QUALITY OF RAW-COOKED MEAT PRODUCT AFTER APPLICATION GRAPE SEED EXTRACT

Marek Bobko*, Miroslav Kročko, Peter Huščík, Andrea Mendelová, Alica Bobková, Juraj Čuboň, Jana Tkáčová, Luboš Harangozo

Address(es): doc. Ing. Marek Bobko, PhD.
1Slovak University of Agriculture in Nitra, Department of Animal Products Evaluation and Processing, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia.
2Slovak University of Agriculture in Nitra, Department of Plant Products Storage and Processing, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia.
3Slovak University of Agriculture in Nitra, Department of Food Hygiene and Safety, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia.
4Slovak University of Agriculture in Nitra, Department of Chemistry, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia.

*Corresponding author: marek.bobko@uniag.sk

INTRODUCTION

Meat is the muscle tissue of slaughter animals composed of water, proteins, lipids, minerals and a small proportion of carbohydrates. Meat and meat products are susceptible to quality deterioration due to their rich nutritional composition (Devatkal et al., 2012). The quality deterioration is due to chemical and microbial changes. The most common form of chemical deterioration is the oxidation of meat lipids. Lipid oxidation is a complex process and depends on chemical composition of meat, light and oxygen access and storage temperature (Kanner, 1994). The lipid oxidation is one of the major problems in meat industries. Meat products that are constituted of lipid and polysaturated fatty acids (PUFAs) tend to deteriorate due to lipid oxidation, leading to development of unpleasant flavours during processing and storage (Mielenik et al., 2006).

Lipid oxidation can be reduced or inhibited by the use of antioxidants in meat and meat products and thus the product quality and shelf-life can be improved. Antioxidants can prevent lipid peroxidation using the following mechanisms: preventing chain inhibition by scavenging initiatiing radicals, breaking chain reaction, decomposing peroxides, decreasing localized oxygen concentrations and binding chain initiating catalysts, such as metal ions (Dorman et al. 2003, Baydar et al., 2007).

Thus, application of suitable agents possessing both antioxidant and antimicrobial activities may be useful for maintaining sausage quality, extending shelf-life and preventing economic loss (Yin and Cheng, 2003). Consequently, several synthetic antioxidants have been added to sausage to prevent undesirable reactions to enhance its shelf-life (Georganedis et al., 2007). However, the increasing concern over the negative consequences from using synthetic antioxidants has emphasized the value of natural antioxidants. So, interest in natural antioxidants and search on naturally occurring compounds with antioxidant and antimicrobial activities has increased dramatically (Lorenzo et al., 2013).

Agro-industries generate numerous waste materials that should be reduced/eliminated to achieve a sustainable agriculture. In this sense, the possibility of using these residues as natural antioxidants in the food industry could represent a significant step towards maintaining an environment balance. For instance in wine and grape juice production, where residues account for approximately 30% of grape (Vitis vinifera) (Rickenbach et al., 2008).

According to the estimates provided by the Organisation Internationale de la Vigne et du Vin (OIV), annual process of grapes is estimated at around 66.5 million tonnes, with 38 million tonnes produced in Europe. At European level, the grape pomace production is about 8 million tonnes per year in total (Burg et al., 2014).

A significant part of the grape pomace is comprised by grape seed which amounts to 38-52% on dry matter basis (Maier, 2009). Among the beneficial effects of parts of a grape, grape seeds are believed to have a powerful antioxidant property due to its rich source of polyphenol compounds. The polyphenol compounds in grape seeds are in range of 60-70 %, only 10 % is in the fruit, and 28 - 35 % in the peels (Garcia-Marino et al., 2006; Nawaz et al., 2006).

It is likely that the demand for using natural antioxidants such as grape seed extract (GSE) has greatly increased in recent years. GSES are substantially constituted with proanthocyanidins. They can react with free radicals and catalyzed metal ions necessary for the oxidation reaction then terminate chain reactions by removing radical intermediates, and inhibit other oxidation reactions by being oxidized themselves (Shahidi and Wanasundara, 1992; Sanchez-

ARTICLE INFO

ABSTRACT

The present study aimed to determine the effect of GSE application on quality (oxidative stability, color and sensory quality) of raw-cooked meat products stored 10 days at 4 °C. Antioxidant activity assessment of applied GSE of different grape varieties in Frankovka modrá (E2) grape varieties was observed higher antioxidant activity (91.2%) than that in Dunaj (E1) and Cabernet Sauvignon (E3) grape variety (85.3, resp. 85.8 %). At the end of storage (day 10), we observed higher oxidation stability in all experimental groups with grape seed extract supplements and therefore a lower MDA value compared to the control group without the addition of extracts. In control group was recorded the highest production of MDA (0.129 mg.kg-1). From experimental groups with the addition of different grape seed extracts, we recorded the highest degree of oxidative stability in the experimental group with the addition of Frankovka modrá extract (0.115 mg.kg-1). The highest degree of oxidative damage from all experimental groups was found in group with the addition of Dunaj extract (0.120 mg.kg-1). The MDA content in the experimental group with the addition of Cabernet Sauvignon grape extract at the end of the refrigeration storage period was 0.118 mg.kg-1. In the evaluation of the individual sensory quality indicators after grape seed extract we did not record statistically significant differences (P> 0.05) between individual groups, indicating that the sensory quality of raw-cooked meat products was not negatively affected by their addition. In the evaluation of the most important indicator of sensory quality (taste) we recorded better average ratings in all experimental groups with the addition of grape seed extract than in the control group. Based on the results of the oxidative stability and sensory quality of the raw-cooked meat product after 10 days of refrigerated storage at 4 °C, we can recommend using natural antioxidants in the production of the meat product in the form of grape seed extract Dunaj, Frankovka modrá and Cabernet Sauvignon to increase oxidative stability thereby increasing the shelf life and sensory quality of the raw-cooked meat product.

Keywords: oxidative stability, grape seed extract, malondialdehyde, sensory

OPEN ACCESS
Moore et al., 1999). The phenolic substances in GSE ranges from 80% to 99%, the most important being resveratrol (trans-3,4',5-trihydroxystilbene). Due to the strong antioxidant activity of resveratrol, it can inhibit peroxidation in a concentration-dependent manner. It does not scavenge hydroxyl radical nor does it react with H₂O₂, making it an inefficient catalyst of subsequent oxidation (Murcia and Martínez-Tome, 2001).

In addition, GSE is rich in proanthocyanidins. The multiple mechanisms of their antioxidant activity are expressed in its ability of radical scavenging, metal chelation, and synergism with other antioxidants (Lu and Foo, 1999). Scientific studies have shown that grape seed extract is a more potent scavenger of reactive oxygen species and that it has greater antioxidant power than vitamin C and vitamin E (Shi et al., 2003). Also, Grape seed extract improves lipid stability by reduced the thiobarbituric acid reactive substances (TBARS) in meat products (Sasse et al., 2009; Kulkarni et al., 2011; Perumalla et al., 2013). Based on the findings of many researches (Tekeli et al., 2014; Iqbal et al., 2015; Lichnovikova et al., 2015; Tournour et al., 2016; Guerra-Rivas et al., 2016; Brenes et al., 2016), application of grape pomace has been shown to a positive effect on animal products, such as improving the carcass parameters in chickens, oxidation stability and storage of meat products, egg production (Kara and Kocaoglu-Guelu, 2012, Kara et al., 2016), and in raw-cooked meat products (Ozural and Vural, 2011; Ozural and Vural, 2013; Ryu et al., 2014). The present study aimed to determine the effect of GSE application on quality (oxidative stability, color and sensory quality) of raw-cooked meat products stored 10 days at 4 °C.

**MATERIAL AND METHODS**

The tested raw-cooked meat products were made from pork meat and additional raw materials purchased at a market and processed according to the recipe for the product type (Table 1). Four groups of meat products were evaluated. The groups were formed on the basis of various additions of GSE during the mixing in a bowl cutter, as follows:

- control group (C),
- experimental group 1 (E1): 10 ml of GSE Dunaj per 1 kg of meat mixture,
- experimental group 2 (E2): 10 ml of GSE Frankovka modra per 1 kg of meat mixture,
- experimental group 3 (E3): 10 ml of GSE Cabernet Sauvignon per 1 kg of meat mixture

The GSE-treated meat product was smoked and heat-treated (temperature in a product core reached 70 °C and persisted for 10 min). After the heat-treatment, the product was cooled to 4 °C. Meat samples were stored at 4±1 °C during the experimental period (10 days).

**Preparation of grape seed extract**

Extraction of grape seeds was carried according to Shirahigae et al. (2010). The homogenized grape seeds (20 g) were mixed with 100 ml of 80% ethanol in a laboratory shaker in the dark and at room temperature for 24 hours. Subsequently, the liquid phase was separated from the solid phase by filtration and added into volumetric flask. The 80% ethanol was then added until a total volume of 100 ml. After that, the liquid fraction was evaporated in the vacuum rotary evaporator at 65 °C. The dry residue was weighed and redissolved in 50 ml of distilled water. The extract was then applied into raw-cooked meat product in an amount of 10 ml per 1 kg of raw material.

**Table 1 Composition of meat product (g).**

<table>
<thead>
<tr>
<th>Component</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pork meat</td>
<td>1000.0</td>
</tr>
<tr>
<td>Water</td>
<td>200.0</td>
</tr>
<tr>
<td>Curing salt</td>
<td>18.0</td>
</tr>
<tr>
<td>Garlic (Allium sativum)</td>
<td>0.5</td>
</tr>
<tr>
<td>Red pepper (Capsicum annuum)</td>
<td>2.0</td>
</tr>
<tr>
<td>Black pepper (Piper nigrum)</td>
<td>3.0</td>
</tr>
<tr>
<td>Mace (Myristica fragrans)</td>
<td>1.0</td>
</tr>
<tr>
<td>Polyphosphate</td>
<td>7.0</td>
</tr>
</tbody>
</table>

**Assessment of antioxidant activity (AOA) with DPPH radical**

The DPPH (2,2-diphenyl-1-picrylhydrazyl) inhibition in GSE according to method of Brand-Williams et al. (1995). The DPPH radical is used to quantify the ability of antioxidants to quench the DPPH radical. The dark purple colour of DPPH will be lost when it is reduced to its nonradical form stable organic nitrogen centred free radical with a dark purple colour which when reduced to its nonradical form by antioxidants becomes colourless. When the DPPH radical is scavenged, the colour of the reaction mixture changes from purple to yellow and decrease of the DPPH radical is measured spectrophotometrically. On the determination of AOA was used which in ethanol solution is in colourless radical form. Its reduction is manifested by the change of colour of solution and is measured spectrophotometrically. Gallate was used as standard and the amount of AOA sample expressed as gallate equivalent was calculated.

**Determination of the oxidative stability**

During four storage times (day 1, 4, 8, and 12), oxidative stability of meat product samples was determined according to Marečíak et al. (2010). The method is based on the rupture of lipid bilayer by free radical to form malondialdehyde (MDA) as a secondary product. Two molecules of thiobarbituric acid react with one molecule of MDA to form pink coloured product showing maximum absorbance at 532 nm called TBARS. The absorbance was measured using UV spectrophotometer (Jenway UV-VIS Spectrophotometer). The results were calculated as malondialdehyde (MDA) quantity per 1 g of sample.

**Sensory evaluation**

Sensory quality of raw-cooked meat products (n = 9) after cooking (80 °C, 5 min) was assessed by five-member panel on the 4th day after processing. Sensory characteristics of meat products including surface appearance and colour, appearance and colour in cross-section, texture, aroma, and taste on a five-point hedonic scale (5 = very good, 1 = very bad).

**RESULTS AND DISCUSSION**

Antioxidant activity assessment of applied grape seed extracts of different grape varieties is shown in Table 2. In Frankovka modrá grape varieties applied in E2 group was observed higher antioxidant activity (91.2%) than that in Dunaj (E1) and Cabernet Sauvignon (E3) grape variety (85.3, resp. 85.8 %). Similarly, Baťjan et al. (2015), and Spákovská et al. (2012) found AA in the range of 69 – 90.9 % in red wine grape varieties. In addition, similar AA values (61.4 – 87.1%) found El-Beshbishy et al. (2009) in red grape seed extracts.

**Table 2 Antioxidant activity (AA) of grape seed extracts of different grape varieties (% ±S.D.).**

<table>
<thead>
<tr>
<th>Grape variety</th>
<th>AA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dunaj</td>
<td>85.3 ±0.7</td>
</tr>
<tr>
<td>Frankovka mudra</td>
<td>91.2 ±0.7</td>
</tr>
<tr>
<td>Cabernet Sauvignon</td>
<td>85.8 ±0.8</td>
</tr>
</tbody>
</table>

**Table 3 Values of thiobarbituric number during the storage expressed as MDA (mg.kg⁻¹) (mean ±S.D.).**

<table>
<thead>
<tr>
<th>Storage time</th>
<th>Group</th>
<th>E1</th>
<th>E2</th>
<th>E3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>0.103 ±0.003</td>
<td>0.092 ±0.005</td>
<td>0.102 ±0.002</td>
<td>0.093 ±0.002</td>
</tr>
<tr>
<td>Day 4</td>
<td>0.113 ±0.002</td>
<td>0.106 ±0.001</td>
<td>0.107 ±0.005</td>
<td>0.104 ±0.002</td>
</tr>
<tr>
<td>Day 7</td>
<td>0.121 ±0.002</td>
<td>0.116 ±0.001</td>
<td>0.117 ±0.005</td>
<td>0.113 ±0.006</td>
</tr>
<tr>
<td>Day 10</td>
<td>0.129 ±0.006</td>
<td>0.120 ±0.006</td>
<td>0.115 ±0.005</td>
<td>0.118 ±0.009</td>
</tr>
</tbody>
</table>

Note: MDA – malondialdehyde; C – control group; E1, E2, E3 – experimental groups.

Oxidation of meat lipids is a complex process and its dynamics depend on numerous factors including chemical composition of meat, light and oxygen access, and storage temperature. The manufacturing processes of meat products cause degradation of the muscle membrane system and have a strong impact on the oxidation of intracellular fat, primarily phospholipids (Karayaka et al., 2011). Thermal treatment makes oxidative processes faster, what significantly changes the value of thiobarbituric acid. The level of oxidative damage of lipids in the manufacture and storage of frankfurters is presented in Table 3.
Table 4 Sensory evaluation of raw-cooked meat products (mean ± S.D.)

<table>
<thead>
<tr>
<th>Sensory characteristic</th>
<th>Group C</th>
<th>E1</th>
<th>E2</th>
<th>E3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface appearance and colour</td>
<td>4.65 ±0.47</td>
<td>4.75 ±0.28</td>
<td>5.00 ±0.00</td>
<td>4.70 ±0.35</td>
</tr>
<tr>
<td>Appearance and colour in cross-section</td>
<td>4.77 ±0.26</td>
<td>4.72 ±0.32</td>
<td>4.75 ±0.50</td>
<td>4.75 ±0.28</td>
</tr>
<tr>
<td>Tenderness</td>
<td>4.85 ±0.23</td>
<td>4.82 ±0.23</td>
<td>4.86 ±0.19</td>
<td>4.95 ±0.10</td>
</tr>
<tr>
<td>Aroma</td>
<td>4.82 ±0.23</td>
<td>4.57 ±0.29</td>
<td>4.82 ±0.17</td>
<td>4.77 ±0.33</td>
</tr>
<tr>
<td>Taste</td>
<td>4.45 ±0.49</td>
<td>4.42 ±0.50</td>
<td>4.42 ±0.50</td>
<td>4.60 ±0.39</td>
</tr>
</tbody>
</table>

Note: C – control group; E1, E2, E3 – experimental groups.

As regards determination of oxidative stability of raw-cooked meat products (stored at 4 °C) on day 1, the highest MDA content was found in control group (0.102 mg.kg⁻¹) compared to experimental groups E1 and E2 (0.092 and 0.093 mg.kg⁻¹, respectively). At the end of storage (day 10), we observed higher oxidation stability in all experimental groups with grape seed extract supplements and therefore a lower MDA value compared to the control group without the addition of extracts. In control group was recorded the highest production of MDA (0.129 mg.kg⁻¹). From experimental groups with the addition of different grape seed extracts, we recorded the highest degree of oxidative stability in the experimental group with the addition of Frankovka modrá extract (0.115 mg.kg⁻¹). The highest degree of oxidative damage from all experimental groups was found in the addition of Dunaj extract (0.120 mg.kg⁻¹). The MDA content in the experimental group with the addition of Cabernet Sauvignon grape extract at the end of the refrigeration storage period was 0.118 mg.kg⁻¹. Our results indicate a higher degree of oxidative stability after application of natural antioxidants and are consistent with the findings of Mielnik et al. (2006), Ouzurl and Yural (2010), Ouzurl and Yural (2013) and Ryu et al. (2014), who also noted an increase in the oxidative stability of raw-cooked meat products after application of natural antioxidants.

The mean value of sensory characteristics of raw-cooked meat products (surface appearance and colour, appearance and colour in cross-section, texture, aroma, and taste) after application of extracts are presented in Table 4. In the evaluation of the individual sensory quality indicators after grape seed extract we did not record statistically significant differences (P > 0.05) between individual groups, indicating that the sensory quality of raw-cooked meat products was not negatively affected by their addition. In the evaluation of the most important indicator of sensory quality (taste) we recorded better average ratings in all experimental groups with the addition of grape seed extract than in the control group. Similar results were found in study of Brannan (2009) who investigated grape seed in ground chicken, as well as Kulkarni et al. (2011) who investigated grape seed in beef sausages, with no significant effects on sensory quality.

CONCLUSION

Based on the results of the oxidative stability and sensory quality of the raw-cooked meat product after 10 days of refrigerated storage at 4 °C, we can recommend using natural antioxidants in the production of the meat for application of natural antioxidants. In the evaluation of the most important indicator of sensory quality (taste) we recorded better average ratings in all experimental groups with the addition of grape seed extract than in the control group. Similar results were found in study of Brannan (2009) who investigated grape seed in ground chicken, as well as Kulkarni et al. (2011) who investigated grape seed in beef sausages, with no significant effects on sensory quality.

Acknowledgments: This work was supported by grants VEGA No. 1/0591/18 and APVV-17-0508.

REFERENCES


