclave. After cultivation, the plates were incubated at a temperature of 7 °C for 5 days (Heetun et al., 2015.(

-3Estimation of Escherichia coli numbers

The same method used to estimate the total bacterial numbers was followed, and the same dilutions were made, except for the difference in the McConkey Agar culture medium, under aerobic conditions. After the culture is completed, the plate with the best tenth dilution is chosen, as the colony growth is within the range of (30-300) colonies.

Statistical analysis

The statistical analysis of the results was conducted using the CRDC random design within the SPSS program, and the results were

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compared using the Least Significant Difference (LSD) test. (P≤0.05) at a significant level p according to (Al-Rawi, 2000(

Results and discussion:

- 1Total bacterial count (log cfu/g(

The results of Table (1) showed the effect of coating with oat starch fortified with cardamom oil or bay leaf powder on the total bacterial count of duck breast meat stored in the freezer at storage periods of 90, 60, 30.0 days, as the data in the table showed significant differences between the averages of the treatments, as the average of the two treatments T6, T4 showed a significant decrease (P≥0.05) in the total bacterial count, as they recorded 24.33, 23.00, respectively, compared to the average of the control treatment T1, which recorded 33.83 and the rest of the average treatments, while we did not find any significant differences between the average of treatments T5, T3, as the total bacterial counts for each of them reached 27.00, 28.41 respectively, which showed a significant superiority (P≥0.05) when compared to the control treatment. Table (1) shows the average storage periods by freezing at 0, 30, 60 and 90 days in the total bacterial count of duck breast meat coated with oat starch fortified with cardamom oil or bay leaf powder in the total bacterial count, as it is noted that there was a highly significant decrease (P≥0.05) in the total bacterial count in favor of the average storage period of 60 and 90 days, as it reached 26.83, 25.55 respectively, compared to the average storage period of 0 and 30 days, which recorded the highest value, reaching 30.77, 28.77 respectively. It is noted from the table that there is a significant decrease (P≤0.05) in the total bacterial counts between the average storage periods with the increase in storage period. The results of Table (1) show the interaction between the values of the treatments and the storage periods, as treatment T6 showed a significant decrease (P≥0.05) in the total bacterial count, which reached 18.66 at a storage period of 90 days, while it is noted from the table that the total bacterial count increased in treatment T1 at a storage period of 0 days, which reached 37.66 .

-2Psychrophilic count which reached 9.00, while treatment T1 recorded, at a(

A scientific explanation of the results of this study should be provided and compared with other studies oat starch fortified with cardamom oil or bay leaf powder on the numbers of psychrophilic bacteria in duck breast meat stored in the freezer at storage periods of 90, 60, 30, and 0 days. The results showed a highly significant decrease (P≥0.01) in the numbers psychrophilic bacteria favor of the average treatment T6, which amounted to (11.08) compared to the average control treatment (T1), which amounted to 19.25. The average treatment T2 had a similar effect, which did not differ significantly from the average control treatment, while no significant differences appeared between the average treatments T5, T4, and T3. The results showed significant differences in the average storage periods, as it is noted that there was a highly significant decrease (P≥0.01) in the numbers of cold-loving bacteria in favor of the average storage period of 90 days compared to the average storage period of 0 days, as they reached (13.50, 17.77) respectively. It is noted from the results of the table that there was a highly significant decrease (P≥0.01) with the advancement of storage periods. The results of Table (2) showed an overlap between the values of the treatments and the storage periods, as treatment T6 showed, at a storage period of 90 days, the lowest value in the

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number of psychrophilic bacteria. The control treatment recorded 9 at 0 day storage duration, the highest value in the number of cold-loving bacteria, which reached 20.00 . .

- 3Escherichia coli (E. Coli) (log cfu/g(

The results of Table (3) showed the effect of packaging with oat starch fortified with cardamom oil or bay leaf powder or both on the numbers of E. coli bacteria in duck breast meat stored in freezing at storage periods of 0, 30, 60 and 90 days, as it is noted that there was a highly significant decrease (P≤0.01) in the average numbers of E. coli bacteria between the average treatments in favor of the average of treatments T6, T4, which recorded ((9.24 8.58 compared to The average of the control treatment T1, which recorded the highest number of E. coli bacteria, amounting to 13.58, while the average of the two treatments T3 and T2 (10.50, 9.91) respectively, which did not differ significantly between them. While the average storage period of 0 days recorded a highly significant increase (P≤0.01) in the number of E. coli bacteria, amounting to 12.38 compared to the storage period of 90 days, which recorded 8.61. It is noted from the table that there is a decrease in the number of E. coli bacteria with the advancement of storage periods. Table (3) shows the interaction values of the treatments and storage periods. Treatment T1 showed a significant increase (P≤0.01) in the number of Escherichia coli bacteria at a storage period of 0 days, as it recorded 15.66 compared to treatment T6 at a storage period of 90 days, as it reached 6.33.

Table (1) Effect of wrapping duck breast meat pieces with oat starch fortified with cardamom oil or bay leaf powder on the total bacterial count (log cfu/g) during freezing storage (mean ± standard error)

Treatment	**Period of Storage (Day)**					
	0	**30**	**60**	**90**	**AT**	Significance
T1	37.66 ± 2.51	36.00 ± 1.73	31.66 ± 1.52	30.00 ± 2.00	33.83^{A} ± 3.66	**
T2	32.66 ± 0.57	32.00 ± 1.73	30.33 ± 1.52	30.33 ± 2.51	31.33^{A} ± 1.82	**
T3	31.00 ± 1.00	30.00 ± 1.00	22.66 ± 0.57	24.33 ± 2.08	27.00^{B} ± 3.88	**
T4	29.66 ± 1.52	23.66 ± 1.15	22.33 ± 2.51	21.66 ± 1.52	24.33^{C} ± 3.62	**
T5	26.00 ± 2.64	27.66 ± 0.57	31.66 ± 1.52	28.33 ± 3.51	28.41^{B} ± 2.93	**
T6	27.66 ± 1.52	23.33 ± 1.52	22.33 ± 2.51	18.66 ± 1.15	23.00^{C} ± 3.66	**
AST	30.77^{a} ± 4.15	28.77^{a} ± 4.75	26.83^{b} ± 4.79	25.55^{b} ± 4.87	33.83^{A} ± 3.66	

LSD storage periods × treatment = 3.37 . The uppercase letters between the means mean the presence of significant differences between the coefficients

The lowercase letters between the means mean the presence of significant differences between the Storage periods :

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T1 (non-coated negative control treatment) , T2 (positive control treatment coated with polyethylene pressure only) , T3 (breast meat piece coated with quart starch) , T4 (breast meat piece coated with Doran starch fortified with cardamom oil only at a rate of 1%) , T5 (pieces coated with oat starch fortified with clover leaf powder only at a rate of 1%) , T6 (pieces coated with starch fortified with cardamom oil at a rate of 0.5% and monthly leaf powder at a rate of 0.5%) .

Table (2) Effect of duck breast meat cut with oat starch fortified with cardamom oil or bay leaf powder on the numbers of cold-loving bacteria (log cfu/g) during freezing storage (mean ± standard error)

Treatment	**Period of Storage (Day)**					
	0	**30**	**60**	**90**	**AT**	Significance
T1	20.00 ± 2.00	19.66 ± 1.52	18.33 ± 0.57	19.00 ± 1.00	19.25^{A} ± 1.53	**
T2	20.00 ± 1.00	20.33 ± 0.57	18.66 ± 1.15	21.33 ± 3.05	20.08^{A} ± 1.78	**
T3	18.33 ± 2.08	17.66 ± 2.08	11.66 ± 0.57	10.33 ± 0.57	14.50^{B} ± 2.91	**
T4	19.66 ± 0.57	15.33 ± 0.57	11.00 ± 1.00	9.33 ± 1.15	13.83^{B} ± 1.26	**
T5	14.66 ± 0.57	15.33 ± 0.57	13.66 ± 1.52	12.00 ± 2.00	13.91^{B} ± 1.72	**
T6	14.00 ± 1.00	11.66 ± 1.15	9.66 ± 0.57	9.00 ± 1.00	11.08^{C} ± 2.19	**
AST	17.77^{a} ± 2.81	16.66^{a} ± 2.19	13.83^{b} ± 1.69	13.50^{b} ± 1.19	19.25^{A} ± 1.53	

LSD storage periods × treatment = 1.77. The uppercase letters between the means mean the presence of significant differences between the coefficients

The lowercase letters between the means mean the presence of significant differences between the Storage periods : T1 (non-coated negative control treatment) , T2 (positive control treatment coated with polyethylene pressure only) , T3 (breast meat piece coated with quart starch) , T4 (breast meat piece coated with Doran starch fortified with cardamom oil only at a rate of 1%) , T5 (pieces coated with oat starch fortified with clover leaf powder only at a rate of 1%) , T6 (pieces coated with starch fortified with cardamom oil at a rate of 0.5% and monthly leaf powder at a rate of 0.5%) .

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Table (3) Effect of packaging duck breast meat pieces with oat starch fortified with cardamom oil or bay leaf powder on the number of Escherichia coli bacteria (log cfu/g) and stored in the freezer (mean ± standard error)

Treatment	Period of Storage (Day)					
	0	**30**	**60**	**90**	**AT**	Significance
T1	15.66 ± 0.57	15.00 ± 1.00	12.66 ± 1.15	11.00 ± 1.00	13.58^{A} ± 1.10	**
T2	13.33 ± 0.57	12.00 ± 1.00	8.66 ± 1.15	7.66 ± 1.52	9.91^{B} ± 0.15	**
T3	10.33 ± 2.08	12.33 ± 2.08	10.33 ± 0.57	9.00 ± 1.00	10.50^{B} ± 1.13	**
T4	10.65 ± 1.15	9.67 ± 1.52	7.66 ± 0.57	6.33 ± 1.52	8.58^{C} ± 0.16	**
T5	12.34 ± 0.57	12.00 ± 1.00	13.33 ± 1.15	11.33 ± 1.15	12.25^{A} ± 1.15	**
T6	12.00 ± 1.00	10.00 ± 1.00	8.66 ± 1.15	6.33 ± 0.57	9.24^{C} ± 0.73	**
AST	12.38^{a} ± 2.03	11.83^{a} ± 2.03	10.22^{b} ± 2.34	8.61^{c} ± 2.30	13.58^{A} ± 1.10	

LSD storage periods × treatment = 1.36 . The uppercase letters between the means mean the presence of significant differences between the coefficients . The lowercase letters between the means mean the presence of significant differences between the Storage periods .

: T1 (non-coated negative control treatment) , T2 (positive control treatment coated with polyethylene pressure only) , T3 (breast meat piece coated with quart starch) , T4 (breast meat piece coated with Doran starch fortified with cardamom oil only at a rate of 1%) , T5 (pieces coated with oat starch fortified with clover leaf powder only at a rate of 1%) , T6 (pieces coated with starch fortified with cardamom oil at a rate of 0.5% and monthly leaf powder at a rate of 0.5%) .

The reason for the decrease in the number of bacteria (total bacteria, cold-loving bacteria, and Escherichia coli) of duck breast meat coated with oat starch and fortified with cardamom oil or bay leaf powder and stored in the freezer for different storage periods may be due to the results of Tables 1, 2 and 3 that the best two treatments caused good Mention the mechanism of action of essential oils and active compounds on bacteria be due to the fact that cardamom oil has the ability to inhibit the growth of many Gram-positive and Gram-negative bacteria, and it also showed antibacterial and anti-yeast activity because it contains active compounds such as cineole and limonene, which show antimicrobial and antioxidant properties (Alqahtani et al., 2024). The reason may also be due to the fact that bay leaf powder, which was tested for its bactericidal activity, is effective against Salmonella and E. coli because it contains cineole and linalool. It also contains active substances such as beta-pinene and tannin compounds, which have antibacterial effects (Muhammad et al., 2020). Some studies have shown that cardamom oil, which contains various active

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compounds such as anthocyanins, phenols, starch, flavonoids, proteins, and sterols, also has various medicinal properties such as antimicrobial, antioxidant, anti-inflammatory, and anticancer activities (Paul et al., 2024). (Ramadan et al., 2024) noted that cardamom oil has the ability to inhibit the growth of many Gram-positive bacteria Bacillus cereus and Staphylococcus aureus and Gram-negative bacteria including Pareugi-nosa and E. coli and the yeast C. albicans. CEO showed antibacterial and antiyeast activity. Bay leaf oil tested for bactericidal activity was shown to be effective against Salmonella enterica and Escherichia coli (Chaudhry and Tariq, 2006). Moreover, both aqueous and ethanolic extracts of bay leaves have antioxidant activity and have effective reducing power against free radicals as well as scavenging superoxide radicals and removing hydrogen peroxide (Benli et al., 2024). These results were consistent with the Iraqi standard specification of the Central Organization for Standardization and Quality Control (COSMAT) for the acceptable quality of meat and its products (Central Organization for Standardization and Quality Control, 2000), which stipulates that the total number of aerobic bacteria should be within the limits of 107 colony-forming units/gram.(Hosseini et al., 2021) showed the effect of adding essential oils on the microbial content of packaged and refrigerated chicken breast to increase the antibacterial effect.

Conclusions:

-1The results showed that the use of oat starch packaging fortified with cardamom oil and bay leaf powder led to a decrease in the microbial content of frozen duck with the advancement of storage periods.

-2The study showed that the nutritional value of oats when used in coating frozen duck breast decreased in microbial content with increasing storage periods.

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