PORK SAUSAGES FORTIFIED WITH VARIOUS CONCENTRATIONS OF LAVENDER ESSENTIAL OIL: MICROBIOLOGICAL AND SENSORIAL PROPERTIES

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Abstract

Several essential oils (EOs) can be used as natural alternatives to synthetic food additives in meat and meat products, especially as effective antibacterial agents. This study investigated how different levels of lavender essential oil (LEO) affected the microbiological and sensory properties of smoked pork sausages. Bacterial growth was followed for 9 days, including tests on days 3, 6, and 9. The smoked pork sausages were divided into two groups: the control group (C) without lavender essential oil and the test group (T) fortified with (0.2%, 0.5%, 1%, 1.5%, 2%, 2.5%, and 3%). The APC and coliform counts indicated that lavender essential oil (LEO) enrichment of smoked sausages has high inhibition of APC and coliform. The lowest minimum inhibitory concentrations (MIC) were obtained with *L. Angustifolia* (0.2%) against both microorganisms. Both EOs caused a significant decrease in bacterial growth in smoked pork sausage stored for 6 and 9 days. Moreover, the results showed that the addition of EO significantly prolonged the odor of smoked pork sausage even at abusive temperature. However, the use of lavender essential oil (LEO) is partially limited due to its intense aroma, which may have negative organoleptic impact. Further studies are needed to enhance the sensory impact of samples enriched with lavender essential oil (LEO).

Key words: (spoilage bacteria, quality, meat products, smoked sausages)

Through the years, numerous synthetic additives have been introduced in order to extend the duration of cold storage, which is the most popular method of preserving fresh meat and meat products (Solomakos *et al*, 2008). However, synthetic additives have been associated with cancerous and perilous properties. Over time, this has intensified consumer's concern about healthy meat products as well as the demand for natural food additives, leading researchers to seek for natural alternatives to synthetic food additives (Mariutti *et al*, 2011). Natural additives such as essential oils are believed to improve the quality of meat and not to leave residues in the product or the environment, and to be one of the ideal options due to their strong antibacterial properties. (Dinesh D. J *et al*, 2013)

Customers' demand for fewer chemicals and more natural foods led to the development of natural substitutes. It appears that essential oils are being considered as a possible substitute. Secondary metabolites can be extracted from the flowers, buds, seeds, leaves, barks, herbs, fruits, and roots of plants by expression, solvent extraction, steam, or hydro distillation. (Mith H. *et al*, 2014, Tăpăloagă D. *et al*, 2018).

Essential oils (EO) are more complex and contain a wide range of volatile and naturally derived bioactive components, making them ideal for use in food production. The major compounds of EO have been shown to have antioxidant, antimicrobial, and antifungal properties through a variety of mechanisms. Varied EOs such as lavender oil, tea tree oil, lemon oil, clove oil, cinnamon oil and thyme oil from different traditional plants have presented higher antibacterial and antioxidant activities. They also successfully extended the shelf life of grain products and improved the quality of food safety. (Bhavaniramya S. *et al*, 2019) A diversity of EOs and their constituents are used as natural antibacterial agents to reduce the impact of microbial activity in foods. (Georgescu M. et al, 2019). The phenolic compounds in essential oils act primarily as membrane permeabilizers. (Bhavaniramya S. *et al*, 2019, Mith H. *et al*, 2014). In another research, EOs from various herbs were used in marinades for fish and meat (pork bacon, pork tenderloin, and chicken fillets) to see how they affected microbial development (Van Haute et al, 2016).

Lavender EO has been proved to be effective in combating bacteria that promote food

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spoilage and a helpful agent in treating and preventing infections in humans. The addition of lavender essential oil to minced beef reduced lipid oxidation while preserving the fresh flavour of the meat for three more days compared to untreated beef (Djenane D. *et al*, 2012). In vitro evidence suggests that lavender essential oil may be effective against a variety of foodborne pathogens, including, but not limited to, *Salmonella, E. coli* and *Shigella, Enterobacteriaceae* at concentrations as low as 10% (Erland L. *et al* 2016, Imelouane B. et al, 2009;). Lavender has been utilized for a long time and modern studies show that it is a safe.

The lavender essential oil contains more than 100 different components that contribute to the chemical and sensory properties of the oil, although many minor components remain unexplained and/or unquantified. A volatile combination of terpenes and their derivatives typically contribute to the distinctive scent of plants. Due to its high linalool concentration, the essential oil extracted from L. Angustifolia is most suitable for use in aromas, and the odor of lavender essential oils is consistent with their geographic distribution (Xiao *et al*, 2017). However, many studies show that the antibacterial activity of the lavender essential oils studied is due to the presence of several antibacterial chemicals such as anethole and terpene hydrocarbons, as well as the ability of the same essential oils to block bacterial cell adhesion and increase microbiological durability (Adaszyńska *et al*, 2013, Sadeghi *et al*, 2013 Abdel-Reheem &Oraby, M. 2015)

MATERIAL AND METHOD

In this study, lavender essential oils were acquired from Fares Orăștie and tested for their microbiological activity in artisanal pork sausage.

a. Sample preparation

The experimental sausages were prepared from eight kilograms of fresh pork, spices such as (140gr / kg) salt, (8gr / kg) thyme, (8gr / kg) sugar, (12gr / kg) pepper, granulated garlic (40gr / kg) and drinking water (400 ml / kg). The smoked pork sausages were divided into two groups: control group (C) without lavender essential oil and treatment groups (T) were divided into 7 groups (1000gr each) and enriched with (0.2%, 0.5%, 1%, 1.5%, 2%, 2.5% and 3%). Bacterial growth was monitored over a period of 9 days, with tests performed on days 3, 6 and 9. Monitoring of coliform bacteria was carried out over a period of 6 days.

b**.** Microbiological analysis:

Counting coliform bacteria was performed according to SR ISO 4832: 2015.

Determination of total plate count (aerobic plate count - APC) was performed according to SR EN ISO 4833-1

c. Sensory evaluation

To illustrate the opinions of typical customers, a committee of ten evaluators, with no experience in sensory protocol nor in sausage evaluation, conducted the sensory analysis. The evaluators' samples were prepared in the oven (at 180°C for 25 minutes). The sensory evaluation followed a procedure with unstructured graphic scales, where one end of the scale represented a completely satisfactory condition of the parameter in question and the other end represented a completely unsatisfactory condition of the parameter in question. A 9-point hedonic scale was used to assess overall acceptability on the third day of the experiment (9=excellent, 8=very very good, 7=very good, 6=good, 5=medium, 4=adequate, 3=fair, 2= poor, 1=very poor).

The characteristics examined by the evaluators were: Cut surface appearance, texture, lavender smell, lavender taste, and overall impression. The acceptability of the condition of the lavender smell and lavender taste characteristics was highlighted

RESULTS AND DISCUSSIONS

1. Results of coliforms count during storage

In accordance with the coliform counts data, all treatment groups (T1-T7) had lower coliform counts than the control group (3 logs CFU /g; 3.41 log CFU /g; and 3.56 log CFU /g), as shown in *figure 1*.

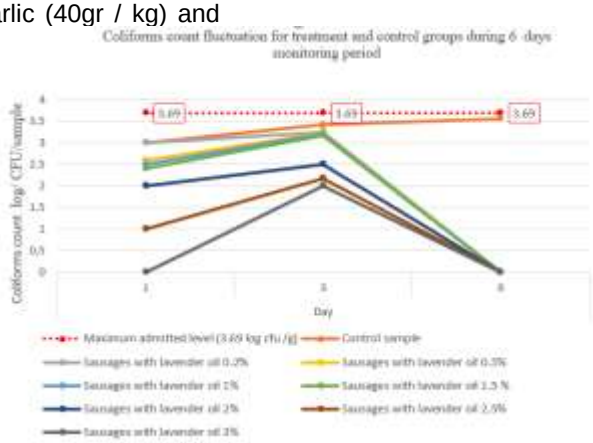

Figure1 **Monitoring of coliforms count during storage**

From day 3 onwards, lower bacterial counts were observed in all treatment groups. This scenario was maintained for all treatments without exception throughout the monitoring period. After three days of cold storage, the number of coliform bacteria in the sausages treated with 1%, 1.5%, 2%, 2.5%, and 3% oil was below 10 CFU/g.

These research results were almost identical to those of Kassem GM et al, 2011 who found that treatment of ground beef at 4°C with cinnamon (C. zeylanicum) oil at different concentrations (0.5%, 1%, 1.5%) resulted in lower coliform counts than the control sample and, that a higher cinnamon concentration (1.5%) was more effective in reducing coliform counts (0.5%). As regards meat quality and shelf life, Shaltout F.A and colleagues (2017) showed that higher oil concentrations were more beneficial than lower ones. Thyme and cinnamon oils have different levels of antimicrobial activity and extend the shelf life of ground beef by 6 days more than control samples, with higher concentrations of both oils being more effective than lower concentrations. In addition, smoked pork sausages treated at refrigeration temperatures with Nigella Sativa Oil showed a significant reduction in coliforms, especially at percentages of 2%, 2.5%, and 3%, similar to Isaconi (Bulai) et al 2021.

2. Aerobic plate count results (APC) during storage

As shown in *figure 2* the APC values of the control sausage samples were 3.04 log CFU /g; 5.27 log CFU /g; 4.39 log CFU /g; and 5.34 log CFU /g on days 3, days 6 and 9, respectively. In the sausage sample treated with (0.2%) LEO, APC values were 3.27 log CFU /g; 5.27 log CFU /g; 4.87 log CFU /g; and 3.23 log CFU /g; at a concentration of (0.5%), APC values were 3.25 log CFU /g; 5.32 log CFU /g; 4.81 log CFU /g; and 3.23 log CFU /g; at a concentration of (1%) and at a concentration of (1.5%), the APC values were 3.23 log CFU /g; 5.39 log CFU /g; 4.44 log CFU /g; and 3.2 log CFU /g.

As the concentration of LEO increased in the samples, the APC values were 3.14 log CFU /g; 5.3 log CFU /g; 4.25 log CFU /g; 3.25 log CFU /g at (2%); 3.11 log CFU /g; 5.25 log CFU /g; 4.25 log CFU /g; 3.14 log CFU /g at (2.5%) concentration and at (3%) concentration APC obtained 3.07 log CFU /g; 5.34 log CFU /g; 4.04 log CFU /g; 3.07 log CFU /g. on day 3, day 6 and day 9 respectively.

The specimens fortified with diverse concentrations of lavender had lower numbers of aerobic microorganisms above the miscibility limit of 5.69 log cfu/g according to Regulation (EC)No. 2073/2005 as compared to the control samples.

This was particularly noticeable for treated samples in day 6 and 9 when compared to control samples. These results were similar to those of Shaltout F.A et al, 2017; and Salem-Amany M et al, 2010) who reported that the antibacterial effect of thyme oil in chilled ground beef reduced the Aerobic plate count (APC) values compared to the control sample. APC levels were reduced more effectively by a high concentration of lavender essential oil (2.5%) than by a lower concentration of the same oil (0.5%).

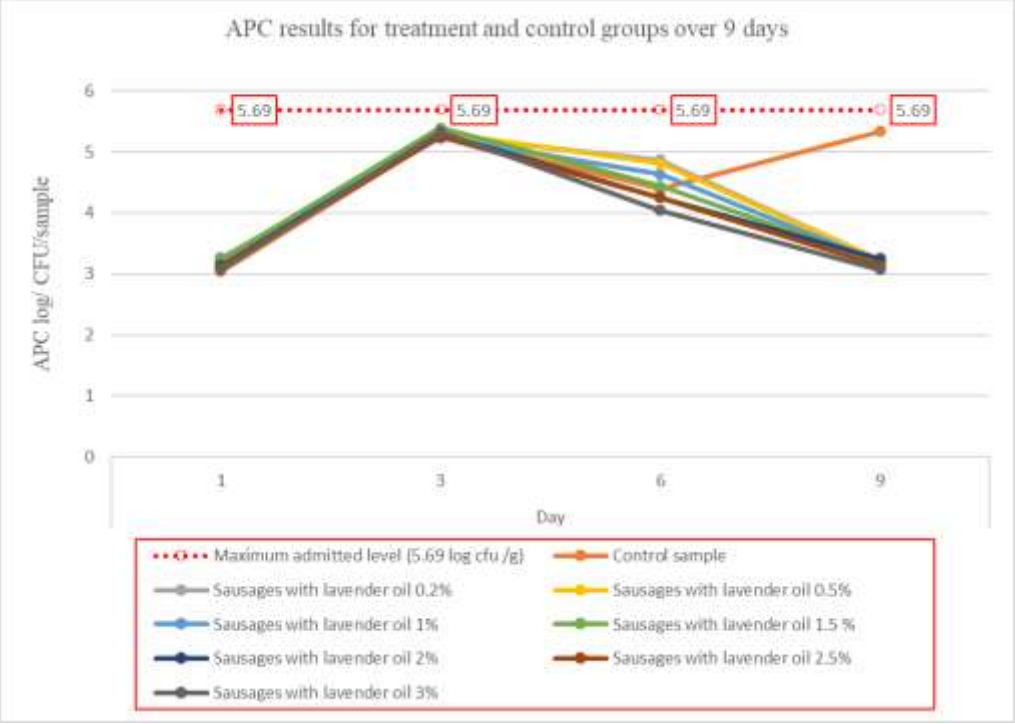

Figure 2 **Results of APC during storage for treatment and control groups over 9 days**

3. Sensory properties in sausages fortified with Lavender essential oil

The major challenges in the use of plant EOs in food are their organoleptic effect, which limits the use of EOs in derived food. (Khanjari, A et al, 2019). Lavender essential oil is one of the most delicate oils. It has a floral aroma that is ideal for various culinary applications (dessert recipes such as scones, lavender lemonade, lavender camembert, lavender tiramisu, lavender sugar, etc.). The addition of lavender to sunflower seed oil has helped to improve the heat stability of the oil and extend its shelf life when deep-fried. (Petruț G et al, 2017).

Figure 3 demonstrates that the sensory characteristics of the different sausage samples treated with lavender essential oil improved on day 3 compared to the untreated samples (control). Moreover, the samples with 2% LEO and 3% LEO showed the greatest improvement in sensory properties, while the samples treated with 1% lavender oil showed the least improvement. The results of the sensory evaluation show that the score for each parameter differed from the score of the control group by a maximum of 4 points. We evaluate the higher score as a consumer-recognized trait, LEO oil, characterizing an aroma associated with the sausage composition. This study is consistent with the findings of Sasse et al, 2009 who established that various herbs and spices, such as thyme, contain components that increase both the color and flavor stability of meat, and that these changes are enhanced by the cooking process, which is related to the increased sensitivity of the human senses in detecting certain molecules called "odor or flavor" that are volatile in warm or hot samples. Meat and meat products cooked at higher temperatures (e.g., grilled) have a stronger odor and flavor because these temperatures cause a change in the chemical composition of the meat. Beneficial effects of spice EOs on the sensory acceptability of several foods have already been reported, including pork meat (Lu et al, 2016), bologna sausage (Viuda-Martos et al, 2010), and ground beef (Khanjari, A et al, 2019).

Negative organoleptic effects can be avoided by choosing appropriate EOs, depending on the type of food. If the active substances are to be used in meat products in higher quantities than standardly, especially in the case for flavorings, more safety research may be required.

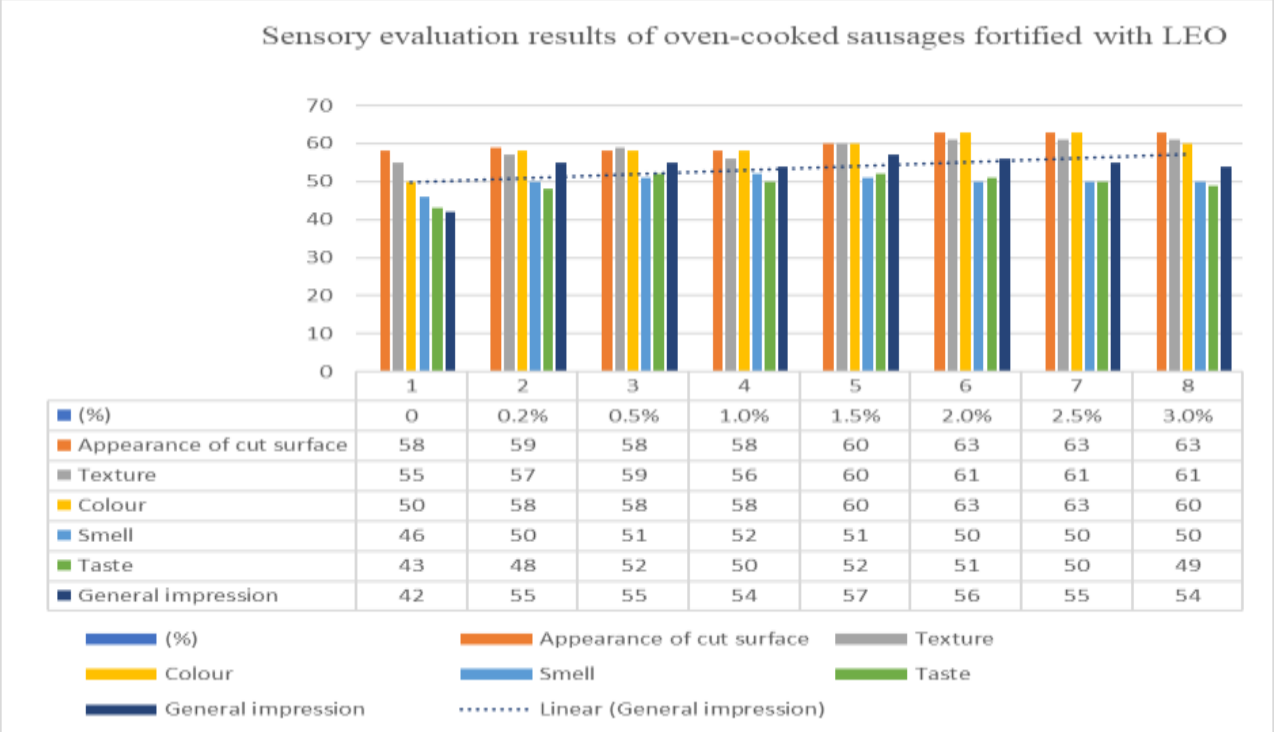

Figure 3 **Sensory evaluation of oven-cooked sausages fortified with LEO**

CONCLUSIONS

All samples showed improved microbiological quality when compared to the control group, in terms of APC and coliform contamination.

This study demonstrates promising results for the use of lavender essential oil as a natural instrument concerning applicability in food and as

a viable option for longer shelf life and higher quality pork sausages. According to the literature, one of the main drawbacks of using EOs in food preservation is the lasting effect of their strong aroma, which can affect the organoleptic properties of foods. However, this study shows a steady improvement in the general impression of increased lavender concentrations.

Further research is needed to understand the synergism and antagonism between the components of LEO and food ingredients before these compounds can be used consistently in commercial implementation.

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