Determination of physicochemical parameters, microbiological counts and sensory attributes of cured pork loin

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ABSTRACT

The high sodium content is an attribute of dry salted meat products. These products are associated with craft techniques, lack of standardization and long times of salting in order to ensure microbiological stability. As a consequence of those procedures the concentration of sodium in the products is high. The diminish of sodium content in meat products is an approach to reduce the risk of high blood pressure in sensitive part of the population. The aim of the present study was to examine the effects of curing on pork loin testing different additives combinations and modifying the concentration of total sodium. Four boneless pork loins (\textit{longissimus dorsi}) were selected and the external fat (lard) was stripped off the muscle. Water activity (aw) and the initial pH of each muscle were measured. The percentage composition was determined from a pool consisting of equal amounts of each of them. Each muscle was divided in two parts (A and A', B and B', C and C', D and D'). The parts were grouped as follows: I) = A and D', II) = B and C', III) = C and B', IV) = D and A'. Each group was treated with different salts formulations. After the salting process, the following parameters were measured: pH, aw and sodium ion concentration. Texture profile analyses were performed and colour parameters were measured. Microbial counts were performed and a sensory evaluation was carried out to compare a commercial product with the two samples containing the highest and the lowest concentrations of sodium respectively. Sensory evaluation analysis showed a slight preference for the product made only with sodium salts. This product and the commercial product were preferred over the sample in which sodium chloride was partially replaced by potassium, calcium and magnesium chlorides. We conclude that the samples were physically and microbiologically stable and there were no significant differences amongst the different formulations.

Keywords: Sodium chloride; \textit{longissimus dorsi}; dry salted meat products.

INTRODUCTION

The high sodium content is an attribute of dry salted meat products. Craft manufacturing techniques and lack of standardization can be associated with these products as well as long salting times in order to ensure microbiological stability. High levels of sodium intake may be crucial for the development of hypertension and the age-related rise of blood pressure typically observed in modern society \cite{1}. On the other hand, if the sodium content of cured meat products is high the organoleptic quality is negatively modified \cite{2}. Since the main source of sodium in the diet is sodium chloride \cite{3}, it is important to change food formulations in order to diminish it. However, the reduction of this additive in cured meat products presents several risks related to the assurance of microbial stability and soft texture. The most commercialized dry salted meat products in Argentina are cured ham (pork leg), \textit{bondiola} (pork neck muscles) and to a lesser extent cured pork loin (\textit{longissimus dorsi}).

The aim of this study was to evaluate the effects of curing with different additives combinations (NaCl, CaCl\textsubscript{2}, MgCl\textsubscript{2}, KCl) on physicochemical parameters, microbiological counts and sensory attributes of cured pork loin.

MATERIALS & METHODS

Four boneless pork loins (\textit{longissimus dorsi}) were purchased from a local slaughterhouse and the external lard was stripped off the muscle. Water activity (aw) and initial pH of each muscle were measured. The proximate composition was determined from a pool consisting of equal amounts of each of them according to \cite{4}. Each muscle was divided in two parts (A and A', B and B', C and C', D and D'). The parts were grouped...
as follows: I) = A and D', II) = B and C', III) = C and B', IV) = D and A'. Each group was rub-salted onto
the surface with different mixtures of additives (per kg of raw product) as follows:
I) 10 g curing salt (90% NaCl; 9.85% sugar; 0.15g NaNO2) + 15 g NaCl
II) 10 g curing salt + 8 g NaCl
III) 10 g curing salt + 6 g KCl + 6 g CaCl2 + 3 g MgCl
IV) 10 g curing salt + 5 g KCl + 8 g CaCl2 + 2 g MgCl

Samples were marinated for 44 h at 5±1ºC. After that, they were washed with water and air-dried for 2 h and
then wrapped in pairs in cellophane semi-permeable casings and covered by an elastic mesh. Samples were
left at 5±1ºC for 120 h. Then, they were put in a dry-maturing oven for 72 h at 15-20 ºC and 70-75% relative
humidity. Then the same relative humidity conditions were maintained, nevertheless the temperature was
between 15-17ºC until the end of the process, when samples reached a total weight loss of approximately
35%.

After the salting process the following parameters were measured: pH, aw and sodium ion concentration as
indicated in [5]. Texture profile parameters were measured by a double compression using a TA-XT2i
(Stable Micro Systems, UK) equipment. Samples were compressed to 50% of their high, and 8 samples from
each treatment were evaluated. Chromatic parameters were measured using a Konica Minolta CR400
(CIELab: L*, a* y b*, D65 illuminant, 2°observer). Microbial counts of total coliforms, mesophilic aerobic
microorganisms, coagulase-positive Staphylococcus and E. coli were performed as indicate in [6] and
Salmonella spp. according to [7]. An affective testing was carried out by 24 non-trained panel members. The
panelists received three coded samples and were asked to rank the samples in order of preference from “liked
best” to “liked least”. The effect of treatments on colour and texture parameters was analysed by Kruskal-
Wallis one way ANOVA using SPSS 14.

RESULTS & DISCUSSION

Proximate composition and sodium content
The proximate composition of pork loin muscles was: moisture content, 73.92%; protein content, 21.97%;
total fat content, 2.94%; ash content, 1.16%.

pH measurement and water activity
The pH variation observed could not been attributable to the different formulations used for the conditions
applied during processing. However, it can be noted that these differences were related to the raw meat used
(Table 1). For example, samples C and C’ presented pH variations of 0.00 and 0.05, respectively, and these
two samples came from the same muscle (see Materials & Methods).
Regarding water activity, it was dependant on the sodium ion content. Thus, those samples which were salted
with the formulations containing higher quantities of sodium presented larger variations the aw. NaCl causes
a higher drop in aw than the other salts used [8]. The sodium content of samples from different treatments had
a direct relationship with the sodium incorporated during the salting process.
Table 1. Initial and final pH $a_w$ values and their variation and sodium content of cured pork loin treated with different additives

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Sample</th>
<th>Initial pH</th>
<th>Final pH</th>
<th>pH variation</th>
<th>Initial $a_w$</th>
<th>Final $a_w$</th>
<th>$a_w$ variation</th>
<th>Sodium Ion (mg/g product)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I A</td>
<td>5.83</td>
<td>5.48</td>
<td>0.35</td>
<td>0.991</td>
<td>0.942</td>
<td>0.49</td>
<td>867</td>
<td></td>
</tr>
<tr>
<td>I D’</td>
<td>6.00</td>
<td>5.80</td>
<td>0.20</td>
<td>0.991</td>
<td>0.935</td>
<td>0.56</td>
<td>1074</td>
<td></td>
</tr>
<tr>
<td>II B</td>
<td>6.01</td>
<td>5.54</td>
<td>0.47</td>
<td>0.991</td>
<td>0.943</td>
<td>0.48</td>
<td>813</td>
<td></td>
</tr>
<tr>
<td>II C’</td>
<td>5.89</td>
<td>5.84</td>
<td>0.05</td>
<td>0.992</td>
<td>0.949</td>
<td>0.43</td>
<td>718</td>
<td></td>
</tr>
<tr>
<td>III C</td>
<td>5.89</td>
<td>5.89</td>
<td>0.00</td>
<td>0.992</td>
<td>0.951</td>
<td>0.41</td>
<td>467</td>
<td></td>
</tr>
<tr>
<td>III B’</td>
<td>6.01</td>
<td>5.44</td>
<td>0.57</td>
<td>0.991</td>
<td>0.953</td>
<td>0.38</td>
<td>415</td>
<td></td>
</tr>
<tr>
<td>IV D</td>
<td>6.00</td>
<td>5.77</td>
<td>0.23</td>
<td>0.991</td>
<td>0.961</td>
<td>0.30</td>
<td>504</td>
<td></td>
</tr>
<tr>
<td>IV A’</td>
<td>5.83</td>
<td>5.41</td>
<td>0.42</td>
<td>0.991</td>
<td>0.948</td>
<td>0.43</td>
<td>548</td>
<td></td>
</tr>
</tbody>
</table>

Chromatic parameters

The colour of dry-cured loins is mainly due to the presence of heme pigments, primarily nitrosomyoglobin and metmyoglobin [9]. The chromatic parameters values of cured pork loins formulated with different salts are presented in Table 2. There were not observed significant differences (p>0.05) among treatments for any of the measured parameters ($L^*$, $a^*$, $b^*$).

Table 2. Chromatic parameters (CIELab) of cured pork loin treated with different additives.

<table>
<thead>
<tr>
<th>Formulation</th>
<th>$L^*$</th>
<th>$a^*$</th>
<th>$b^*$</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>37.68±2.36</td>
<td>9.24±1.43</td>
<td>5.77±1.36</td>
</tr>
<tr>
<td>II</td>
<td>34.51±1.70</td>
<td>9.03±0.97</td>
<td>4.88±0.49</td>
</tr>
<tr>
<td>III</td>
<td>35.86±0.51</td>
<td>9.18±0.76</td>
<td>4.88±0.16</td>
</tr>
<tr>
<td>IV</td>
<td>38.02±1.71</td>
<td>9.03±1.92</td>
<td>5.43±0.21</td>
</tr>
</tbody>
</table>

Texture profile analysis

Table 3 shows the mean values of texture parameters (hardness, springiness, cohesiveness, gumminess and chewiness). According to the ANOVA analysis, there were not significant differences among cured pork loins prepared with different salts formulations (p >0.05).

Cured pork loins elaborated with the formulation II and IV presented the lowest and the highest values respectively for all measured texture parameters (Table 3). Aliño et al. [3] informed that the relationship between hardness and water content is due to the fact that there is product shrinkage proportional to water loss during drying of meat products and also drying promotes a closer contact between proteins, forming new interactions, increasing hardness. In the present work, the higher values of texture parameters measured in samples elaborated with the formulations I and IV could not be associated with lower $a_w$ (Table 2). We associated these differences with the variability of raw meat properties, which could be more relevant than the formulation used.

Table 3. Texture profile analysis of cured pork loin treated with different additives

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Hardness (N)</th>
<th>Springiness</th>
<th>Cohesiveness</th>
<th>Gumminess</th>
<th>Chewiness</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>5.77±0.48</td>
<td>0.670±0.073</td>
<td>59.12±10.46</td>
<td>344.34±84.37</td>
<td>233.38±81.54</td>
</tr>
<tr>
<td>II</td>
<td>5.04±0.95</td>
<td>0.634±0.109</td>
<td>58.30±13.19</td>
<td>300.70±119.97</td>
<td>197.67±109.40</td>
</tr>
<tr>
<td>III</td>
<td>5.58±0.66</td>
<td>0.694±0.090</td>
<td>59.44±5.78</td>
<td>334.05±73.91</td>
<td>236.35±79.26</td>
</tr>
<tr>
<td>IV</td>
<td>5.98±0.18</td>
<td>0.729±0.035</td>
<td>59.87±8.13</td>
<td>360.10±57.40</td>
<td>269.90±44.60</td>
</tr>
</tbody>
</table>
Microbiological counts

Regarding microbiological counts (total coliforms, mesophilic aerobic microorganisms, *coagulase-positive Staphylococcus*, *E. coli* and *Salmonella* spp), there were only observed differences in cured loins treated with different salts in mesophilic aerobic microorganisms’ counts. Samples treated with the lowest amount of sodium showed the highest mesophilic aerobic microbial count (Table 4). The reduction of sodium content favored the growth of this type of microorganisms.

Table 4. Microbial counts of cured pork loins treated with different additives

<table>
<thead>
<tr>
<th>Sample</th>
<th>Total coliforms (ufc/g)</th>
<th>Mesophilic aerobic microorganisms (ufc/g)</th>
<th>Coagulase-positive Staphylococcus (ufc/g)</th>
<th><em>Escherichia coli</em></th>
<th><em>Salmonella spp</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>&lt;1.10⁷</td>
<td>1.10⁵</td>
<td>&lt;1.10²</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>II</td>
<td>&lt;1.10⁷</td>
<td>2.10⁵</td>
<td>&lt;1.10²</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>III</td>
<td>&lt;1.10⁷</td>
<td>&gt;5.10⁵</td>
<td>&lt;1.10²</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>IV</td>
<td>&lt;1.10⁷</td>
<td>&gt;5.10⁵</td>
<td>&lt;1.10²</td>
<td>ND</td>
<td>ND</td>
</tr>
</tbody>
</table>

Sensory evaluation

We carried out an affective test using D’ (formulation I), D (formulation IV) and a commercial product. The sodium ion concentrations were 1074 mg/g, 504 mg/g and 2094 mg/g respectively. (here it was the typing mistake it should say “2094” instead of “209”)

The affective test showed a slight preference for the product made only with sodium salts. This product and the commercial product were preferred over the sample in which sodium chloride was partially replaced by potassium, calcium and magnesium chlorides (Figure 1).

CONCLUSION

Cured pork loins obtained using different salts formulations were physically and microbiologically stable. The $a_w$ was lower in those samples with higher NaCl concentrations added. Texture profile analysis and colour parameters were similar among treatments. Reducing sodium content caused an increase in the mesophilic aerobic microorganisms’ counts.
ACKNOWLEDGMENTS

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REFERENCES

[6] ICMSF (Method 1. Pages 137,120,166,231,189)