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Evaluating the Effects of Thyme and Cinnamon on the Microbial Quality of Beef

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Abstract

THIS study examined the antimicrobial properties of thyme and cinnamon extracts in relation to the microbial quality and shelf-life of beef. Beef samples were randomly sourced from various supermarkets and butcher shops in the Menoufia Governorate, Egypt. Samples were categorized into three groups: a control group with no treatment, a group treated with 1% thyme extract, and another treated with 1% cinnamon extract. The microbial quality of beef was evaluated by assessment the total bacterial counts, coliform counts, and staphylococcal counts over a 15-day storage period store at 4°C. The results indicated that both thyme and cinnamon extracts significantly inhibited Bacterial growth compared to the control group. Specifically, thyme-treated samples demonstrated a decrease in total colony count from 6.5±0.06 on day one to 4.7±0.03 by day nine, while cinnamon-treated samples exhibited a reduction from 6.17±0.07 to 3.1±0.04. Sensory evaluations revealed that thyme-treated samples maintained acceptable quality for up to three days, whereas cinnamon-treated samples remained acceptable for up to nine days. These findings suggest that thyme.

Keywords: Bacterial quality, thyme, cinnamon, beef, natural preservatives.

Introduction

The preservation of meat is a critical concern in the food industry due to the inherent risks of microbial contamination and spoilage. Such hazards not only jeopardize public health, leading to foodborne illnesses but also result in substantial economic losses throughout the meat supply chains [1, 2]. Traditional chemical preservatives have been widely used to mitigate these issues, effectively extending the shelf0life of meat. However, increasing consumer awareness of food safety has raised concerns regarding the potential health risks associated with these chemical additives, particularly their residual effects and the development of microbial resistance [3]. This growing apprehension has led to an urgent demand for safe and effective natural alternatives that can maintain the quality and safety of meat products.

Natural extracts, especially those sourced from herbs like thyme (*Thymus sp*.) and cinnamon (*Cinnamomum sp*.), have attracted considerable interest due to their notable antimicrobial properties. These extracts are abundant in bioactive compounds, such as terpenes and phenolic compounds, which exhibit extensive antimicrobial and antioxidant activities [4, 5]. Numerous studies have indicated

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that these natural preservatives can effectively inhibit the growth of spoilage and pathogenic microorganisms without adverse health effects, positioning them as viable candidates for meat preservation [6, 7]. Their potential not only lies in their ability to prolong shelf life but also in their capacity to enhance the overall quality of meat products.

Recent incidents of foodborne illnesses have highlighted the critical need for effective preservation techniques that guarantee food safety. The utilization of thyme and cinnamon presents a promising approach, enhancing the shelf life of meat while concurrently preserving sensory qualities that meet consumer expectations [8, 9]. Nevertheless, the effectiveness of these natural extracts depends on various factors, including their concentration and application methods. It is essential to optimize these parameters to achieve the maximum antimicrobial efficacy while retaining the desirable sensory characteristics of the meat.

In light of these considerations, the present study aims to evaluate the antimicrobial efficacy of thyme and cinnamon extracts on beef quality. By systematically assessing microbial counts and sensory characteristics over a defined storage period, this research seeks to elucidate the potential of these natural extracts as effective preservatives. The findings of this study are expected to contribute to the advancement of safer and more sustainable practices in meat preservation, aligning with current consumer demands for clean-label products free from synthetic additives.

Material and Methods

Preparation of Plant Extracts

Aqueous extracts from Thyme (Thymus sp.) and cinnamon (Cinnamomum sp.) leaves were prepared at the National Research Centre, Dokki, Cairo, Egypt [10].

Experimental Design

A total of 2250 g of fresh beef samples from thigh cut were collected from local supermarkets and butcher shops in Menoufia Governorate, Egypt. The samples were minced and divided into three groups (250 g):

- Control Group: Untreated samples.
- Thyme-Treated Group: Samples treated with 1% thyme plant extract according to [19]. Essential oils of thyme were added to the beef samples groups to achieve final concentration (1%). The essential oils were mixed with the beef samples for a further 30 seconds to ensure even mixing. All the samples with oils and the controls were packed in polyethylene bags, labeled and stored at 4ºC. Sensory (color, odor, texture and overall acceptability).
- Cinnamon-Treated Group: Samples treated with 1% cinnamon plant extract

The samples were tagged, individually packed in polyethylene bags, and kept at 4 ±1ºC. The samples were analyzed for microbiological and sensory properties during the chill storage period (at zero, 3rd, 6th, 9th, 12th, and 15th days), and the experiment was conducted in triplicate

Microbiological Analysis

Meat samples were rigorously analyzed throughout the storage period to assess the total bacterial count (TBC) using the pour plate method on plate count agar (HIMEDIA, M091S) at a controlled temperature of 35°C, in compliance with ISO 13299 [11]. Additionally, the quantification of *Staphylococcus aureus* was performed on Baird Parker agar base (HIMEDIA, M043), with incubation at 37°C for 48 hours, following FDA guidelines [12]. The evaluation of total coliform count was conducted in accordance with ISO 4832 [13] on violet red bile agar media (HIMEDIA, M049), which was also incubated at 37°C for 24 hours.

Sensory Evaluation

The evaluation was conducted in accordance with ISO 13299 [11]. Sensory attributes of the meat samples were assessed by a panel of ten highly trained evaluators. Attributes such as color, odor, texture, and overall acceptability were meticulously analyzed. The sensory evaluation utilized a ten-point scale (1–10) for quantifying the results.

Statistical analysis

All measurements were conducted in triplicate, and the data were presented as means ± standard deviation (SD) utilizing SPSS software (version 16.0 for Windows, SPSS Inc., Chicago).

Results

Microbial Analysis

The antimicrobial properties of thyme and cinnamon extracts on beef were assessed by quantifying total bacterial counts, coliform counts, and staphylococcus counts throughout a 15-day storage duration.

Total bacterial Count

The antimicrobial efficacy of thyme and cinnamon extracts on total colony counts is summarized in Table 1. Treatment with thyme resulted in a significant reduction in total colony counts, decreasing from a mean value of 6.50 ± 0.06 log CFU/g on day one to 4.70 ± 0.03 log CFU/g by day nine. This is agree with EOS (2005) [20] permissible limit not more than 10^6 cfu/g. In comparison, cinnamon extract demonstrated an even more pronounced antimicrobial effect, with total

colony counts declining from 6.17 ± 0.07 log CFU/g on day one to 3.10 ± 0.04 log CFU/g by day twelve. Conversely, control samples exhibited an increase in microbial load, reaching spoilage levels by day nine, indicating a lack of microbial control in the absence of treatment. Statistical analysis indicated a significant difference ($P < 0.05$) between the treated and control groups throughout all storage periods, thereby affirming the effectiveness of both thyme and cinnamon as natural preservatives, On the other hand cinnamon is better than thyme as natural preservative and more effective in reducing the number of bacteria in beef as shown in above results

Coliform Count

The data presented in Table 2 demonstrates the efficacy of thyme and cinnamon extracts in reducing coliform counts in beef samples. The application of thyme resulted in a progressive decline in coliform counts, beginning at 3.55 ± 0.05 log CFU/g on day one and decreasing to 1.20 ± 0.11 log CFU/g by day nine. Similarly, cinnamon extract exhibited significant antimicrobial activity, decreasing coliform counts from 3.48 ± 0.06 log CFU/g to 1.75 ± 0.02 log CFU/g by day twelve. In contrast, control samples exhibited a marked increase in coliform counts, reaching spoilage levels by day six. The statistically significant differences ($P < 0.05$) in microbial reduction between the treated and control groups across various storage periods highlight the robust antimicrobial properties of both thyme and cinnamon extracts in mitigating coliform bacteria.

Staphylococcal Count

As shown in Table 3, both thyme and cinnamon extracts were effective in significantly reducing staphylococcal counts in beef samples compared to the untreated control group. Thyme-treated samples exhibited a decrease from 4.76 ± 0.45 log CFU/g on the first day to 2.70 ± 0.04 log CFU/g by the ninth day. Cinnamon-treated samples demonstrated a more pronounced reduction, decreasing from 4.77 ± 0.90 log CFU/g on the first day to 1.10 ± 0.04 log CFU/g by the twelfth day. In contrast, control samples showed a steady increase in staphylococcal counts, reaching spoilage by the ninth day. These results indicate the superior antimicrobial effects of cinnamon over thyme in controlling staphylococcal growth, with both treatments significantly delaying spoilage.

Sensory Evaluation

The sensory evaluation of the beef samples treated with thyme and cinnamon extracts is summarized in Table 4. The thyme-treated samples maintained acceptable sensory characteristics—such as colour, odour, appearance, overall acceptability, and consistency—for up to three days. However, after this period, the sensory qualities started to deteriorate, leading to the samples being deemed unacceptable by the ninth day.

In contrast, cinnamon-treated samples demonstrated a longer period of sensory stability, remaining in good condition for up to nine days. These samples exhibited acceptable attributes even on the twelfth day, reflecting the superior preservative qualities of cinnamon in extending shelf life without compromising sensory properties.

Discussion

The results of this study highlight the significant antimicrobial properties of thyme and cinnamon extracts in beef, indicating their potential as effective natural preservatives. The documented decrease in microbial counts, encompassing total bacterial, coliform, and staphylococcal counts, aligns with an expanding body of research that emphasizes the antimicrobial effectiveness of natural plant extracts in food preservation [4, 5]. Both thyme and cinnamon extracts have demonstrated a significant reduction in microbial loads during the storage period, effectively extending the shelf life of beef samples. This improvement in preservation can be ascribed to the bioactive compounds found in these extracts, particularly thymol and cinnamaldehyde, which are acknowledged for their capacity to disrupt microbial cell membranes, interfere with metabolic pathways, and inhibit critical cellular processes [14, 15].

The significant decrease in microbial counts is consistent with research indicating the extensive antimicrobial efficacy of these compounds against various spoilage and pathogenic microorganisms [16]. The notable reduction in total colony counts identified in this study suggests that both thyme and cinnamon exhibit potent bacteriostatic and bactericidal properties, rendering them effective candidates for meat preservation. Notably, cinnamon extract displayed a more prolonged antimicrobial effect in comparison to thyme, as indicated by the lower microbial counts and extended shelf life in samples treated with cinnamon. Cinnamon exerts its antimicrobial effects through various mechanisms, including the disruption of microbial cell walls via antioxidant compounds, interference with the cytoplasmic membrane, leakage of cellular components, alteration of fatty acid and phospholipid profiles, impact on DNA and RNA synthesis, and inhibition of protein translocation [17].

The findings from the sensory evaluation underscore the efficacy of thyme and cinnamon as natural preservatives, particularly in their ability to maintain sensory attributes over time. Thyme-treated samples exhibited acceptable sensory qualities for a duration of three days, whereas cinnamon-treated samples demonstrated an impressive retention of sensory quality for up to nine days. This extended shelf life, achieved without compromising sensory

acceptability, positions cinnamon as a highly promising candidate for wider applications in food preservation. However, previous research indicates that utilizing higher concentrations of these extracts may result in adverse alterations to the sensory characteristics of food products, including overpowering flavour or aromas [11]. This underscores the necessity for meticulous optimization of plant extract concentrations to achieve a balance between antimicrobial effectiveness and consumer preferences.

The growing consumer demand for clean label product free from synthetic additives adds further significance to these findings. The use of natural preservatives, such as thyme and cinnamon, offers a viable alternative to synthetic chemical preservatives, which have been associated with health risks related to residue accumulation and the development of microbial resistance (Nazir et al., 2017). As consumers increasingly seek safer, more natural food products, essential oils represent a compelling solution that addresses both food safety and market demand.

Conclusion

The findings of this study indicate that thyme and cinnamon extracts serve as effective natural agents for mitigating microbial contamination and prolonging the shelf life of beef. These extracts not only ensure the microbial safety of meat products but also maintain their sensory attributes, rendering them suitable for food preservation applications. Future investigations should focus on optimizing the concentration and application techniques of these extracts to enhance their efficacy while preserving sensory acceptability. In addition to that cinnamon is better than thyme as natural preservative and more effective in reducing the number of bacteria in beef as shown in above results. Furthermore, examining the synergistic effects of combining thyme and cinnamon with other natural antimicrobials may lead to the development of more robust preservation strategies. Such advancements present significant potential for the wider adoption of natural preservatives within the food industry, providing safer and more sustainable alternatives to synthetic chemicals.

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Declaration of Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical of approval

The study design received approval from the Research Ethical Committee of Faculty of Veterinary Medicine, Benha University, Egypt (ethical number: BUFVTM04-11-24).

TABLE 1. Effect of Thyme 1% and Cinnamon 1% on Total bacterial Count (Mean ± SE)

Groups / Storage Period	Control	Thyme 1%	Cinnamon 1%	P-Value
1st Day	6.85 ± 0.03	6.50 ± 0.06	6.17 ± 0.07	.001
3rd Day	7.10 ± 0.06	6.20 ± 0.06	5.83 ± 0.07	.000
6th Day	8.37 ± 0.12	5.03 ± 0.06	5.57 ± 0.07	.000
9th Day	S	4.70 ± 0.03	4.40 ± 0.04	.019
12th Day	S	S	3.10 ± 0.04	-
15th Day	S	S	S	-

TABLE 2. Effect of Thyme 1% and Cinnamon 1% on Total Coliform Count (Mean ± SE)

Groups / Storage Period	Control	Thyme 1%	Cinnamon 1%	P-Value
1st Day	3.63 ± 0.07	3.55 ± 0.05	3.48 ± 0.06	.297
3rd Day	3.71 ± 0.04	3.47 ± 0.07	3.29 ± 0.05	.005
6th Day	4.84 ± 0.03	2.41 ± 0.06	2.05 ± 0.01	.000
9th Day	S	1.20 ± 0.11	1.95 ± 0.05	.001
12th Day	S	S	1.75 ± 0.02	-
15th Day	S	S	S	-

TABLE 3. Effect of Thyme 1% and Cinnamon 1% on Staphylococcus Count (Mean ± SE)

Groups / Storage Period	Control	Thyme 1%	Cinnamon 1%	P-Value
1st Day	4.85 ± 0.34	4.76 ± 0.45	4.77 ± 0.90	.231
3rd Day	5.10 ± 0.08	3.20 ± 0.08	3.33 ± 0.13	.001
6th Day	6.37 ± 0.23	3.03 ± 0.12	3.24 ± 0.20	.000
9th Day	S	2.70 ± 0.04	2.40 ± 0.06	.017
12th Day	S	S	1.10 ± 0.04	-
15th Day	S	S	S	-

TABLE 4. Impacts of natural extracts Thyme 1% and Cinnamon 1% on sensory attributes (color, odor, texture, over all acceptability) in examined meat samples

Group	Days	Color	Odor	Appearance	Overall Acceptability	Consistency	Grade
Control	0	V	V	V	V	V	Very Good
Control	3	G	G	G	G	G	Acceptable
Control	6	U	U	U	U	U	Unacceptable
Control	9	S	S	S	S	S	Spoiled
Thyme 1%	0	V	V	V	V	V	Very Good
Thyme 1%	3	G	G	G	G	G	Good
Thyme 1%	6	G	G	G	G	G	Good
Thyme 1%	9	U	U	U	U	U	Unacceptable
Cinnamon 1%	0	V	V	V	V	V	Very Good
Cinnamon 1%	3	G	G	G	G	G	Good
Cinnamon 1%	6	G	G	G	G	G	Good
Cinnamon 1%	9	G	G	G	G	G	Good
Cinnamon 1%	12	G	G	G	G	G	Acceptable

V = Very Good, G = Good, U = Unacceptable, S = Spoiled

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تقييم تاثير الزعتر والقرفه البكتيريولوجي علي اللحم البقري

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الملخص

اجريت هذه الدراسه لتقييم تاثير الزعتر والقرفه البكتيريولوجي علي اللحم البقري وعلاقتهما بالجوده الميكربيه ومده الصلاحيه وتم تجميع عدد من العينات العشوائيه من مختلف محلات الجزاره والبقاله بمحافظه المنوفيه وتم تقسيم العينات الي الي ثلاث مجموعات احدها بدون معامله بالزعتر او القرفه والثانيه معامله ب1% زعتر والثالثه معامله ب1 %قرفه وتم قياس الجوده الميكروبيه عن طريق العد الكلي البكتيريى وعدد الكوليفورم وعددالمكروب العنقودي الذهبي لمده 15 يوم وفي درجه حراره 4 م واسفرت النتائج عن انخفاض ملحوظ في نمو البكتريا وعددها الكلي في الجموعه المعامله بالزعتر من 6.5±0.06 في اليوم الاول الى 4.7±0.03 في اليوم التاسع بينما المجموعه المعامله بالقرفه من اللحم البقري انخفض العد الكلي البكتيري من 6.17±0.07 الى 3.1±0.04. اظهر التقييم الحسي لمجموعه العينات المعامله بالزعتر عن محافظه علي جوده القبول لمده ثلاثه ايام بينما المجموعه المعامله بالقرفه حافظت علي جوده القبول لمده تسعه ايام وانخفض العد البكتيري من ولذلك يوصي باستخدام الزعتر والقرفه كماده حافظه طبيعيه للحم البقري حيث انها تزيد من صلاحيتها.

الكلمات الداله : الجوده البكتيريه، الزعتر، القرفه، اللحم البقري، الحوافظ الطبيعيه.