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EFFECT OF SODIUM CHLORIDE REDUCTION IN DRY PORK ON SENSORY QUALITY PARAMETERS AND INSTRUMENTALLY MEASURED COLOUR

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Abstract: The aim of this paper was to examine sensory properties and instrumentally measured colour of dry pork produced with less amount of sodium chloride. Trial was consisted from five batches, two control and three experimental. Pork from control group was cured with 6% nitrite curing salt (C1 group) and with 3% nitrite curing salt (C2 group), respectively. Pork from 1st experimental group was produced with 2% nitrite curing salt and 1% potassium chloride; pork from 2nd experimental group was produced with 1,5% nitrite curing salt and 1,5% potassium chloride; dry meat from 3rd experimental group was produced with 2% nitrite curing salt and 1% ammonium chloride. Curing process lasted for 7 days; smoking, drying and ripening for 21 days. In final products, water activity, moisture, protein and fat content was determined. Taste was best evaluated in dry pork from C2 group and worst in dry pork from 2nd group. The most expressed saltiness was determined in dry pork from the first control group (C1) that corresponded to the largest amount of added salt. Due to most expressed bitter taste, the evaluation for overall acceptability for dry meat from the second experimental group was the lowest. The evaluation for overall acceptability of dry pork from the first control group was significantly lower in the comparison with the evaluations for dry meat from the second control group (C2) and the first experimental group ($P \leq 0.05$).

Keywords: dry pork, sodium chloride reduction, saltiness, sensory evaluation

Introduction

Due to several negative health influences of excessive dietary sodium intake, it is necessary to reduce salt/sodium content in food. Excessive sodium

intake may cause hypertension that is one of the major risk for prevalence for cardio-vascular diseases and can lead to direct risk of heart attack (*Perry and Beevers, 1992*), hypertrophy of the left heart chamber (*Schmieder and Messerli, 2000*), sodium retention in extracellular fluid (*MacGregor and de Wardener, 1997*), greater possibility of infection by *Helicobacter pylori* and risk of gastric cancer (*Tsugane et al., 2004*), increase of urinary excretion of calcium and risk of forming of kidney calculi (*Cappuccio et al., 2000*), risk of reduced bone density (*Devine et al., 1995*), exacerbations of asthmatic seizures (*Mickleborough et al., 2005*) and increase of HOMA (homeostasis model assessment) insulin resistance in patients with essential hypertension (*Kuroda et al., 1999*).

Dietary sodium intake in many cases exceeds requirements recommended by World Health Organization. Sodium chloride (salt) content can be reduced in meat products in different ways but most common is partial replacement of sodium chloride with potassium chloride (*Terell, 1983; Guàrdia et al., 2006*). Besides potassium chloride, other chloride salts, mainly salts of magnesium and calcium and ascorbates can be used as replacers (*Ruusunen and Puolanne, 2005*). The main problem in this case is the occurrence of a bitter taste of product, because only sodium chloride has a clearly salty taste.

According to some literature data, the sodium content could be reduced in dry-cured pork loin down to 50% by using a mixture of potassium-chloride, magnesium-chloride and calcium-chloride without significantly affecting either the sensory and/or safety quality of the final product (*Aliño et al., 2009; Armenteros et al., 2009*). Sodium content could also be reduced in dry-cured ham by about 40% by similar mixture of chloride salts keeping similar physicochemical properties and low microbiological development (*Blesa et al. 2008; Aliño et al., 2010*).

Partial substitution of sodium-chloride with other chloride salts, *Blesa et al. (2008)* did not found out significant changes in microorganism count at different formulations of salts.

The aim of this paper was to examine the changes in sensory quality of dry pork caused by replacing of sodium chloride with potassium-chloride and ammonium chloride as well as instrumentally measured colour.

Material and Methods

Dry pork production

Five groups of dry meat were produced. Pork (*m. longissimus dorsi*) was cured with nitrite curing salt in the different amount and with the mixtures of sodium-chloride and other chloride salts according to the Table 1. After curing for 7 days, smoking and drying lasted for 21 days in the smoking house under the environmentalconditions.

Table 1. **Added salts and additive, g/kg**

Group	Sodium chloride, g/kg	Potassium chloride, g/kg	Ammonium chloride, g/kg	Sodium nitrite, mg/kg
C1	60.00	-	-	150
C2	30.00	-	-	75
1st	20.00	10.00	-	50
2nd	15.00	15.00	-	37.5
3rd	20.00	-	10.00	50

Instrumental colour determination

Colour of dry pork was evaluated using colorimeter (Minolta Chroma Meter RC-400). The CIE system color profile of lightness (L*), redness (a*) and yellowness (b*) was measured by reflectance colorimeter using illuminant source D65, 8-mm aperture and 10° observation angle (*CIE, 1976*).. The colorimeter was calibrated throughout the experiment using a standard white ceramic tile (Y = 87.2; x = 0.3173; y = 0.3348). Color was measured on three cut surface of dry pork at room temperature of 22°C, at samples temperature of 10°C and on each surface three measurements were carried out.

Sensory evaluation

Surface and cut colour, consistency, odour, taste and overall acceptability were assessed by a sensory panel. Numeric-descriptive scales with 5 points were used, whereas 5 is the best evaluation and 1 is the worst. Saltiness, hardness and bitter taste evaluated by 5 points system, whereas the 5 is the most expressed attribute and 1 is at least expressed attribute. Sensory evaluation was carried out by 6 trained assessors under the same conditions.

Data analysis

The results are presented as mean ± SD. Statistical differences between averages were significant at the levels $P \leq 0.05$ and $P \leq 0.01$ by Student's t-test.

Results and discussion

The results of the instrumental determination of cut surface colour of products are presented in Table 2.

Table 2. Results of the instrumental determination of cut surface colour of dry pork, CIE Lab system

Group	L* - lightness	a* - redness	b*- yellowness
C1	33.10 ± 3.24^{x}	8.10 ± 0.87^{x}	6.81±0.80
C2	34.44 ± 0.10^{x}	9.47 ± 0.80^{y}	8.47±1.42
1	37.97 ± 2.18^{y}	8.44 ± 1.10^{x}	8.68±0.58
2	34.52 ± 1.93^{x}	8.64 ± 0.40^{x}	8.80±1.31
3	32.44 ± 2.41^{x}	9.25 ± 0.37^{y}	7.50±1.71

^{x,y} Numbers with different superscript letters are significantly different ($P \leq 0.01$)

In this study, lightness of samples of the first experimental group (37.97±2.18) was significantly higher ($P \leq 0.01$) compared to lightness of dry meat from the first control group (33.10±3.24), from the second control group (34.44±0.10) and products from the second and third experimental group (34.52±1.93 and 32.44±2.41, respectively). Highly significant ($P \leq 0.01$) differences was determined between redness of dry meat from the first control group (8.10±0.87) and from the second control group (9.47±0.80) as well as samples of third experimental group (9.25±0.37). No significant differences ($p > 0.05$) were determined between yellowness for all examined group.

Results of sensory evaluation of dry pork are shown in tables 3, 4 and 5.

Regarding surface colour, cut colour and odour all groups recieved similar grades. The lowest grades for consistency received dry pork from the first control group (C1), significantly different from all other groups ($P \leq 0.05$). It can be explained with the largest amount of salt used for the production of dry pork production in this group. Regarding to smaller amount of salt used in dry meat from other groups, consistency was evaluated as better and more desirable. Sensory evaluation for consistency was in relation with the hardness which was significantly higher ($P \leq 0.01$) in dry pork from the first control group (C1) compare with dry meat from other groups.

The higher grade for taste received dry pork from the second control group (C2) and it was significantly different ($P \leq 0.05$) in the relation to dry meat from the first control group (C1) and from the first and third group of dry meat. The lowest grade received product from the second experimental group and it was statistically different from dry meat from other groups ($P \leq 0.01$). The lowest grade

for taste for dry pork from this group is the result of bitter taste originated from potassium chloride that highly evaluated in the comparison with products from other groups ($P \leq 0.01$). Bitternes was expressed in the highest level in dry pork from the first and from the third group and it was significantly different from the products from the first and the second control group ($P \leq 0.01$). It was result of reducing sodium chloride content and adding of potassium chloride and ammonium chloride.

The most expressed saltiness was determined in dry pork from the first control group (C1) that corresponded to the largest amount of added salt (6%). It was statistically different from grades for dry meat from other groups ($P \leq 0.01$). According to this finding, the evaluation for overall acceptability of dry pork from the first control group was significantly lower in the comparison with the evaluations for dry meat from the second control group (C2) and the first experimental group ($P \leq 0.05$). Due to most expressed bitter taste, the evaluation for overall acceptability for dry meat from the second experimental group was statistically different from others ($P \leq 0.01$).

Obtained results are not completely in accordance with findings of some other authors which reduced sodium chloride content replacing with other chloride salts. *Aliño et al. (2009)* and *Armenteros et al. (2009)* found out that sodium content can be reduced in dry cured pork loin down to 50% by using a mixture of potassium chloride, magnesium chloride and calcium-chloride without significant affecting either the sensory quality of the final products. Also *Aliño et al. (2010)* claim that sodium content can be reduced in dry-cured ham production about 40% by replacing with mixture of chloride salts keeping similar physicochemical properties.

Table 3. Sensory evaluation of surface and cut colour and consistency of dry pork, n = 6

Group	Surface colour	Cut colour	Consistency
C1	4.50±0.41	4.25±0.38	3.83 ± 0.37^{a}
C2	4.83±0.24	4.67±0.47	4.50 ± 0.41^{b}
1	4.83±0.24	4.92±0.19	4.50 ± 0.76^{b}
2	4.92±0.19	4.50±0.29	4.50 ± 0.41^{b}
3	4.92±0.19	4.42±0.45	4.50 ± 0.41^{b}

^{a,b} Numbers with different superscript letters are significantly different ($P \leq 0.05$)

Table 4. Sensory evaluation of odour, taste and overall acceptability of dry pork, n = 6

Group	Odour	Taste	Overall acceptability
C1	4.67±0.47	$4.25\pm0.48^{a,x}$	$4.08\pm0.19^{a,x}$
C2	4.58±0.45	$4.92\pm0.19^{b,x}$	$4.58\pm0.34^{b,x}$
1	4.67±0.47	$4.25\pm0.48^{a,x}$	$4.33\pm0.55^{b,x}$
2	4.33±0.47	$3.50\pm0.58^{b,y}$	3.50 ± 0.50^{y}
3	4.67±0.47	$4.25\pm0.48^{a,x}$	$4.17\pm0.90^{a,x}$

^{a,b} Numbers with different superscript letters are significantly different ($P \leq 0.05$)
^{x,y} Numbers with different superscript letters are significantly different ($P \leq 0.01$)

Table 5. Sensory evaluation of saltiness, hardness and bitter taste of dry pork, n = 6

Group	Saltiness	Hardness	Bitter taste
C1	4.67 ± 0.47^{x}	4.67 ± 0.47^{x}	1.33 ± 0.75^{x}
C2	3.67 ± 0.75^{y}	4.17 ± 0.90^{y}	1.50 ± 0.76^{x}
1	3.67 ± 0.69^{y}	4.17 ± 0.90^{y}	$2.33\pm1.37^{a,y,z}$
2	4.00 ± 0.58^{y}	4.25 ± 0.25^{y}	$3.50\pm0.76^{y,q}$
3	4.17 ± 0.69^{y}	3.92 ± 0.45^{y}	$2.83\pm0.37^{a,y}$

^{a,b} Numbers with different superscript letters are significantly different ($P \leq 0.05$)
^{x,y,z,q} Numbers with different superscript letters are significantly different ($P \leq 0.01$)

Conclusion

Moderate reduction of sodium-chloride by replacing with potassium-chloride and ammonium-chloride had no influence on sensory perception of colour of dry pork, as the surface colour, so as cut colour.

No differences were obtained in instrumentally measured yellowness that was similar in dry pork from all groups. Higher level of lightness determined in the product in which sodium-chloride was replaced with one third of potassium chloride, but redness was lower in the dry meat in which sodium-chloride replaced with one third and one half of potassium chloride.

Dry meat produced with the largest amount of sodium-chloride had higher grade of hardness that influenced lower grade for consistency.

Perception of saltiness was lower in products with smaller amount of added sodium-chloride and in dry meat with in which sodium-chloride was replaced with potassium-chloride and ammonium-chloride. Also these products

had better overall acceptability except dry meat in which sodium-chloride was replaced with potassium chloride in the amount of one half.

Uticaj smanjenja sadržaja natrijum-hlorida u suvom svinjskom mesu na parameter senzornog kvaliteta i instrumentalno merenu boju

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Rezime

Cilj ovog rada je bio da se ispitaju senzorske karakteristike i instrumentalno merena boja suvog svinjskog mesa proizvedenog sa smanjenim sadržajem natrijum-hlorida. Za potrebe eksperimenta, proizvedeno je pet grupa suvog mesa, od kojih su dve kontrolne. Meso iz prve kontrolne grupe salamureno je sa 6% nitritne soli za salamurenje (C1 grupa), a meso iz druge kontrolne grupe (C2) sa 3%. Meso iz prve ogledne grupe (1) proizvedeno je uz dodatak 2% nitritne soli za salamurenje i 1% kalijum-hlorida; meso iz druge ogledne grupe (2) uz dodatak 1,5% nitritne soli za salamurenje i 1,5% kalijum-hlorida, dok je meso iz treće ogledne grupe (3) proizvedeno sa 2% nitritne soli za salamurenje i 1% amonijum hlorida. Proces salamurenja trajao je sedam dana, a dimljenje, sušenje i zrenje 21 dan. U gotovim proizvodima određivani su aktivnost vode, sadržaj vlage, proteina i masti. Suvo svinjsko meso iz druge kontrolne grupe dobilo je najbolju ocenu za ukus, dok je najnižu dobilo meso iz druge ogledne grupe. Slanost je bila najizraženija u suvom mesu iz prve kontrolne grupe, što je u saglasnosti sa najvećom količinom upotrebljenog natrijum-hlorida. Usled najviše izraženog gorkog ukusa, ocena za ukupnu prihvatljivost suvog mesa iz druge ogledne grupe bila je najniža. Ocena za ukupnu prihvatljivost suvog mesa iz prve kontrolne grupe bila je statistički značajno niža u poređenju sa ocenama za suvo meso iz druge kontrolne grupe (C2) i prve ogledne grupe ($P \leq 0,05$).

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