STARTER CULTURES AND CARROT FIBER POSITIVELY AFFECT ON WEIGHT LOSS AND SENSORY CHARACTERISTICS OF TEA SAUSAGE

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Abstract


The results of the research of the effects of the meat starter culture Lactobacilus sakei + Staphylococcus carnosus, carrot fibers and extract of rosemary on the physical, chemical and sensory properties of the fermented smoked sausage are given in this article. Theresearch has been done on five (5) variants of the fermented smoked sausage made in industrial conditions. The use of the meat starter culture Lactobacilus sakei + Staphylococcus carnosus and carrot fibers allows for a smaller loss of mass in the production process and better overall sensory properties of the final product. The use of rosemary extract does not display significant influence on the properties of the sausage.

Key words: durable sausage, rosemary, starter culture, appearance, aroma, color

Introduction

Sausages are the largest group of meat products. There are several hundred types of sausages and several hundred thousand brands. The production of sausages dates back to ancient times. The favorite foods of the ancient Greeks were the sausages. They had several types of sausages including the salami, supposedly originating from the city of Salamis, located on the east coast of Cyprus, which was ruined in 499 B.C.

The production of sausages in Europe started in Italy some 250 years ago. The Italians transferred the recipe to Hungary some 150 years ago, and the spreading of the sausage all over Europe had begun (Incxe 2003).

The durable sausages are rather wanted on the market due to their nutritive and gastronomical properties but, because of the price of the ingredients used, as well as the time and energy needed for their production, their price is relatively high (Turibatovic et al., 2004; Raseta et al., 2010).

Today, there is an increased production of raw sausages under industrial conditions where the process of maturing – fermentation is taking place in special acclimatized chambers under controlled conditions (Karolyi et al., 2005; Stojanovski et al., 2008). In order for the maturing, process of the durable sausage to be shortened and they being directed purposefully, the GDL (Glukono delta lacton), different sugars, vitamin C, starter cultures are added together with increased temperature and air circulation. The maturing-fermentation of the durable sausage is a complex process that includes chemical, biochemical, physic-chemical and microbiological interaction between the ingredients, the additives, the starter culture and the components of the smoke (Saicic, 2006). In the production of the sausage, the drop of pH value during the maturing and fermentation is very significant. This is achieved in two ways: by using certain microorganism and by using additives (Vukovic et al., 1986). Lactic cultures are regularly used in raw sausages, with the increased usage of specific kinds of these and other microorganisms known as starter culture (Radetic, 1997).

The usage of starter cultures and the correct guidance of the “Sremska” salami production process lead to a faster drop-off in the pH value, faster separation of the water from the mass, lower aw-values, early creation of the characteristic flavor and consistency of slices. Simultaneously, with the use of the starter cultures and the other additives that accelerate the production process and enchase the quality of the raw sausages, an effort is made to lower the energetic value of the sausages due to the constant request by many costumers for hypo energetic foods. Therefore, in the developed countries
during the production of the different types of sausages, vegetable dietary fibers are being added in order to decrease the used fat but also to maintain the same quality.

The adding of plant fibers like inulin, wheat, citrus, potato, oats and peas improves the nutritive value of the normal fat pork sausage and beef burger (<230 g.kg⁻¹) and the reduced fat pork sausage and beef burger (<100 g.kg⁻¹) (Mc. Donah et al., 2004).

The adding of 10 g.kg⁻¹ plant fibers from carrots in the raw sausages reduces the loss of mass during the maturing for about 6 g.kg⁻¹ in comparison to the non-plant fiber sausages (Huber et al., 2003).

In order to slow down the oxidation process during the maturing of the sausages, antioxidants are used. Recently the use of natural sources of antioxidants such as different plants, parts of plants, fruits or their extracts has increased.

Tanege et al. (2002) determined that the use of culinary herbs and their extracts including rosemary, had significant effect on the oxidation of fats at the pork meat.

The use of green tea and grape seed is slowing down the oxidation of fats and contributes to the sustainability of the beef burgers which are produced with reduced levels of sulfites and which are kept for up to nine days under retail conditions (+4°C).

In the last 15 years in the Republic of Macedonia, multiple meat product production facilities have been built. Some of them, with greater or lesser success, are producing raw sausages, usually fermented smoked sausage and kulen with GDL additives. There is no use of starter cultures, plant fibers and herbs with antioxidant properties except the traditional spices (onions, garlic, red paprika, white and black pepper). This was the reason why we decided to study the effects of the use of starter cultures and rosemary extract on the performance of the fermented smoked sausage production in our meat industry.

**Materials and Methods**

The fermented smoked sausage is produced under industrial conditions in The Meat Industry and Slaughterhouse in Sveti Nikole, Republic of Macedonia. The mixture for the sausage is prepared from a first category meat (380 g.kg⁻¹), second category meat (380 g.kg⁻¹), and CMT (240 g.kg⁻¹). The temperature of the pork meat before cutting the meat was – 3.2°C and the one of the CMT -11.5°C. The frozen meat and the CMT are being diced until the particles are 5 mm and then additives, spices-rosemary extract, carrot fiber and starter culture are added. The mixture is pilled in a artificail colagen tubing with a diametar of 36 mm and lenght of 30 cm with a vacuum filler.

Five groups of sausages were made using GDL, starter culture, carrot fibers and rosemary.

1 - G- glucono delta lacton (GDL) (3.0 g.kg⁻¹ in 100 kg meat)
2 -S- Starter kulture  25 g/100kg.
3 - SCF – starter kulture 25g/100kg. + carrot fiber 15 g.kg⁻¹
4 - SR - starter kulture 25g/100kg. +rosemary 0,032 g.kg⁻¹
5 - SCFR - starter kulture 25g/100kg. + carrot fiber 10 g.kg⁻¹ + rosemary 0,032 g.kg⁻¹.

The starter culture is a commercial product F-SC-11 Bactoferm made by Chr. Hansen, Denmark. It is a mixture of cultures including Lactobacillus sakei and Staphilococcus carnosus in a dry frozen form (25 g/100 kg meat). The firs bacterium causes fast acidification and the second one causes a consistent color, and a soft aromatic flavor. The Rosemary extract - liquid. Product Akras Austrian company. Fiber trade name Fibrotex Bu 4 is product of company Kerry Austria. Additives such as nitrous salt for brining (22- g.kg⁻¹), sodium ascorbate (0.5 g.kg⁻¹), dextrose (4.0 g.kg⁻¹) milled black pepper (0.20 g.kg⁻¹), garlic powder (0.20 g.kg⁻¹) and spicy mixture of tea sausage composed of salt 75%, garlic powder, ekstraat of black pepper, coriander, piment, and muscat flower (4. 0 g.kg⁻¹). Prepare the Meat Industry and Slaughterhouse in Sveti Nikole. After filling, the sausage has undergone a regime of smoking and drying in the climate chamber for a period of 15 days according to the program used in the Meat Industry and Slaughterhouse in Sveti Nikole. During the drying and fermentation, the temperature and pH of each day during the first week as well as the 15th day was measured; AW was measured on the 7th and on 15th day. After the manufacturing process, the chemical composition and the sensor analysis was carried out for the finished product. PH was measured by a pH potentiometer EBRO- Merch with a combined electrode, and a built-thermometer probe for simultaneous measurement of pH and temperature. Aw was measured using aw - Aqvqlab meters (Washington). The TBK- test is preformed using the (Tarladgis et al., 1960) and the modified (Shahidi et al., 1987) methods using a 8.1 factor for the conversion of the absorbance bet units to TBK numbers (Shahidi et al., 1983).

The chemical composition was determined using the standard methods: the water after drying at 105°C to constant weight, protein by Kjeldahl apparatus, using sox let methods for fats and for minerals burning at 525°C. The sensor analysis was carried out by experienced professionals using 9 - stepped scale established by the VNIMP - Moscow. The following sensors properties of tea sausage were graded: outward appearance, cut appearance, texture, color, smell and taste.
Results and Discussion

PH dynamics of sausages during ripening and drying is given in Table 1. The table shows that the initial pH values ranging from 5.83 to 5.88. By the 7th day of drying and ripening, the pH has decreased in both groups of sausage. Then they reached the lowest pH. The pH value of up to seven days was 4.90 for variants S and SCFR and up to 5.14 for the variant G.

On the 15th day, these values are a bit higher, and they range from 4.96 in the alternative SCF to 5.20 in the alternative G. At the samples of the variant G where GDL is used on the first day, a swift drop in pH (5.85 to 5.56) is registered, but on the second day, there are increased values compared to the other variants. The variants with starter cultures containing carrot fiber or rosemary (SCF and SCFR) the drop in pH is more balanced and there are little differences between them.

The results of our study are consistent with studies that have been made by various authors. Rede et al. (1995) found that sausages, which were added a GDL, had a faster decline in pH (5.80 to 5.30) in comparison to the sausages produced with starter cultures. PH drop was greatest on the first day and after the 7th day pH it rose again. To obtain a stable fermented sausage and to extend their shelf life a pH 5.3 or lower should be provided at the end of the fermentation and the drying process (Canadian Food Inspection 19977; Waters, 2000). Both groups of sausage meet this criterion (at the end of the production process pH ranges from 5.02 to 5.20). On the seventh day after their making, the AW was 0.907 in the SCFR variant and up to 0.914 in variant G. On the 15th day AW value dropped from 0.847 to 0.862. Differences in AW between all variants are small and not statistically significant. Rede et al. (1995) found a faster and greater fall in aw value in a sausage with GDL compared to a sample with starter cultures.

The results in relation to the losses on mass in the sausage during production are given in Table 2. From the table it can be seen that the loss to the masses in the 7th-day of production is estimated at 282.2 to 295.5 g.kg⁻¹. It is determined that the variant with the starter culture had significance (p<0.01) of a greater degree than other varieties of loss of weight. Differences between other variants were

### Table 1

<table>
<thead>
<tr>
<th>PH dynamics of sausages</th>
<th>Variants</th>
<th>Variants</th>
<th>Variants</th>
<th>Variants</th>
<th>Variants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days</td>
<td>G</td>
<td>S</td>
<td>SCF</td>
<td>SR</td>
<td>SCFR</td>
</tr>
<tr>
<td>0</td>
<td>5.85±/-.03</td>
<td>5.83±/-.03</td>
<td>5.84±/-.03</td>
<td>5.85±/-.02</td>
<td>5.87±/-.03</td>
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<td>1</td>
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<td>5.74±/-.01</td>
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<td>5.34±/-.02</td>
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<td>3</td>
<td>5.43±/-.03</td>
<td>5.16±/-.03</td>
<td>5.15±/-.02</td>
<td>5.22±/-.04</td>
<td>5.15±/-.03</td>
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<td>4</td>
<td>5.34±/-.05</td>
<td>5.02±/-.04</td>
<td>5.05±/-.02</td>
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<tr>
<td>5</td>
<td>5.29±/-.03</td>
<td>4.95±/-.02</td>
<td>4.98±/-.03</td>
<td>4.97±/-.01</td>
<td>4.96±/-.01</td>
</tr>
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<td>6</td>
<td>5.22±/-.02</td>
<td>4.93±/-.01</td>
<td>4.94±/-.01</td>
<td>4.95±/-.01</td>
<td>4.93±/-.01</td>
</tr>
<tr>
<td>7</td>
<td>5.14±/-.04</td>
<td>4.90±/-.02</td>
<td>4.92±/-.01</td>
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<td>4.90±/-.02</td>
</tr>
<tr>
<td>15</td>
<td>5.20±/-.03</td>
<td>5.02±/-.02</td>
<td>4.96±/-.02</td>
<td>5.01±/-.01</td>
<td>4.97±/-.04</td>
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### Table 2

<table>
<thead>
<tr>
<th>Mass loss during the maturing of the sausage</th>
<th>Variants</th>
<th>Variants</th>
<th>Variants</th>
<th>Variants</th>
<th>Variants</th>
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</thead>
<tbody>
<tr>
<td>Days</td>
<td>G</td>
<td>S</td>
<td>SCF</td>
<td>SR</td>
<td>SCFR</td>
</tr>
<tr>
<td>15</td>
<td>36.78±/-.70</td>
<td>37.82±/-.16</td>
<td>37.08±/-.14</td>
<td>38.07±/-.10</td>
<td>36.75±/-.12</td>
</tr>
</tbody>
</table>

### Legends for all Tables

G - Glukono Delta laktone
SCF - Starter kulture + Carrot fiber
SCFR- Starter culture + Carrot fiber + Rosemary
S - Starter culture
SR -Starter Culture + Rosemary
insignificant. At the 15th day of maturing the loss in weight, it was estimated at 367.5 to 380.7 g.kg⁻¹. Statistics show that the alternative processing of SR (with starter cultures and rosemary) has significantly (p<0.01) greater loss in mass over the alternatives SCFR < G, SCF and the variant with a significant (p<0.05) increased loss of weight over the alternatives in which a carrot fiber is being added.

The loss of weight of the sausage determined in our studies is consistent with the results achieved by other authors. Joksimovic et al. (1981) found loss of weight at sausage during the drying and ripening phase from 221.2 to 359.7 g.kg⁻¹. Huber et al. (2003) identified less-loss of weight by 60 g.kg⁻¹ at the raw sausages with carrot fiber compared with those without fiber. Susić et al. (1987) found a loss in weight of 361.6 g.kg⁻¹ among the sausage with Tari-S77 and at sausage starters with 365.0 g.kg⁻¹, during the production (the 14th day).

The loss in weight during the drying is directly reflected to the loss of water content and the chemical composition of the product.

The results of chemical composition of the product are given in Table 3. From the table it can be seen that most of the water (334.7 g.kg⁻¹) is contained in the variant SCFR (with carrot fibers and rosemary being added) and the least (301.2 g.kg⁻¹) is in the SR variant (with starter culture and rosemary). The differences in the contents of the water between the SR variant on one side and SCFR, CSF, and G on the other side, as well as between the SCFR and S are statistically significant at p < 0.05. The lesser content of the water in the sausage variant SR and S is the result of a larger loss in weight during the drying of the sausages.

The contents of the proteins; ranges from 241.5 g.kg⁻¹ to 255.8 g.kg⁻¹. The differences between the variants are small and insignificant. The content of the fat at the examined sausages ranges from 368.2 g.kg⁻¹ to 385.8. The content of mineral substances at the sausages is from 40.2 g.kg⁻¹ to 42.9 g.kg⁻¹. The differences between the contents of the ashes are insignificant.

Joksimovic et al. (1981) and Palic et al. (1982) examined the chemical composition of sausages. They found that the water content of the sausage was from 296 to 330 g.kg⁻¹, the protein content from 204.5 to 220.10 g.kg⁻¹, the fat content of 320.0 to 600 g.kg⁻¹, the mineral matter content from 41.5 to 55.9 g.kg⁻¹. The differences in the chemical composition of the sausages in our tests in relation to tests of other authors are probably the result of the composition and the type and the participation of meat and fat, the type and the amount of additives and the technological process itself.

As it can be seen from Table 4, the lowest value of the reviews has a variant of the sausages produced with the addition of GDL (G). It is apparent that the sausages containing carrot

### Table 3
The chemical composition of the product is presented

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Variants</th>
<th>Variants</th>
<th>Variants</th>
<th>Variants</th>
<th>Variants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>G</td>
<td>S</td>
<td>SCF</td>
<td>SR</td>
<td>SCFR</td>
</tr>
<tr>
<td>Water</td>
<td>32.55±/-.087</td>
<td>31.07±/-.080</td>
<td>32.68±/-.038</td>
<td>30.12±/-.065</td>
<td>33.47±/-.080</td>
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<td>Protein</td>
<td>25.23±/-.154</td>
<td>25.58±/-.122</td>
<td>24.15±/-.085</td>
<td>25.32±/-.086</td>
<td>24.36±/-.066</td>
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<tr>
<td>Fat</td>
<td>36.82±/-.058</td>
<td>37.55±/-.045</td>
<td>37.56±/-.021</td>
<td>38.58±/-.055</td>
<td>36.90±/-.091</td>
</tr>
<tr>
<td>Ashes</td>
<td>4.29+/-.010</td>
<td>4.02+/-.012</td>
<td>4.18+/-.017</td>
<td>4.22+/-.019</td>
<td>4.07+/-.019</td>
</tr>
</tbody>
</table>

### Table 4
The sensor grades of tea sausage

<table>
<thead>
<tr>
<th>Sensory characteristic</th>
<th>Variants</th>
<th>Variants</th>
<th>Variants</th>
<th>Variants</th>
<th>Variants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>G</td>
<td>S</td>
<td>SCF</td>
<td>SR</td>
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</tr>
<tr>
<td>Outer appearance</td>
<td>2.3</td>
<td>3</td>
<td>3.5</td>
<td>3</td>
<td>3.5</td>
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<tr>
<td>Section appearance</td>
<td>14.4</td>
<td>16</td>
<td>16.4</td>
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<tr>
<td>Consistency</td>
<td>7.8</td>
<td>13.5</td>
<td>13.5</td>
<td>13.5</td>
<td>13.5</td>
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<tr>
<td>Colour</td>
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<td>13.2</td>
<td>13.5</td>
<td>12.9</td>
<td>13.5</td>
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<tr>
<td>Smell</td>
<td>15.5</td>
<td>16.9</td>
<td>16.9</td>
<td>17.4</td>
<td>17.4</td>
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<tr>
<td>Taste</td>
<td>17</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Average value</td>
<td>3.175</td>
<td>4.175</td>
<td>4.28</td>
<td>4.195</td>
<td>4.3</td>
</tr>
<tr>
<td>% from the maximal posible efects</td>
<td>63.8</td>
<td>93.5</td>
<td>85.9</td>
<td>84.0</td>
<td>86.5</td>
</tr>
</tbody>
</table>
fiber (variant SCF and SCFR) got higher grades. Based on the grade, which was expressed through the average value and in percentage of its maximum quality, it can be noted that these values are the highest at the variants with carrot fiber (SCFR and SCF) and lowest at the variant with GDL (G). Adding the rosemary did not show any influence on the quality. The sensory traits are graded with satisfactory assessments with an exception of the variant with GDL. An application layer and a darker color across sectional area were observed at this variant. The samples with a starter culture and especially the samples with a carrot fiber had more attractive color to the surface and in the cross section, as well as a better and more solid consistency. The results of our study in relation to the surface and in the cross section, as well as a better and more solid consistency. The results of our study in relation to the sensor quality of sausages go along with the results of the other authors (Rede et al., 1995; Popov et al., 1996; Savic et al., 2001). That indicated that variants with starter cultures have a hard consistency and pronounced smell and taste compared with a variant produced with a GDL.

TBK Results - Tested sausages- given in Table 5. The table shows that there is a higher number of TBK at the sausages produced with the addition of GDL variant (G) then the variants with starter cultures. The difference is statistically significant (p <0.01). This result is in accordance with Hechelman (quoted according Radetic (1997) that GDL can lead to intensified proliferation of microorganisms that are unfavorable such as lactobacilli that produce peroxides, which can cause rancidity and unwanted color. Sausages to which rosemary was added (SR and SCFR) had significantly (p <0.05) lower TBK numbers of variants of S. Based on the TBK test it may be concluded that rosemary extract has a definite effect on antioxidants in raw sausages.

Our results are not in line with some results that were obtained by other authors (Sharlote von Canstein, 2005; Korolija, 1972; Susic et al., 1987). Differences in TBK - values identified in our polls and those who cite other authors probably are the result of using different types and quality of raw materials (adipose tissue) and additives, as well as the method according to TBK - test was performed.

## Conclusion

Initial pH values for all five variants are almost identical and range from 5.83 to 5.88. By the 7th day of drying and ripening, the pH declined in all sausage groups and then it is slightly increased. At the end of the production process a pH value of (4.96 to 5.20) was achieved and aw-values (0.847 to 0.862), which provide good stability and sustainability for the finished product. The starter culture did not indicate a significant influence over the loss of the mass (calo) of the smoked sausage during the production process, neither over the chemical composition not the level of oxidation (TBK-numbers) of the comleted product. The sausage with the carrot fiber added, has significantly (p<0.05) small loss in weight, during the manufacturing process it is of slightly firmer consistency and contains significantly (p<0.05) more water. The use of rosemary on the sausage during manufacturing process has certain antioxidant properties and shows no influence on the physical - chemical and sensory properties of the finished product. The use of meat starter cultures and carrot fiber allows for the production of sausages with lower mass losses during the manufacturing process and good overall sensory properties of the finished product. Based on this, we can recommend the use of starter cultures and carrot fiber in the production of the sausage.

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Received December, 12, 2012; accepted for printing September, 2, 2013.