SENSORY AND MICROBIOLOGICAL CHARACTERISTICS OF DRY-CURED RAW HAMS, SALTED WITH NaCl AND A MIXTURE OF NaCl AND KCl

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Abstract – Artisanal ham was produced in order to assess its microbiological and sensory quality. The raw materials for the ham were extracted from free-range raised pigs. 5 left legs were salted with sodium chloride (Treatment A) and 5 right legs were salted with a mixture of sodium chloride and potassium chloride (Treatment B). The legs underwent salting, post-salting, drying and curing processes. Once the complete production process was finished, a microbiological assessment was carried out in accordance with the Chilean Food Health Regulations.
Sensory quality was assessed through acceptability tests comparing both hams.

Keywords: quality, curing, raw material.

I. INTRODUCTION

Due to the current concern regarding eating habits, production of healthier meats and meats with fewer chemicals is being promoted. Because of this, reduction of salt content in products is recommended. The salt content in ham is between 5 to 8%, which makes this product not recommended for people suffering from hypertension [1] [2].

It has been established that an intake of more than 6 g of NaCl per day per person is linked with an increase in blood pressure. For this reason, limitation of sodium intake must be achieved by reducing daily common salt (NaCl) intake to less than 5 g per day per person (OMS/FAO [3] [4]).
Dry-cured raw ham, regardless of its origin, is a Ready-to-eat (RTE) food, which undergoes no pre-consumption treatment aiming to reduce potential abnormal or non-harmless bacterial load contained in it. This load may be caused by microbial deterioration, high pathogen load or high amounts of commensal flora, due to uncontrolled alterations during the production process [5].
In Chile, raw ham intake has grown during the past decade, which is reflected in an increase of domestic demand for the product [6].
The proposed hypothesis is that replacing sodium chloride (NaCl) with potassium chloride (KCl) in a 25% of the production process of raw pork ham does not present differences in sensory and microbiological characteristics.
The aim of the present paper was to compare sensory and microbiological characteristics of hams salted with 100% NaCl and a mixture of 75% NaCl and 25% KCl.

II. MATERIALS AND METHODS

Experimental Design
Treatment A: Leg salted with 100% NaCl (5 repetitions)
Treatment B: Leg salted with NaCl (75%) and KCl (25%) (5 repetitions)
The aforementioned legs were extracted from 5 pigs, where the left leg was processed using treatment A and the right leg of the same pig was processed with treatment B.

Production of artisanal raw ham
The pigs spent 35 days with their mother, 165 days in free-range grazing on cultivated land and 40 days on feed, where they ate grain, vitamin and mineral rations.
The initial average weight of the legs was 10.28±0.46 kg for treatment A and 10.28±0.69 kg for treatment A.
During production, the legs were salted during 1.5 days per kg of weight. Once the salting process had finished, the surface of the legs was washed

with water, dried and kept 95 days in cold chambers at 3°C. Lastly, in order to produce an adequate dehydration to achieve curing of the product, the legs were kept 280 days at ambient temperature.
The used processes are based on a Spanish technique used for the production of Jamón Serrano [7].

Microbiological analysis of the finished product
Sanitary quality of all hams was assessed under microbiological criteria in accordance with the Chilean Food Health Regulations (FHR). Presence of microorganisms *Staphylococcus aureus* and *Salmonella spp* was analyzed. Additionally, presence of *Listeria monocytogenes* was analyzed, by applying the criteria for ready-to-eat foods that do not promote growth of this microorganism.

Sensory assessment of the finished product
In order to assess sensory quality of the artisanal ham, a sensory panel was planned aiming to categorize acceptability of the product's inherent characteristics that may determine preference of the product once consumed [8] [9]. In this panel, we included aroma, color, taste, texture and global acceptability of samples.
The sampling for each ham was taken by slicing <2 mm thick by approximately 4 cm long by 3 cm wide pieces from the rear part (posterior portion) of the leg to be presented to a panel of tasters.

Statistical analysis
Variable assessment was carried out with descriptive statistics, paired sample analysis (treatment A and B) and independent sample analysis (experimental groups and mass-produced ham).

III. RESULTS AND DISCUSSION

Microbiological analysis
Table 1 shows the findings that indicate that the analyzed samples of artisanal ham showed negative growth in the used culture media for all mentioned microorganisms, thus complying with the microbiological parameters of the Chilean Food Health Regulations (FHR) according to the food group and sampling plan considered for each examined microorganism in all analyzed samples.

Table 1 Microorganisms included for the sampling of dry-cured raw meats in the Chilean FHR (Modified by the Chilean Ministry of Health) [10].

	Sampling Plan		Per gram limit				
Parameter	Risk Category	Sampling Classes	n	c	m	M	Results *
S. aureus ufc/g	5	3	5	2	10	102	<10
Salmonella en 25 g	10	2	5	0	0	---	0
L. monocytogenes ufc/g	10	2	5	0	100	---	0

*Results derived from the analysis of artisanal ham and mass-produced ham samples.
n: examined units
c: maximum number of samples that may contain the amount of microorganisms included in 'm' and 'M' in order for the product to be acceptable.
m: value of the microbiological parameter by which or under which the product does not present health risks.
M: value of the microbiological parameter over which the product presents health risks

Dry-curing raw ham is a successful conservation method as finding surviving pathogenic microorganisms after the curing process is infrequent. In his study, Martín *et al* (2008) [11] determined no presence of *Enterobacteriaceae* 12 months after production of Jamón Ibérico.

Sensory analysis
According to the frequency of the opinion on all attributes, the option good of the affective scale was the most frequent choice for all three samples of the study. The analysis used to contrast global acceptability results of the samples showed no significant differences (p=0.05) between all three products.

Table 2 Results of the sensory assessment in minimum, average and maximum value assigned by the panel of tasters.

	Minimum	Average	Maximum
Treatment A Ham			
Aroma	2	3	5
Color	2	4	5
Taste	1	4	5
Texture	1	4	5
Global Acceptability	2	4	5
Treatment B Ham			
Aroma	1	3,5	5
Color	2	4	5
Taste	2	4	5
Texture	2	4	5
Global Acceptability	2	4	5
Mass-produced ham			
Aroma	1	3	5
Color	2	4	5
Taste	2	3	5
Texture	1	4	4
Global Acceptability	2	3,5	5

Sample values: 1=very bad, 2=bad 3=regular, 4=good and 5=very good.

The panel of judges found no significant differences for the sensory assessment of all 5 assessed attributes. Table 2 shows that the average and maximum values positively match for treatments A and B.

This proves that it is possible to produce low sodium artisanal ham without metallic or bitter taste and which can compete mass-produced ham using 100% NaCl in the production process.

Additionally, sensory analysis clearly showed that the salting treatment with a mixture of NaCl and KCl did not present significant differences compared to other hams. This ham was even preferred by the panel of tasters regarding the attribute aroma. For this reason, this treatment can be successfully used to reduce sodium content in meat products without affecting the biochemical and sensory properties of the finished product.

IV. CONCLUSION

After 290 days, hams for both treatments comply with the microbiological criteria of the Chilean Food Health Regulations.

Replacing sodium chloride (NaCl) with potassium chloride (KCl) in 25% of the production of artisanal ham does not cause any difference in its sensory characteristics, and is additionally positively valued by the panel of tasters.

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