THE IMPACT OF THE COMBINATION OF CITRATES AND ACETATES ON THE SHELF-LIFE OF BEEF PACKAGED IN A MODIFIED ATMOSPHERE

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Abstract: Fresh ground beef from the thigh area (Musculus Semimembranosus) was treated with the Bombal Fresh additive (containing a combination of citrates and acetates), with the ratio of 5g per 1kg of meat. After being treated the meat was vacuumed in a modified atmosphere with a combination of the O₂ and CO₂ gases with a ratio of 80:20% and was stored at a temperature of +2°C and +6°C for 8 days. Samples were taken and analyzed on the 1st, 3rd and 7th day. At the same time control tests were performed on fresh ground beef from the thigh area (Musculus Semimembranosus) that hadn’t been treated with Bombal Fresh. The results have demonstrated that the samples that were treated with Bombal Fresh and stored at a temperature of +2°C had a lower bacterial count than the samples stored at a temperature of +6°C and the control samples. The samples treated with Bombal Fresh and stored at a temperature of +2°C received higher organoleptic marks than the samples that were stored at +6°C and the control samples. For all the different sensory properties that were tested (color, discoloration and the intensity of foreign scents) the samples treated with Bombal Fresh and stored at a temperature of +2°C received higher marks than the samples that were stored at +6°C and the control samples.

Key words: citrate, acetate, modified atmosphere, thigh

Introduction

When producing meat products, meat producers and processors are faced with the task of finding and introducing new technologies for the prevention of the growth of microorganisms, for which key factors are surface contamination and temperature variation or the inability of keeping the cold chain from the start to the end of the handling process of meat and meat products. The challenge of the maintaining of the safety and control of the product is correlated with the way it’s
packaged, the packaging material, the conditions during producing, storing and
distribution, all with the purpose of optimization of the sensory properties and
microbiological parameters which are indicators of the safety level of the product
(Ercolini et al., 2006; Paul et al. 2007; Nuchas et al., 2008).Fresh ground beef is a
product which spoils easily and is sensitive to external factors: temperature,
conditions and time of storing, surface contamination and the way it has been
packaged (Sperber 2010). The deeper layers of tissue in healthy animals are
generally sterile (Petaja-Kaminen and Puollane 2007; Petaja et al. 2010; Talon
et al., 2004). When faced with unavoidable temperature variation during the
production of meat and meat products, additional steps are needed to insure that the
meat and meat products are safe for the consumers. All of these additional steps are
combined with meat curing or brining. In the last few years different combinations
of salts of organic acids (acetic, lactic, tartaric or citric) have been made that can be
applied to the meat during the curing of brining process, or directly (without curing
or brining). One such compound is the combination of acetate and citrate. Acetates
increase the acidity of the environment where they are applied and so obstruct the
growth of meat spoilage bacteria. Citrates penetrate the cells of microorganisms
and cause damage to the cell structure (Dragoev 2004). Afterwards the treated
meat is packaged under vacuum or in a modified atmosphere (MAP), which is used
as an effective way of prolonging the shelf-life and maintaining of the quality of
fresh and ground meat (Radetic et al., 2007; Koustomanis et al., 2008; Milijasević
et al., 2008; Ozlem et al., 2011). MAP is a type of packaging from which air is
completely removed and then the vacuum is filled with a gas or a mixture of gases.
The goal of this study is to examine the impact of the combination of citrates and
acetates on the shelf-life of beef packaged in a modified atmosphere.

Material and Method

As material we used fresh ground beef from the thigh area (Musculus
Semimembranosus). After the butchering and the primary processing, the meat was
left to cool for 24 hours at a temperature of +4°C, after which the thighs were
deboned and categorized. During the deboning process, the bones, tendons and
cartilage were removed from the thigh and the pieces of meat were shaped. The
beef categorized as class 1 was ground with a Wolf meat grinder with a 5mm hole
diameter strainer. Afterwards, the ground beef was portioned and placed into
vessels measuring 100mm:180mm:35mm (width: length: height) and vacuumed
with a machine that vacuums the meat in a modified atmosphere (MULTIVAC
R245), with a combination of inert gasses O₂:CO₂ (80:20). The portioned beef was
then separated into three groups. A mixture of citrates and acetates (trade name
Bombal Fresh, manufactured by Van Hees, Germany) with the ratio of 5g per 1kg
of meat was added to the first and second group. This additive contains E262-
sodium acetate, cooking salt, E331-sodium citrate and E351-silicon dioxide. The
third group wasn’t treated with Bombal Fresh and it served as a control group. All the ground beef samples were packaged in a modified atmosphere with a combination of inert gasses $O_2:CO_2$ (80:20). Finally, they were separated, labeled and stored for 8 days at a temperature of $+2^\circ C$ and $+6^\circ C$. Microbiological tests on the count of aerobic mesophilic bacteria as well as tests on the sensory properties were conducted on the 1st, 3rd and 7th day. The microbiological tests followed the ISO 4833:2008 method. The tests on the sensory properties were conducted according to the numeric descriptive scale (ISO 6658:2002) with grades from 1 to 5, shown on table 1.

### Table 1. Quantitative descriptive scale for the grading of the tested sensory properties

<table>
<thead>
<tr>
<th>Grade</th>
<th>Quality level</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Too acceptable</td>
</tr>
<tr>
<td>4</td>
<td>Very acceptable</td>
</tr>
<tr>
<td>3</td>
<td>Acceptable</td>
</tr>
<tr>
<td>2</td>
<td>Borderline acceptable</td>
</tr>
<tr>
<td>1</td>
<td>Unacceptable</td>
</tr>
</tbody>
</table>

The following sensory properties were graded: color, discoloration and intensity of foreign scents. The sensory properties of the samples were graded by a panel of 7 experts. The gathered results were mathematically statistically processed with the help of the Microsoft Excel 2003 and its standard add-in program Data Analysis Tool Pak.

### Results and discussion

The results of the microbiological tests are given in table 2.

### Table 2. Total aerobic mesophilic bacteria count ($\log_{10}$cfu/g) in the tested samples

<table>
<thead>
<tr>
<th>Days</th>
<th>Control samples</th>
<th>Treated samples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+2°C</td>
<td>+6°C</td>
</tr>
<tr>
<td>1st day</td>
<td>4,88</td>
<td>5,58</td>
</tr>
<tr>
<td>3rd day</td>
<td>4,52</td>
<td>6,85</td>
</tr>
<tr>
<td>7th day</td>
<td>4,58</td>
<td>6,98</td>
</tr>
</tbody>
</table>

We can see from the table that the untreated control samples stored at a temperature of $+2^\circ C$ and $+6^\circ C$ had the highest bacterial count. As early as on the third day of storage, the bacterial count in the untreated samples stored at a temperature of $+2^\circ C$ was determined to be $4,52 \log_{10}$cfu/g. In the untreated samples stored at a temperature of and $+6^\circ C$ it amounted to $6,85 \log_{10}$cfu/g.
samples aren’t fit for consumption. On the seventh day of storage, the treated samples that were stored at a temperature of +2°C had a total bacterial count of 4,41 log_{10} cfu/g, and in the treated samples that were stored at a temperature of +6°C it amounted to 4,98, log_{10} cfu/g. The bacterial count in the untreated samples that were stored at a temperature of +6°C crossed the safe limit of 6,0-6,17 on the 3rd and the seventh day of storage. The results of the sensory testing of the samples are given in table 3 and table 4.

Table 3. Grading of the sensory properties of the tested samples stored at +2°C

<table>
<thead>
<tr>
<th>Sensory properties</th>
<th>Days</th>
<th>Control samples</th>
<th>Control samples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st day</td>
<td>3rd day</td>
<td>7th day</td>
</tr>
<tr>
<td>Surface color</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5,00 ±0,0</td>
<td>4,90 ±0,28</td>
<td>4,82 ±0,38</td>
</tr>
<tr>
<td>Cross-section color</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5,00 ±0,0</td>
<td>4,90 ±0,30</td>
<td>4,88 ±0,38</td>
</tr>
<tr>
<td>Discoloration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5,00 ±0,0</td>
<td>4,88 ±0,25</td>
<td>4,84 ±0,25</td>
</tr>
<tr>
<td>Intensity of foreign scents</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5,00 ±0,0</td>
<td>4,28 ±0,52</td>
<td>3,23 ±0,52</td>
</tr>
</tbody>
</table>

Table 4. Grading of the sensory properties of the tested samples stored at +6°C

<table>
<thead>
<tr>
<th>Sensory properties</th>
<th>Days</th>
<th>Control samples</th>
<th>Treated samples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st day</td>
<td>3rd day</td>
<td>7th day</td>
</tr>
<tr>
<td>Surface color</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5,00 ±0,0</td>
<td>4,88 ±0,38</td>
<td>4,80 ±0,39</td>
</tr>
<tr>
<td>Cross-section color</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5,00 ±0,0</td>
<td>4,90 ±0,30</td>
<td>4,85 ±0,38</td>
</tr>
<tr>
<td>Discoloration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5,00 ±0,0</td>
<td>4,87 ±0,28</td>
<td>4,82 ±0,27</td>
</tr>
<tr>
<td>Foreign scent intensity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5,00 ±0,0</td>
<td>4,20 ±0,58</td>
<td>3,18 ±0,50</td>
</tr>
</tbody>
</table>

From the tables we can see that the treated samples that were stored at a temperature of +2°C and +6°C preserved their color the longest, both on the surface and also in the inner layers. The series of untreated samples stored a temperature of +2°C and +6°C performed slightly worse when compared to the treated samples stored at the same temperatures. When the samples were tested for discoloration, the highest marks were again received by the samples that were treated with Bombal Fresh and stored at a temperature of +2°C and +6°C, with the untreated
samples performing slightly worse. The samples treated with Bombal Fresh and stored at a temperature of +2°C and +6°C received higher marks when tested for the intensity of foreign scents when compared to the untreated samples stored at the same temperatures. By the 7th day, there was a discharge of exudates and an emergence of unacceptable scents in the samples that were stored at a temperature of +6°C. The impact of the higher storing temperature was manifested at the 7th day with the discharge of exudates and the emergence of unacceptable scents. The lowest marks for the sensory properties were given to the untreated samples that were stored at + 2°C and +6°C. The gathered results reflect those of the study by Jayasingh et al. (2002). The object of their study was ground veal packaged in a modified atmosphere with a high oxygen level. They determined that the color and the bacterial count was the same in the treated and the control samples (as is the case with the samples stored at a temperature of +2°C). However, the thiobarbituric acid value, which serves as an indicator of the oxidation level as well as the sensory acceptability of meat when packaged in a high oxygen level atmosphere, was much worse after the 6th and 10th day when compared to the control samples. Ercolini et al. (2006) determined that there was a slow growth of lactic acid bacteria in the samples of fresh beef which has been packaged in a modified atmosphere with a 60% O₂ to 40% CO₂ ratio. They came to the realization that ground beef samples in retail can keep the acceptable color without the emergence of undesirable scents for up to 5 days if they are stored at a temperature of +4°C. In the samples that were stored at a temperature of +25°C undesirable changes and microbial growth over the safe limits appeared after 12 hour storage. Ozlem et al., (2011) concluded that packaging ground beef in a modified atmosphere with a 70%O₂ to 30%CO₂ ratio was conductive to the growth of the lactic acid bacteria.

**Conclusion**

With the addition of a combination of citrates and acetates, there was a perceivable improvement of the microbiological environment and the organoleptic grades of the treated samples when compared to the control samples. When looking at the results of the microbiological tests, the treated samples stored at +2°C and +6°C demonstrated a reduction in the quantity of microorganisms when compared to the untreated samples stored at the same temperatures. The impact of higher temperature at the 7th day of storing was manifested by the discharge of exudates and the emergence of scents that are unacceptable for fresh meat. The gathered results from the research demonstrate that there is a clear impact of the compound composed of acetates and citrates accompanied by vacuuming with inert gasses on the prolongation of the shelf-life of ground beef. Further research should focus on determining on how citrates and acetates combine with other salts and the duration of storing.
Uticaj kombinacije citrata i acetata na održivost govedjeg mesa pakovanog u modifikovanoj atmosferi

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Rezime

Sveže govedje meso buta (Musculus Semimembranosus) tretirano je sa preparatom Bombal fresch (koji sadrži kombinaciju citrata i acetata) u količini od 5gr. na kilogram mesa. Nakon tretiranja mleveno meso je vakumirano u modifikovanoj atmosferi sa kombinacijom gasova O₂ i CO₂ 80% : 20 % i čuvano na temperaturama od 2 °C i 6 °C 8 dana. Uzorci su analizirani 1-og, 3-ćeg i 7 –og dana. Uradjene su i kontrolne probe svežeg govede mlevenog mesa od buta (Musculus Semimembranosus) bez dodavanja bombal fresa.

Rezultati su pokazali da su uzorci tretirani sa bombal fres čuvani na temperaturi od 2 °C imali su manji ukupni broj bakterija u poređenu sa uzorcima čuvanih na temperaturi od 6 °C i od kontrolnih uzoraka. Uzorci tretirani sa bombal fresom čuvani na temperaturi od 2 °C imali su bolje senzorne ocene od uzoraka čuvanih na temperaturi od 6 °C.

References


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developed modified atmosphere induced by the respiratory activity of meat microflora. Food Microbiology, 25

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