Effect of lavender oil, clove oil and frankincense extract on sensory and microbial properties of raw drumsticks in refrigerator

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ABSTRACT
Prevention of microbial spoilage and extension of shelf life are usually the main goals of food additives. Therefore, this evaluation focused on the physical and antimicrobial effects of clove and lavender oils and frankincense extract (1.0%) on the shelf-life of raw, fresh chicken drumsticks after soaking for 24 hours in the refrigerator (4 ± 1 °C). Assessment of the used additives was conducted through sensory evaluation and microbiological quality through nine days of refrigeration. The treated chicken drumstick samples were much more acceptable overall than the control samples, which started to go bad after 6 days of storage. The treated groups with lavender and frankincense, on the other hand, were still acceptable after 9 days of storage. However, all of the additives that were tested were able to kill microbes. The frankincense aqueous extract was the most effective at stopping the growth of microbes, especially Staphylococcus aureus (Staph. aureus) and total fungal (mould and yeast) counts. Lavender and clove oils came in second and third, respectively. So, it can be concluded that the used herbal byproducts, either oils or aqueous extracts, gave a promising preservative effect on the treated samples with a significant enhancement of the sensory quality. Frankincense extract showed higher acceptability rates in comparison with the other examined additives; therefore, more research on its phytochemical structure, active principles, and side effects can be conducted.

1. INTRODUCTION
Poultry meat, especially chicken meat, is one of the most common foods preferred by consumers due to its health benefits with low-fat content, and high nutritional value due to its components of vitamins, minerals, and essential amino acids needed for body growth and immunity (Choi et al., 2023). On the other hand, it has been considered an ideal medium for spoilage and pathogenic microbial growth because it contains growth factors that represent minerals, nitrogenous complex, and high moisture (Katiyo et al., 2020). Contamination of poultry meat and meat products may occur throughout handling, and processing stages till cold storage, whether due to personal faults and/or environmental and technical factors (Shaltout, 2020). So, using food additives with physical and antimicrobial functions became necessary to prevent the growth of microorganisms, prolong storage time, and increase overall quality and safety of the meat products.

Food additives can be either of chemical origin or natural origin such as herbal extracts and essential oils (Shaltout et al., 2017). Lavender (Lavandula angustifolia) and clove (Syzygium aromaticum) oils are food additives with significant preservation effects referring to their components of natural bioactive substances with antifungal, antibacterial, and antioxidant properties (Chouhan et al., 2017). Lavender has an ancient medicinal role due to its sedative, antibacterial and antifungal actions, therefore, it can be used in food preservation like meat, fish, dairy, fruits, and vegetables (Ez zoubi et al., 2020). On the other hand, clove oil has valuable effects on the immune and cardiovascular systems besides its effects as antiviral, antifungal, antibacterial, and antiprotozoal, which may be assigned to eugenol with humulene and Caryophyllene (Haroz-gonzalez et al., 2021). Frankincense (Boswellia sacra) is a gum resin that has a strong, wide range of antimicrobial effects toward some foodborne pathogens like S. aureus, E. coli, and Candida albicans (Almutairi et al., 2022). Frankincense byproducts were used as early as the 11th century to treat microbial infections such as urinary infections, oral infections, arthritis, and asthma (Almeida-da-Silva et al., 2022).

This work was conducted to evaluate the improving effect of lavender, clove oils, and frankincense aqueous extract on the sensory and microbiological quality of raw drumsticks in refrigerated storage at 4 °C to obtain safe food for consumers without any public health hazard and enhance shelf life.

2. MATERIALS AND METHODS

2.1. Collection of chicken drumsticks
A sum of 3200 g of raw fresh chicken drumsticks (approximately 32 pieces) was collected from poultry butchers located in Benha City, Qalubiya Governorate, Egypt.

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2.2. Preparation of the used additives

Commercially prepared ready-to-use clove and lavender (Lavandula) oils were extracted using a hydro-distillation technique and then were kept in dry-sealed amber glass containers in the refrigerator until use (Barros et al., 2022). On the other hand, frankincense aqueous extract was performed according to Riyad et al. (2020), where frankincense resin powder was mixed with boiled dist. water for one hour, followed by sieving and dryness in an electric oven, at 55 °C, overnight. Working solutions (1.0%) of the used oils and dried aqueous extracts were prepared by dissolving in tween-8 for oils and dist. water for the aqueous extract.

2.3. Experiment grouping

The drumstick samples were divided into four primary groups (8 drumsticks/each group, where each sample weighed about 100 g). Sensory and microbiological quality were investigated before treatment for each group. Each group was partitioned into four secondary groups as follows: (G1) untreated control group; and groups of G2 to G4 were treated with clove oil, lavender oil, and frankincense extract (1.0%), respectively.

Treated groups were treated by soaking in the tested extract. Zero time is 24h post soaking in the relevant extract. Samples were fried for taste scoring. Changes in the superscript letters above mean values indicate significant differences.

2.4. Statistical analysis

SPSS version 20 was used to analyze the data. The significance of the differences in the mean values of the groups under investigation was determined using ANOVA analysis and the Duncan post hoc value. A significance level of p < 0.05 was deemed significant.

3. RESULTS

The findings shown in Table (1) indicate that the tested additives (1.0%) had a positive impact on the sensory attributes and overall acceptability of the chicken drumstick samples that were treated and stored under refrigeration. The control samples showed signs of organoleptic deterioration by the sixth day of storage (score <1), according to the results; however, the groups that received frankincense treatments were still suitable by the ninth day of storage (score: 3.5). When compared to the other additives under investigation, frankincense extract displayed greater acceptability rates.

As shown in Tables (2-5), a promising significant (when p ≤ 0.05) antimicrobial activity of the tested additives was observed through significant retardation in the microbial replication and multiplication represented by their count/g of the treated samples; where the total bacterial count (TBC) (CFU/g) for clove oil, lavender oil, and frankincense extract treated samples were 4.5x10^5, 8.2x10^5 and 4.5x10^5, respectively. Although, all of the examined additives showed antimicrobial activity, frankincense aqueous extract had a higher inhibitory effect on microbial growth, especially against Staph. aureus and fungal counts, followed by lavender and clove oils, respectively; however, they did not show reductions in their counts, only retardation in growth in comparing with the control group's count in the same day of examination, total bacterial count and E. coli counts had a various reduction value in different treated groups.

Table 1. The effects of the examined additives (1.0%) on the overall acceptability of chicken drumstick samples stored at 4°C

<table>
<thead>
<tr>
<th>Groups</th>
<th>Tested parameter</th>
<th>Control</th>
<th>Clove oil</th>
<th>Lavender oil</th>
<th>Frankincense extract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero day</td>
<td>Color</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Odor</td>
<td>5</td>
<td>4.5</td>
<td>4.5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Taste</td>
<td>5</td>
<td>4.8</td>
<td>4.8</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Texture</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Overall</td>
<td>5.0±0.0</td>
<td>VG</td>
<td>4.8±0.5</td>
<td>VG</td>
<td>4.8±0.2</td>
</tr>
<tr>
<td>6th day</td>
<td>Color</td>
<td>3.2</td>
<td>4.0</td>
<td>4.2</td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td>Odor</td>
<td>2.6</td>
<td>3.8</td>
<td>4.0</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td>Taste</td>
<td>3</td>
<td>4.4</td>
<td>4.6</td>
<td>4.7</td>
</tr>
<tr>
<td></td>
<td>Texture</td>
<td>3.2</td>
<td>4.2</td>
<td>4.4</td>
<td>4.8</td>
</tr>
<tr>
<td>Overall</td>
<td>3.0±0.2</td>
<td>A</td>
<td>4.1±0.4</td>
<td>G</td>
<td>4.3±0.3</td>
</tr>
<tr>
<td>9th day</td>
<td>Color</td>
<td>&lt;1</td>
<td>3.2</td>
<td>3.8</td>
<td>3.2</td>
</tr>
<tr>
<td></td>
<td>Odor</td>
<td>&lt;1</td>
<td>2.8</td>
<td>3.2</td>
<td>3.8</td>
</tr>
<tr>
<td></td>
<td>Taste</td>
<td>&lt;1</td>
<td>3.2</td>
<td>3.4</td>
<td>3.8</td>
</tr>
<tr>
<td></td>
<td>Texture</td>
<td>&lt;1</td>
<td>3.0</td>
<td>3.6</td>
<td>4.4</td>
</tr>
<tr>
<td>Overall</td>
<td>&lt;1</td>
<td>S</td>
<td>3.5±0.3</td>
<td>A</td>
<td>3.5±0.3</td>
</tr>
</tbody>
</table>

Zero time is 24h post soaking in the relevant extract. S: Spoiled (S) VG: Very good (VG) G: Good (G) A: Acceptable (A) U: Unacceptable (U) B: Bad (B)
4. DISCUSSION

Any further processing changes of muscle following an animal's slaughter results in meat products; these are vital and indispensable in a balanced diet due to their high-water content and high nutritional value proteins. But for the same reason, it's highly conducive to the growth of microbes, which primarily occur in slaughterhouses; where, 80–90% of the microflora in meat originates there (Shaltout et al., 2022).

The agri-food industry is regarded as one of those that has a direct impact on human existence. The food sector needs to be able to supply meals that will probably guarantee consumers' nutritional satisfaction. Many ancient cultures have been using herbal byproducts for ages to enhance the flavor and scent of their meal. Additionally, because of their antibacterial qualities, they have been utilized as a food preservative (Hintz et al., 2015). According to data on foodborne illnesses worldwide, two-thirds of foodborne disease outbreaks are caused by bacterial food poisoning (Abebe et al., 2020). Salmonella spp., E. coli, and Staph. aureus are the primary microbes linked to manipulation techniques (Bukhari et al., 2021).

Referring to the obtained results in Table 1, the used extracts revealed significant sensory improvement of the treated samples. Although, clove and lavender oils had an enhancement effect on the overall sensory quality, odor, and taste were slightly adversely affected immediately after overnight soaking that may be referred to their powerful odor and the volatile substances in the oily extracts (Guo and Wang, 2020). On the other hand, frankincense aqueous extract showed a remarkable ripening effect in the treated samples, with improving taste and overall acceptability represented by elongation in the shelf life up to the 9th day of the cold storage.

Enhanced sensory characteristics of the treated drumstick may be linked with the bioactive contents of the used additives that play powerful antimicrobial and antioxidant effects (Riyad et al., 2020).

Because meat and meat products are perishable and high in vital nutrients, they are especially susceptible to microbial deterioration. Improper preservation can lead to public health issues. Novel ingredient systems linked to natural and organic foods have been used recently to improve the microbiological quality of meat and meat products. The antibacterial properties of natural antimicrobials derived from plants have been shown in numerous studies to be effective. The food business is paying more and more attention to the use of natural antimicrobials as additives to improve the quality of meat products.
The antimicrobial effects of the applied additives, as shown in Tables (2–5), were consistent with the findings of Wang et al. (2018), Hassanien et al. (2019), and Zaqqou et al. (2022), who found a noteworthy improvement in the meat samples treated with clove oil. Eugenol, together with a tiny amount of cariophyllene and humulene, is responsible for clove's antimicrobial properties and unique scent through its effects by the lipophilic nature of components which facilitate penetrating bacterial cell membrane and mitochondria lead to proton pump fail and ATP pool depletion causing cytoplasmic protein denaturation and cell membrane lysis (Daniel et al., 2009; Nazzaro et al., 2013; Safrudin et al., 2015). Due to its essential oil (EO) qualities, lavender species are among the most widely grown in the world; numerous research studies have demonstrated their biological and antibacterial capabilities (Carrasco et al., 2016). The essential oil of lavender is yellow and has a strong floral aroma. It is mostly extracted using steam or hydrodistillation, yielding a yield of about 3%. The main components of this oil are oxygenated monoterpenes, monoterpene hydrocarbons, and sesquiterpenes, with the highest concentrations being linalool, linalyl acetate, (Z)-β-ocimene, terpinen-4-ol, lavandulol acetate, β-caryophyllene, (E)-β-ocimene, α-terpineol, and 1,8-cineole that enhancing its antibacterial effect and enabling to prevent bacterial cell attachment, protein denaturation and promote microbiological stability (Sadeghi et al., 2013; Pieracci et al., 2021). Because of its bioactive components, which have the potential to benefit human health, lavender species, and their essential oils have been employed in popular medicine since ancient times. In particular, the richness in phenolic compounds confers to lavender EOs a high antioxidant activity due to a protective effect against the oxidative damage caused by free radicals (Turgut et al., 2017). Referring to the recorded results of the lavender oil antimicrobial activity in Tables (2-5), came in agreement with those recorded by Predoi et al. (2018) and Atia (2019) who recorded a significant antimicrobial effect of lavender oil against foodborne K. pneumonia and S. aureus. Authors attributed their antimicrobial activity to their bioactive compounds, especially linalool, and other compounds.

The resin of frankincense is derived from Boswellia trees, members of the Burseraceae family. It is one of the earliest aromatic and therapeutic herbs (Khalifa et al., 2023). A combination of water-soluble gums (polysaccharides), alcohol-soluble resins (diterpenes and triterpenes), and essential oils (mono- and sesquiterpenes) make up the oleogum resin of frankincense (Hamn et al., 2005). Since 5000 years ago, Indians have documented the health benefits of frankincense powder and extracts, as they were utilized as anti-inflammatory agents and in combination to treat various infections (Lemnkh and Teketay, 2003; Mertens et al., 2009). It is thought that frankincense extract antimicrobial effect may be referred to as its ability to reduce bacterial cell membrane integrity and decline extracellular polysaccharide production (Ahers et al., 2021). The obtained results in Tables (2-5) agree with those of Abdallah et al. (2009) and Al-Kharousi et al. (2023), who recorded the variable antimicrobial activity of different frankincense extracts against different foodborne and environmental pathogens, especially E. coli and S. aureus including MRSA strains.

5. CONCLUSIONS

After all, the used clove, lavender, and frankincense byproducts revealed significant enhancement in the sensory, microbial, and keeping quality of the treated drumstick samples in the refrigeration storage; where frankincense aqueous extract had more preferable action than the other used treatments.

6. REFERENCES


