The effect of added lactates to quality of freshly marinated meat

H. Medić, M. Horvat, M. Heigl, S. Vidaček, N. Marušić, T. Janči

Summary
The effect of added potassium and sodium lactate to organoleptic characteristics and sustainability of marinated fresh meat was researched in this paper. Researches were conducted on marinated pork neck and shoulder. Bacteriological, physical-chemical analyses and organoleptic researches were also conducted. Added lactates influenced the pH value, total bacterial count and organoleptic characteristics of the product, but they did not influence the peroxide number and the content of fatty acids in samples during storage. The addition of lactates to products made of marinated meat extends their shelf life and maintains organoleptic characteristics of the product.

Keywords: lactate, marinated meat, organoleptic characteristics

Introduction
Marinades are a complex mixture of spices and ingredients which prolong the sustainability of a product (Björkroth, 2005). They create or enhance aroma, maintaining the level of moist in a treated product, and at the same time they contribute to the food economy (Hoogenkamp, 1999).

Traditionally, meat was marinated in wine vinegar (acetic acid) or in wine, which are still used to that purpose, but except for them some other ingredients are also used, like: soy sauce, citrus juice, whey, yogurt, etc.

In order to extend the shelf life, processes of injection and tumbling of solutions which most frequently contain organic acid salts (lactates, citrates) or phosphates, then salt in a desired ratio with a later addition of the mixture of spices during tumbling (McGee et al., 2003; Alvarado and Sams, 2004).

Meat can be marinated in two ways: by injecting a solution in muscle tissue or by meat tumbling. By injecting a marinade solution into the meat, it quickly and deeply penetrates the meat and it is equally distributed. The thinner meat parts, the quicker the process and it develops continuously. In tumbling, both meat and marinade solution are put into a machine where they are stirred under vacuum for certain period of time (20 – 30 minutes) until the meat absorbs it. Marinating must be performed at low temperatures in order to prevent the increase in the temperature of meat and subsequent conditions suitable for bacterial growth.

Marinated meat is packed in different ways into plastic dishes with a film, by vacuuming or modified atmosphere packaging, and end product is kept at low temperatures for 3 – 5 days.

Lactates added to the product in processing process can efficiently prohibit, i.e. slow the development of the unwanted microflora in meat and products. Lactate activity is based on a strong bacteriostatic effect through the ability of lactates to affect the decrease of water activity. The effect of lactates to prevention of microbial development in the product is explained by the so-called lactate effect. Lactate in a non-dissociated condition diffuses into microbial cells where it dissociates and causes an increase in acidity (Paul et al., 2007). Except for the bacteriostatic effect, lactates contribute to production profitability which results from their effect to decrease the shrinkage of the product, which appears during thermal treatment and storage (shrinkage decrease 1-3%). Lactates contribute to development of desirable organoleptic characteristics and they affect positively the development of color, texture, taste and odor of the product (Bloukas et al., 1997).

The usual share of lactates added to total product weight is 2-5%, which depends on the kind of product. Sustainability of the product

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can be increased by using lactates for 30 to 110%, depending on the used quantity and kind of the product. Researches have shown that the addition of 1-2% of Na-lactate to vacuum-packed fresh pork sausages extended their shelf life for at least two weeks. Lag phase (initial growth phase) of aerobic bacteria was prolonged and the growth of anaerobic bacteria of lactic acid which produce acid was prevented (Brewer et al., 1993). Šmidt et al., (2009) researched the effect of potassium and sodium lactate to minced beef, packed in a modified atmosphere at 2°C and 8°C. The beef meat was treated with 4% potassium lactate, 4% sodium lactate, and the combination of 2% potassium lactate and 2% sodium lactate. In comparison to untreated samples of beef meat, the improvement in microbiological and organoleptic grade of samples was visible with the addition of lactates in all combinations. Tan and Shelef (2002) were researching the effect of sodium lactate and lactates to chemical and microbiological changes in cooled and frozen minced meat. Treating the meat with 2% sodium lactate or potassium lactate and 1 or 2% NaCl extended the shelf life of minced pork stored at 2°C from 7 to 14 days.

The color of meat has a crucial role for a potential buyer or consumer. Even though a lactate has been described as a stabilizer of color in raw and cooked meat product, a biochemical mechanism by which a lactate improves the stability of color of muscles is not completely clear. Research results of Mancini and Ramanathan (2008) confirmed a positive influence of lactates to stability of meat color.

This paper researched the influence of potassium and sodium lactate to sustainability of marinated products of pork meat, organoleptic characteristics, shrinkage in thermal treatment and prevention of oxidative changes. The researches were conducted in meat industry Danicad.o.o., Podravkad.d.

<table>
<thead>
<tr>
<th>Chemical composition</th>
<th>Sample</th>
<th>Marinated pork neck</th>
<th>Marinated pork shoulder</th>
</tr>
</thead>
<tbody>
<tr>
<td>water content</td>
<td>1</td>
<td>68.30</td>
<td>72.56</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>68.89</td>
<td>71.12</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>67.86</td>
<td>72.22</td>
</tr>
<tr>
<td>fat content</td>
<td>1</td>
<td>4.30</td>
<td>2.54</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>7.21</td>
<td>2.64</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>5.99</td>
<td>1.75</td>
</tr>
<tr>
<td>NaCl %</td>
<td>1</td>
<td>2.09</td>
<td>2.00</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2.00</td>
<td>1.88</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>2.58</td>
<td>2.17</td>
</tr>
</tbody>
</table>

Table 1 Chemical composition of marinated pork neck and shoulder

sample 1- without lactate addition
sample 2- with potassium lactate
sample 3- with sodium lactate

Material and methods
Pork meat was obtained in industrial slaughter of meaty pigs, 110 kg...
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Pig carcasses were cooled up to +4°C. Shoulder meat without bones, skin and subcutaneous fatty tissue, as well as boneless pork neck were used for marinating. The meat of shoulder and neck was sliced manually to steaks.

As secondary raw materials for the production of the marinated product there were used:
- Marinade Braten und Grillgewürz (RAPS, Austria); table salt (Solana Pag); Purasal S – sodium lactate (PURAC, USA); Purasal PD4 – potassium lactate (PURAC, USA); Promi cut (sodium polyphosphate E450/E451); vegetable oil (Zvijezda, Zagreb); water-ice in 50:50 ratio.
- Marinade "Braten und Grillgewürz" contains spices (pepper, paprika, herbs), flavor enhancer; monosodium glutamate (E621), glucose (dextrose).
- Promi cut contains sodium diphosphate and triphosphate E450/451.
- Purasal S consists of natural sodium lactate.
- Purasal PD4 consists of L-potassium lactate and sodium diacetate.

Three groups of samples of pork shoulder and three groups of samples of pork neck were prepared in the aim of research, and they differed in the addition of means for extending the shelf life of products, which were added to meat samples in quantity of 3%.

Sample group A1 contains pork neck, marinated, without the addition of means for extending the shelf life.

Sample group A2 contains pork neck, marinated, with the addition of Purasal PD 4.

Sample group A3 contains pork neck, marinated, with the addition of Purasal S.

Sample group B1 contains pork shoulder, marinated, without the addition of means for extending the shelf life.

Sample group B2 contains pork shoulder, marinated, with the addition of Purasal PD 4.

Sample group B3 contains pork shoulder, marinated, with the addition of Purasal S.

Fresh boneless meat of shoulder and neck was used for sample preparation, 4°C.

Each sample group was weighed, and calculation of the brine was made. Meat samples were added 10% brine of 0-4°C.

Mixing of meat and marinade was performed manually. Samples were packed in styrofoam plates, closed by a stretch film and stored in a cold storage at +2°C.

pH value was determined by a digital pH meter “Testo 230” (Testo, Germany, 2004).

Determining water as the basic constituent in samples was performed by a standard ISO method.

### Table 3 Total aerobic mesophilic count in marinated meat samples during storage

<table>
<thead>
<tr>
<th>Samples</th>
<th>Days</th>
<th>cfu/g of sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>1</td>
<td>1.3x10⁵</td>
</tr>
<tr>
<td>A2</td>
<td>1</td>
<td>9.6x10⁴</td>
</tr>
<tr>
<td>A3</td>
<td>1</td>
<td>3.8x10⁴</td>
</tr>
<tr>
<td>B1</td>
<td>1</td>
<td>1.2x10⁴</td>
</tr>
<tr>
<td>B2</td>
<td>1</td>
<td>1.6x10⁴</td>
</tr>
<tr>
<td>B3</td>
<td>1</td>
<td>6.0x10³</td>
</tr>
</tbody>
</table>

A1 marinated pork neck A3 marinated pork neck with sodium lactate
A3 marinated pork neck with potassium lactate
B1 marinated pork shoulder B2 marinated pork shoulder with potassium lactate
B3 marinated pork shoulder with sodium lactate

![Figure 3 Free fatty acids content in marinated meat during storage](image_url)
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(The ISO 6886/1996). Fat was determined by the Soxlet method. Salt was determined by a standard titration method by Volhard (ISO 1841/1996). Peroxide number was determined by iodometric method according to ISO method (3960/1998).

The content of fatty acids in the fat of marinated products was determined by the gas chromatography of their methyl esters. Fat is extracted by the Weibull-Stoldt method (ISO, 763/1982), after which methyl esters were prepared by the standard method (ISO, 5508 and 5509/2000).

The analysis of fatty acids was conducted by using a Varian 3900 gas chromatograph (Varian Analytical Instruments, Walnut Creek, USA) equipped with a flame ionization detector with electronic flow control (DEFC) and split/splitless CP-1177 injector with electronic flow control (IEFC). Fatty acids are identified by the standard mixture expressed as % of total fatty acids (by the normalization method).

Total aerobic mesophilic bacterial count, Salmonella spp., Staphylococcus aureus, Escherichia coli, sulphite-reducing clostridia and Listeria monocytogenes were determined in microbiological researches. These researches were performed according to the Regulation on microbiological criteria for food (Anon., 2008) and Guidance on microbiological food criteria (Anon., 2011).

Sensory researches were conducted by the modified QDA method (the combination of scoring and QDA). The product is quantified in all its qualitative characteristics by the QDA method. A general impression of raw meat is evaluated, then surface appearance of raw meat, color of raw meat, odor of raw meat, structure of raw meat by touch, general impression of roasted meat, surface appearance of roasted meat, color of roasted meat, odor of roasted meat, taste of roasted meat, saltiness of roasted meat, structure of roasted meat, and after taste of roasted meat. Thermal treatment of meat was conducted in an oven at 200°C/45 min. Each sample was put into the oven on a separate aluminium foil with the addition of 3 spoons of oil to pork shoulder samples and 2 spoons of oil to pork neck samples.

Results and discussion

The results of certain chemical compounds’ analysis were presented in Table 1, and the results of measuring pH values during the process of storage were shown on Figures 1 and 2. Samples without the addition of lactates had a higher initial pH value than those with the addition of lactates, which is in accordance with the professional literature data (Brewer et al., 1995). pH values were
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Pork neck samples with the addition of lactates had higher pH values than the initial ones on the 14th day of storage, as well as higher pH value than the samples without the addition of lactates. Brewer et al. (1995) consider that sodium lactate decreases the fall in pH value by decreasing the growth of lactic acid bacteria, especially in vacuum packaged meat products. In comparison to the initial pH values, the changes in pH values on the 14th day of storage are lower in the samples of pork shoulder than in the samples of pork neck.

In control samples of pork neck and pork shoulder during storage there appears the growth in peroxide number from 0 (mmol O2/kg of fat) to 0.92 (mmol O2/kg of fat) at the most. Changes in peroxide number during storage did not differ significantly in the samples with or without lactates.

The share of free fatty acids (Figure 3) grows until the 7th day in the samples of pork neck, i.e. until the 11th day in the samples of pork shoulder, after which it decreases. The highest share of free fatty acids on the 14th day of storage was in the samples of pork shoulder without the addition of lactates. In the samples of pork neck on the 14th day of storage there weren’t noticed significant differences in the content of free fatty acids with or without the addition of lactates. Decomposition of triacylglycerol and phospholipids can cause the increase in the share of free fatty acids, whereas the decrease can be explained with peroxidation of free fatty acids (Püssa et al., 2009).

The percentage of saturated fatty acids in total fatty acids ranged from 37.62 to 46.57%, monounsaturated from 38.04 to 48.94% and polyunsaturated from 6.89 to 11.87%. During storage there appeared the growth in share of saturated fatty acids which caused the decrease in the share of unsaturated fatty acids, which is in accordance with the results of research by Xu et al. (2008).

Out of saturated fatty acids in total fatty acids, the highest values belonged to palmitic acid, then stearic, and the lowest belonged to myristic and heptadecanoic acid.

Out of unsaturated fatty acids in total fatty acids, the highest values belonged to oleic, then linoleic and the lowest belonged to palmitoleic acid.

Total aerobic mesophilic bacterial count grows in all samples of marinated product during storage (Table 3). It is visible that total bacterial count grows the most in samples without the addition of lactates, whereas the least growth of total bacterial count is in the samples with the addition of potassium lactate.

Bacteriostatic activity is possible because of the capability of lactates to influence the decrease of water activity in the product (Bloukas et al., 1997), and bacterial development intensity depends on it.

Samples of pork neck without the addition of lactates were microbiologically safe until the 7th day of storage, whereas the sample of pork shoulder without the addition of lactates was microbiologically safe on the 7th day of storage too.

Samples of marinated meat with the addition of sodium lactate and potassium lactate were microbiologically safe on the 11th day of storage, except for the sample of pork neck with the addition of sodium lactate whose total bacterial count was somewhat increased and was 1.4x10^6 cfu/g. Samples of pork shoulder with the addition of potassium lactate were microbiologically safe on the 14th day of storage. Considering the fact that these are the samples with Purasal PD4, which contains sodium diacetate along with potassium lactate, it is possible that the obtained results are a consequence of synergy of both compounds. By researching the influence of potassium and sodium lactate to beef meat, Šmidt et al. (2009) obtained the most desirable microbiological values on the samples with the addition of potassium lactate.
The addition of lactates during the production of marinated fresh meat is desirable because it extends the shelf life and it doesn't impair organoleptic characteristics along the way. The samples with the addition of lactates on the 11th day of storage had significantly better organoleptic characteristics than the samples without the addition of lactates, and the samples with the addition of sodium lactate were evaluated as the best. After 14 days of storage, all samples were of impaired organoleptic characteristics, with highest aberration in the samples without the addition of lactates, which were not suitable for consumption any more.

**References**

Anonymus (2008): Pravilnik o mikrobiološkim kriterijima za hranu (N. N. 74/08)

Anonymus (2011): Vodič za mikrobiološke kriterije za hranu Ministarstvo poljoprivrede, ribarstva i ruralnog razvoja


Bloukas, J. G., E. D. Paneras, G. C. Four-
Cegielska-Radziejewska, R., J. Pikul (2004): Sodium lactate addition on the quality and shelf life of refrigerated sliced poultry sausage packaged in air or nitrogen atmosphere. J. Food Protect. 67, 601-606

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