Antimicrobial Activity of Coriander Essential Oil and Vacuum Packaging to Poultry Sous Vide Meat

Miroslava Kačániová[1], Lucia Galovičová[1], Petra Borotová[2,3], Simona Kunová[4]

[1]*Institute of Horticulture, Faculty of Horticulture and Landscape Engineering, Slovak University of Agriculture, Tr. A. Hlinku 2, 94976 Nitra, Slovakia*
[2]*AgroBioTech Research Centre, Slovak University of Agriculture, Tr. A. Hlinku 2, 94976 Nitra, Slovakia*
[3]*Institute of Applied Biology, Faculty of Biotechnology and Food Sciences, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 94976 Nitra, Slovakia*
[4]*Institute of Food Sciences, Faculty of Biotechnology and Food Sciences, Slovak University of Agriculture, Trieda A. Hlinku 2, 949 76 Nitra, Slovakia*

Abstract
Poultry meat is currently considered as a dietetic food due to its valuable biological and nutritional characteristics. This poultry meat is high in protein, essential amino acids, minerals and is low in fat. Meat is for its optimal composition and high-water activity very suitable breeding ground for undesirable microorganisms that cause microbial spoilage of meat. To prolong the shelf life of meat and preserve its quality and hygienic properties various forms of packaging are used. The aim of our work was to investigate the antimicrobial activity of essential oil from coriander in combination with vacuum packaging. Samples were collected from sous vide chicken breast meat, prepared in vacuum. *Listeria monocytogenes* and coriander essential oil were applied on the chicken breast meat. After application, the samples were prepared by sous vide cooking at four different temperatures (50 °C, 55 °C, 60 °C, and 65 °C) during different time of intervals (5; 15; 30; and 60 min). The primary objective was to isolate and analyze the bacteria by matrix-assisted laser desorption/ionization time-of-flight (MALDI-TOF) Biotyper and with mass spectrometry (MS). Gram-positive and Gram-negative bacteria were identified. Most frequent type of bacteria isolated from samples were Gram-negative bacteria. The presence of the dominant species *Listeria monocytogenes* varied depending on temperature and time.

Keywords: antimicrobial activity, coriander essential oil, sous vide, *Listeria monocytogenes*

1. Introduction

Sous Vide (SV) is a French term used for cooking "under vacuum". Processing of the foods by SV method is carried out under precisely controlled temperature and cooking time in order to preserve original taste, softness, and texture. During the process a water bath is used for heating in which a plastic heat-stable vacuum-sealed pouches with raw foods are inserted. Low-temperature cooking was described hundred years ago, but it started to be famous at 1970s by French chefs. The increase in the use of this method started in the middle of 2000s not only in restaurants but also at homes, catering services or industrial processes. The big advance of this method is easy application and suitability for cooking of various foodstuffs like meat, fish, fruits, or vegetables [1]. . A wide use of this technique increases an importance of constant studying how to improve the quality of the final products. The researchers try to examine in detail the influence of cooking time and improve the serve conditions before the introducing to

* Corresponding author: Miroslava Kačániová, miroslava.kacaniova@gmail.com

consumer. They also deal with a product shelf-life extension and elimination of the microbiological contamination [2,3].

Poultry meat can be contaminated by various pathogenic microorganisms which can be spread by handling and cutting of uncooked meat. This often leads to beginning of food borne illnesses, like salmonellosis. Thus, importance of food processing and packaging with use of various methods seems to be highly significant in order to increasing of shelf-life of meat [4-6].

Listeria monocytogenes is considered a major global food-borne pathogen as well as one of the main microbiological hazard-associated with sous vide processing due to its psychrotrophic nature and high heat resistance [7-9]. Thermal resistance of *Listeria monocytogenes* is dependent on several factors such as strain variability, growth conditions, exposure to acid conditions or heat shock, physiological state of the cells, heating medium, experimental design and food characteristics, *e.g.* water activity, pH, salt, levels, and presence of inhibitors [10-12].

Since the sensory quality of the poultry meat is poor and unflavoured meat does not often meet the satisfaction borders in people, there is a necessity of improving the taste by additional ingredients like salt and spices [4]. Also, essential oils may also improve sensory properties and moreover they have antimicrobial properties.

C. sativum commonly known as clove is an aromatic herb often used as spice during cooking process. Its seeds have good nutritional properties and helps to accelerate the digestion processes. The coriander EO is prepared predominantly from fruits and leaves, where the majority of biologically active substances are stored [13]. The yield and the chemical composition of *C. sativum* EO changes with maturation of plant. It also varies among the different plant parts which cause the different aroma of fruit and herb EO. On the other hand, immature fruits and leaves causes some unpleasant odour caused by molecule trans-tridecene [14].

The objective of this study was to evaluate the microbiological quality of chicken breast sous vide meat following the application of *Listeria monocytogenes* and *Coriander sativa* (coriander) essential oil.

2. Materials and methods

Essential Oil

Coriandrum sativum essential oil (EO) was purchased from Hanus, s. r. o. (Nitra, Slovakia). EO was stored in the dark at 4 °C before the analyses.

Chickens meat samples

Chicken breast were prepared as follows (Table 1, 2): MC: fresh meat was vacuum packaged into polyethylene bags, stored anaerobically at 4 °C and cooked at 55-60 °C for 5-60 min.

MCC: fresh meat was treated with 0.1% coriander EO, vacuum packaged into polyethylene bags, stored anaerobically at 4 °C and cooked at 55-60 °C for 5-60 min.

MLM: fresh meat was treated with *L. monocytogenes*, vacuum packaged into polyethylene bags, stored anaerobically at 4 °C and cooked at 55-60 °C for 5-60 min.

Table 1. Heat treatment conditions using the sous vide method of control samples

Control meat (MC)	Control meat with coriander EO (MCC)
1. Control 4 °C	14. Control 4 °C
2. 55 °C 5'	15. 55 °C 5'
3. 55 °C 15'	16. 55 °C 15'
4. 55 °C 30'	17. 55 °C 30'
5. 55 °C 60'	18. 55 °C 60'
6. 60 °C 5'	19. 60 °C 5'
7. 60 °C 15'	20. 60 °C 15'
8. 60 °C 30'	21. 60 °C 30'
9. 60 °C 60'	22. 60 °C 60'
10. 65 °C 5'	23. 65 °C 5'
11. 65 °C 15'	24. 65 °C 15'
12. 65 °C 30'	25. 65 °C 30'

13. 65 °C 60'	26. 65 °C 60'

Table 2. Heat treatment conditions using the sous vide method of samples with bacteria

Meat with *L. monocytogenes* (MLM)	**Meat with *L. monocytogenes* with coriander EO (MLMC)**
27. Control 4 °C	40. Control 4 °C
28. 55 °C 5'	41. 55 °C 5'
29. 55 °C 15'	42. 55 °C 15'
30. 55 °C 30'	43. 55 °C 30'
31. 55 °C 60'	44. 55 °C 60'
32. 60 °C 5'	45. 60 °C 5'
33. 60 °C 15'	46. 60 °C 15'
34. 60 °C 30'	47. 60 °C 30'
35. 60 °C 60'	48. 60 °C 60'
36. 65 °C 5'	49. 65 °C 5'
37. 65 °C 15'	50. 65 °C 15'
38. 65 °C 30'	51. 65 °C 30'
39. 65 °C 60'	52. 65 °C 60'

MLMC: fresh meat was treated with *L. monocytogenes* and 0.1 coriander EO, vacuum packaged into polyethylene bags, stored anaerobically at 4 °C and cooked at 55-60 °C for 5-60 min.

The samples were prepared under sterile conditions until raw chicken breast (550 g) were divided into 52 samples. The meat was taken (10 ± 0.2 g) and placed into knurled vacuum bags, some of the samples were exposed to *Listeria monocytogenes*, then packed with a vacuum sealer (Proficook PC-VK 1015). The control was prepared from raw meat on day zero that was not cooked. The next day, the essential oils were added to the samples and maceration was performed for 24 hours. The samples were placed into the CASO SV1000 sous-vide device. *L. monocytogenes* CCM 4699 was prepared at 1×10^8 cfu and added to the sample at a volume of 100 µL.

Microbiological analyses

Chicken breasts were cut into 5 g pieces with a sterile scalpel and forceps, immediately transferred into a sterile stomacher bag containing 45 mL of 0.1% buffered peptone water (BPW, pH 7.0, Basingstoke, UK) and homogenized for 60 seconds at room temperature.

For each sample, appropriate serial decimal dilutions were prepared in 0.79 % peptone water solution. The amount of 100 µL of each dilution of the prepared samples was spread on the surface of the dry agar media. Plate Count Agar (PCA, Oxoid, UK) with samples were incubated for 2 days at 30 °C and total viable counts (TVC) of microorganisms were determined. Oxford Agar with Oxford supplements was used for detection of *L. monocytogenes* 100 µL of the sample was inoculated on the plate. Incubation was carried out at 37°C for 24 h.

Identification of bacteria

After incubation, the isolated colonies were picked and resuspended in 300 µL of sterile distilled water and mixed thoroughly. Subsequently, 900 µL of absolute ethanol were added. The mixture was centrifuged at 10,000 x g for 2 min. A supernatant was discarted, the pellet was centrifuged again and residual ethanol was removed. The precipitate was allowed to dry at room temperature.

Then 30 µL of formic acid (70%) and 30 µL of acetonitrile were added and mixed thoroughly with the pellet.The solution was centrifuged at maximum speed for 2 minutes and 1.5 µL of the supernatant was spotted on a polished MALDI target plate (Bruker Daltonics, Bremen, Germany). Immediately after drying, 1.5 µL of the matrix solution was added to each spot and allowed to air dry.

The samples were then processed with the MALDI-TOF MS spectrometer equipped with the Flex Control software (Bruker Daltonics). Each spectrum was obtained by averaging 40 laser shots obtained in the automatic mode with the minimum laser power necessary to ionize the samples. The

spectra were analysed, and the results were compared to the database according to the real-time software, v3.1 classification.

Statistical analyses

All analyses were performed in triplicate. Statistical variability of data was processed using the Microsoft-Excel® software.

3. Results and discussion

The present study was aimed to assess the control of microbiological hazards of a food with the application of heat treatment and EO. Raw meat stripped of any antibacterial treatment is prone to microbiological spoilage and the growth of all bacterial groups. Our microbiological analysis confirmed that the coriander oil had the best inhibitory effect on *Listeria* and TVC.

TVC in chicken breast samples without the addition of EOs ranged from 2.21 to 6.56 log cfu/g (Figure 1).

TVC in chicken breast with the addition of coriander EO ranged from 1.78 to 5.36 log cfu/g (Figure 2).

TVC in chicken breast with the addition of *L. monocytogenes* ranged from 1.78 to 6.54 log cfu/g (Figure 3).

TVC in chicken breast inoculated with *L. monocytogenes* and coriander EO ranged from 1.78 to 5.89 log cfu/g (Figure 4).

The studies have shown that properties and the type of the foods affects the shelf life of SV cooked products [15-18]. Mol et al. [17] examined the influence of the storage temperature on the shelf life of the bonitos, that were SV cooked for 10 min at 70 °C. Storage at 4 °C was possible for 28 days while the storage at 12 °C decreased to 15 days. Diaz et al. [16] examined the shelf life at SV cooked pork loin. It took 10 weeks for the meat to become unacceptable which proved that use of SV cooking and way of packaging have positive influence on shelf life. Another studies proved the similar result with shelf life of SV cooked meat foods [7, 15, 19, 20].

In the food industry, the quality and safety of prepared or processed foods, are of prime importance. The microorganisms present in food can lead to spoilage and deterioration of the quality of food products, and if ingested by humans can cause infection and illness. Thus food manufacturers try their best to reduce or eliminate microorganisms from food products. It has been estimated that about one-third of the world's food production is lost annually on account of microbial spoilage or contamination [21].

Coriander EO has been reported to inhibit a broad spectrum of microorganisms [22-24] and has proven its efficacy as an antibacterial agent [25-33].

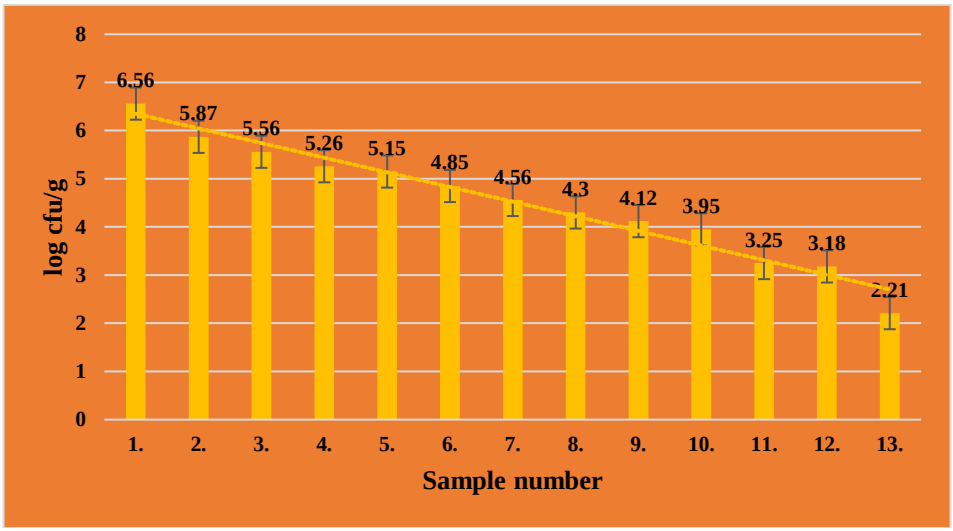

Figure 1. The total number of microorganisms in chicken breast samples without addition of EO

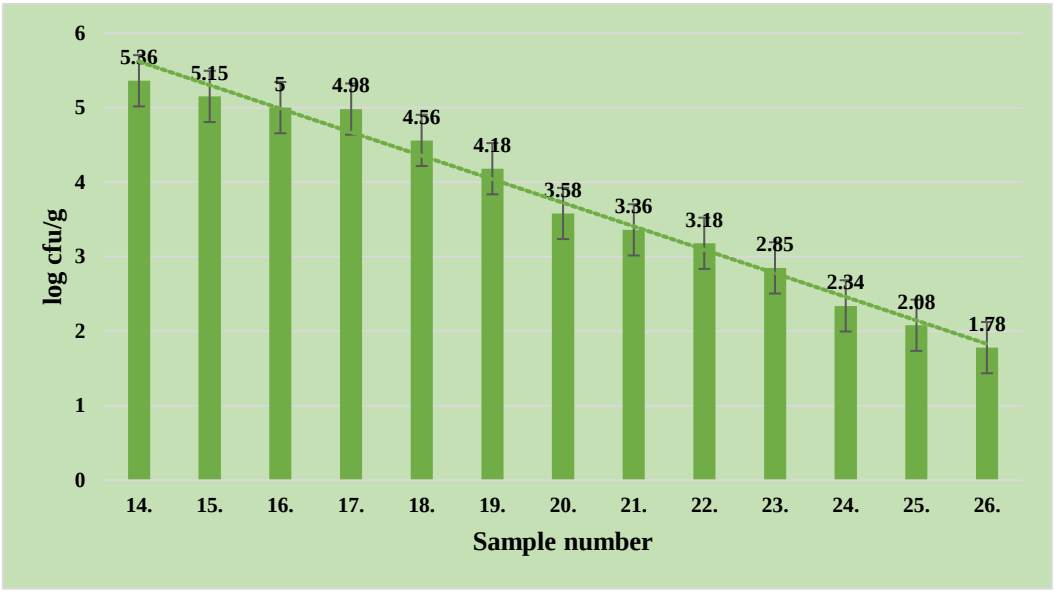

Figure 2. The total number of microorganisms in chicken breast samples with the addition of coriander EO

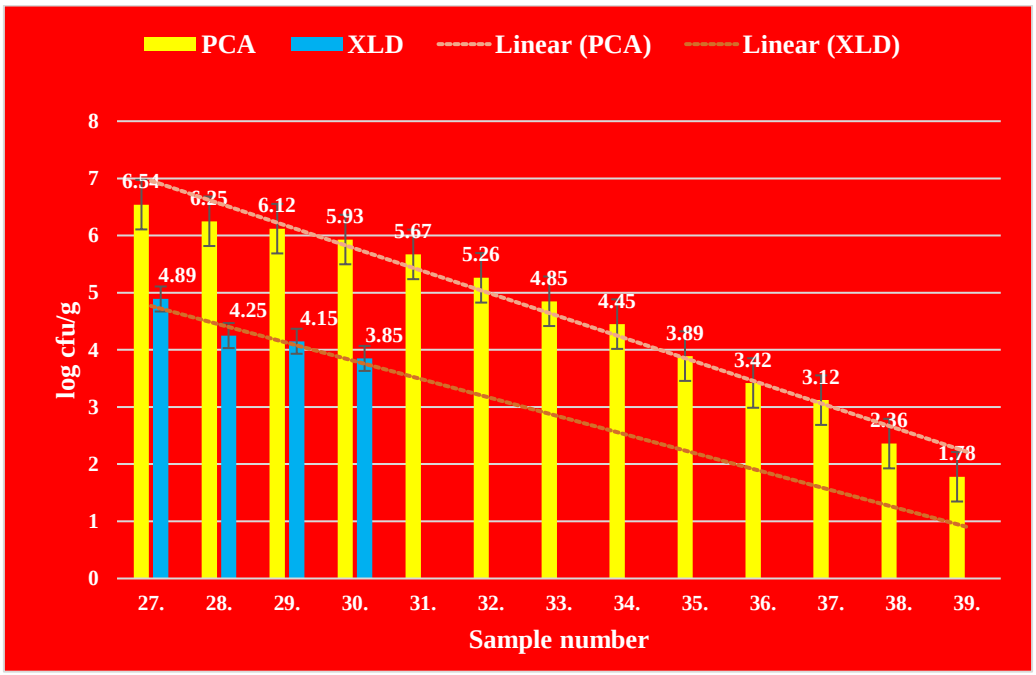

Figure 3. The total number of microorganisms and *L. monocytogenes* in chicken breast without EO addition

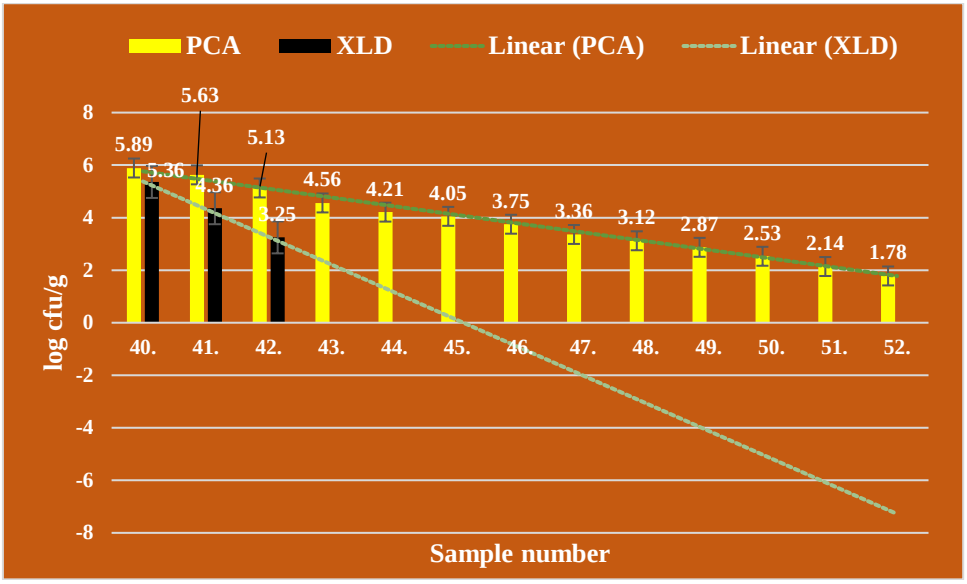

Figure 4. The total number of microorganisms and *L. monocytogenes* in chicken breast with the addition of coriander EO

The total number of *Listeria monocytogenes* in the samples treated with this bacterium is showed in figures 3 and 4. *L. monocytogenes* was viable only in the control sample and the sample treated with 55 °C for 5-30 min. In the samples treated with the coriander EO, the incidence of *L. monocytogenes* was observed in the control and samples treated with 55 °C for 5 and 15 min.

The incidence of the isolated bacterial species from the chicken breast is showed in Figure 5. The most isolated bacterium from all the samples was *Escherichia coli* (41.56%).

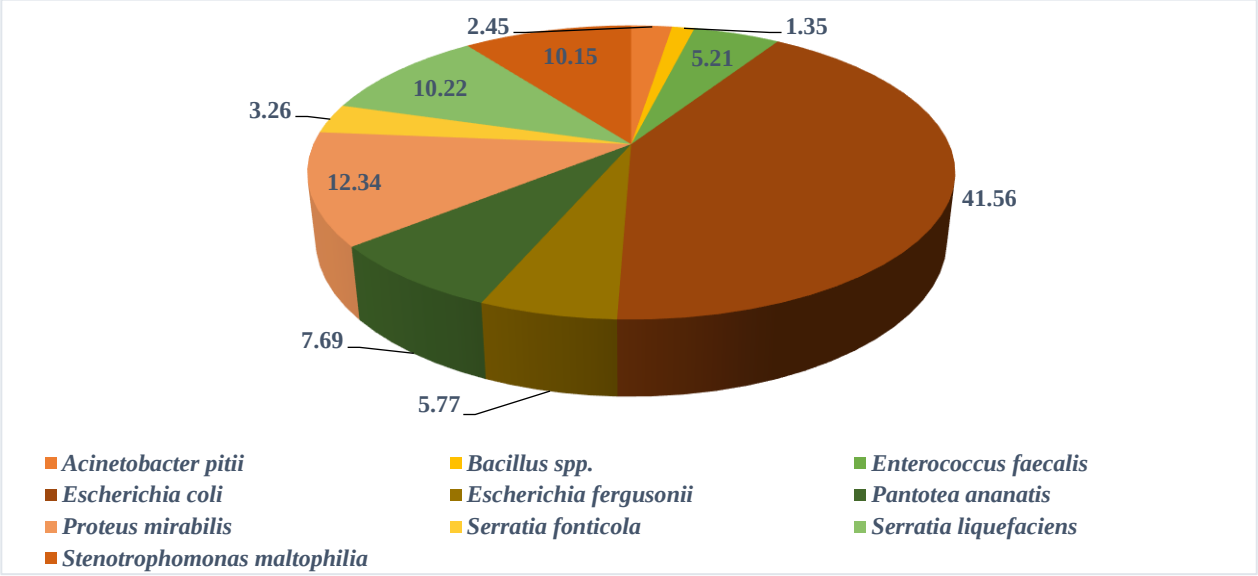

Figure 5. Incidience of the isolated bacterial species

The essential oils from *Coriandrum sativum* L. showed antioxidant, antimicrobial, anti-inflammatory, anticancer and cytotoxic efficacy in many research and clinical studies. These extracts and essential oils can also retard lipid oxidation in food matrices, so they can be used in future in food technology as potential substitutes of synthetic antioxidants in food preservation. Due to this properties can essential oil contribute to increased storage stability of the sous vide cooked food products [34].

4. Conclusions

Chicken breasts is a good matrix for the microbial growth including pathogenic microbiota. Storage and processing conditions may influence the microbiological contamination of chicken meat. Our study shows that the sous vide cooking is an effective method for the treatment of chicken breast to protect the meat from spoilage. The initial quality of raw material is important to ensure the final meat quality. The treatment should be carried out in a strictly controlled manner, which can be difficult to perform at home.

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