The influence of cooking methods and juniper essential oil on lipid oxidation in pork chops

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Abstract. In this research, the effects of three cooking methods (boiling–vacuum bag, boiling–plastic bag and baking) on the lipid oxidation and overall sensory acceptability of pork chops marinated with and without juniper essential oil were investigated. The thiobarbituric acid reactive substance content was affected by both marinating and cooking methods. Pork chops from juniper essential oil marinade had lower thiobarbituric acid reactive substance values throughout the marinating and two cooking methods (boiling–plastic bag and baking) in comparison to their control counterparts. The pork chops with juniper oil, regardless of cooking method, were evaluated with significantly higher scores for overall acceptability than all analysed control pork chops.

1. Introduction

Different cooking methods are applied to meat to improve its hygienic quality by reducing the number of pathogenic microorganisms and extending shelf life [1]. This is accompanied by enhanced palatability, tenderness and flavour [2,3]. However, cooking causes physico-chemical changes in protein, carbohydrate, lipid and other minor components, thus altering the nutritional value of meat [1,4,5]. Lipid oxidation occurring during cooking is the main reason for quality deterioration of meat and meat products [6]. The rate and level of lipid oxidation could be affected by cooking procedures (temperature, time, moist or dry heat) [2,3,7].

In order to prevent oxidative rancidity and increase meat products’ shelf-life, numerous natural products containing phenolic compounds have been used to replace chemical antioxidants which could have harmful effects on people’s health [8,9,10,11]. Recent investigations showed that essential oils and extracts from various herbs and spices provide a good alternative to synthetic antioxidants [12,13,14,15].

Juniper (Juniperus communis L.) is a plant belonging to the family Cupressaceae. It is defined as a small coniferous long-lived tree or an evergreen shrub and is distributed throughout Europe, North Asia, and North America. Common juniper has been used as medicinal plant for centuries. Juniper oil was applied in the treatment and prevention of cholera, helminthiasis and renal infections. Also, it has been used in gastronomy as a spice for meat and meat products and as a natural ingredient in cosmetic, pharmaceutical and food industries [16,17]. Nowadays, the cones of J. communis and their essential oils are recognized by the European Pharmacopoeia [18,19,20].
There is a scarcity of data regarding the effect of juniper essential oil on lipid oxidation in meat and meat products. Therefore, the aim of this study was to investigate the impact of juniper essential oil along with different cooking methods (boiling and baking) on lipid oxidation in pork meat.

2. Experimental part

2.1. Raw materials
Fresh whole pork loins (M. longissimus thoracis et lumborum) were obtained from a local supermarket. The chosen pork loins were of normal meat quality, regarding criteria for pH (pH <6.0) and lightness (CIE \(L^*\) value = 43-50). All external fat, fascia and separable connective tissue were removed. Thereafter, pork loins were cut perpendicular to the longitudinal orientation of the muscle fibres into 1 inch thick pork chops. The Juniperus communis essential oil used in this study was of commercial origin.

2.2. Marinating of pork chops
Two different marinades were prepared for the current study. Both marinades consisted of 2.2% salt in water solution and were in the proportion of 15 g marinade per 100 g meat. Juniper essential oil was used in marinade at a concentration of 20 \(\mu\)l per 100 g meat (JEO). Water with salt and no essential oil was used as a control (C). Both marinades were applied by massaging during 20 minutes.

2.3. Cooking procedure
The applied cooking procedures were: two boiling procedures (boiling – each pork chop was placed in a vacuum sealed plastic bag or packed into a plastic bag and totally immersed in an electric water bath at 90°C until the final internal temperature of 72°C was achieved), and; baking (each pork chop was cooked on a grill in an electric air-convection oven preheated to 163°C until 72°C was reached in the centre of the sample). After the cooking, the pork chops were cooled at room temperature and used for further analyses.

2.4. Thiobarbituric acid–reactive substances (TBARS) determination
The extent of lipid oxidation was assessed by the TBARS method of Botsoglou et al. [21], with modifications described by Šojić et al. [22]. Results were expressed as mg malondialdehyde (MDA) per kg of meat.

2.5. Sensory analysis
Sensory analysis was carried out by eight trained panellists. Cooked pork chops were cut into 1.0 \(\times\) 1.0 \(\times\) 1.0 cm pieces and evaluated for overall acceptability on a nine–point scale (1 – dislike extremely, 2 – dislike very much, 3 – dislike moderately, 4 – dislike slightly, 5 – neither like nor dislike, 6 – liked slightly, 7 – liked moderately, 8 – liked very much and 9 – like extremely).

2.6. Statistical analysis
Statistical analysis was carried out using Statistica 13.0 (TIBCO Software Inc., Palo Alto, USA) one-way and two-way ANOVA. One-way ANOVA was used for analysis of the overall sensory acceptability of cooked pork chops. Two-way ANOVA was used for analysis of TBARS as a function of the marination (C and JEO) and of the cooking method (boiling-vacuum bag, boiling-plastic bag and baking). Duncan's test was used to identify significant differences among main effects (marination and cooking methods). Significances were established at the level of \(P < 0.05\).

3. Results
Lipid oxidation of raw marinated C and JEO pork chops measured as TBARS was, on average, 0.07 and 0.03 mg MDA/kg, respectively. Raw JEO pork chops had significantly \((P < 0.05)\) lower TBARS values compared to C pork chops, which could be related to the presence of added juniper essential oil.
oil. The effect of different marinade formulations and cooking methods on lipid oxidation of the cooked pork chops is presented in Table 1. As was expected, all cooking methods significantly (P < 0.05) increased TBARS values. Similar results were obtained by several other authors [2,23,24]. The increase in TBARS values after the applied cooking methods could be due to the high temperatures that promoted oxidation processes, thus increasing the levels of thiobarbituric reactive substances [1,4].

**Table 1.** Thiobarbituric reactive substance values (mg malondialdehyde/kg) of cooked pork chops as affected by cooking method and marinade formulation and significance of interactions between marinade type and cooking method

| Marination type | TBARS (mg MDA/kg) | Two-way ANOVA |
|-----------------|-------------------|---------------|
| Control pork chops | Pork chops with juniper essential oil | Marination effect P | Cooking method effect P | Marination × cooking method interaction P |
| Boiling – vacuum bag | 1.29<br>a1 | 0.000044 | 0.000001 | 0.003360 |
| Boiling – plastic bag | 1.20<br>b2 | 0.94<br>b1 |
| Baking | 1.59<br>b2 | 1.11<br>b1 |

**Note:** Different letters indicate significant differences (P < 0.05) between pork chops following the same marinade formulation. Different numbers indicate significant differences (P < 0.05) between pork chops following the same cooking methods.

Cooking causes membrane disruption that releases prooxidant substances, such as non-haem iron, thereby accelerating the oxidative processes [25]. Application of high temperature (163°C) during baking generated significantly (P < 0.05) higher TBARS values than at 90°C (boiling) for C pork chops (1.59 and 1.29 or 1.20 mg MDA/kg, respectively). Similar results were found by other authors [1,2,4,24]. However, there was no significant (P < 0.05) difference between JEO pork chops prepared by boiling–vacuum bag and baking, regarding TBARS values (1.14 and 1.11 mg MDA/kg, respectively). These values were significantly (P < 0.05) higher than those of JEO pork chops cooked by boiling–plastic bag (0.94 mg MDA/kg). Significantly lower TBARS values were measured in JEO marinated pork chops prepared by boiling–plastic bag and baking (0.94 and 1.11 mg MDA/kg, respectively) compared to their counterparts from control groups (1.20 and 1.59 mg MDA/kg, respectively). This result could be explained due to addition of juniper essential oil that retarded lipid oxidation during cooking [26]. The major components in the composition of juniper essential oil are α-pinene, sabinen, β-pinene, limonene and myrcene [17,20]. However, the antioxidant activity of juniper essential oil could be attributed to its components α-terpinene and γ-terpinene that are present in lower concentrations [19].
Figure 1. Overall sensory acceptability of marinated cooked pork chops

The results of the sensory analysis revealed a significant (P < 0.05) difference for overall sensory acceptability between pork chops treated with different marinades (Figure 1). The JEO pork chops cooked by baking were the most acceptable, but their scores were not significantly (P < 0.05) different from JEO pork chops cooked by boiling–vacuum bag and boiling–plastic bag (8.88, 8.75, and 8.75, respectively). Also, there was no significant (P < 0.05) difference among the sensory score values of C pork chops.

4. Conclusion
Cooked pork chops are highly susceptible to lipid oxidation due to the applied heat treatment. Results in this study show that juniper essential oil can retard lipid oxidation in raw and cooked pork meat. Also, juniper essential oil has a positive effect on overall sensory acceptability of cooked pork chops. Usage of herb essential oils and extracts which possess antioxidant properties could retard lipid oxidation and prevent loss of nutritional value of food.

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