Effect of iodized salt on the physico-chemical parameters and the sensory properties of dry-cured pork loin

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SUMMARY

In the meat industry sea salt is usually used for dry-cured meats, for few products iodized salt (or table salt), and for most pasteurized and sterilized meat products nitrite salt is used. The main ingredient of nitrite salt is non-iodized (evaporated) salt. The aim of present study was to examine if the use of sea salt or iodized sea salt instead of non-iodized (evaporated) salt affects the physico-chemical parameters and sensory characteristics of dry-cured meat. For this purpose, three experimental groups of dry-cured pork loins were prepared: group produced from fresh loins with not-iodized sea salt, group produced with iodized sea salt, and group produced with evaporated non-iodized salt, as control. Analyses of dry-cured pork loins included physicochemical analysis of basic composition, measuring lipid oxidation product (the thiobarbituric acid reactive substances and peroxide number), thermodynamic water activity, instrumental analysis of colour with chromometer Minolta CR-200b, as well as sensory analysis using the method of quantitative descriptive analysis. Introducing iodized sea salt (with declared 26 to 39 mg potassium iodide/kg and determined 15 mg of I/kg) showed that iodine cannot accelerate lipid and colour oxidation, but evaluation of sensory attributes indicated perceived rancid odour and flavour compared to control group (evaporated non-iodized salt) of dry-cured pork loins.

Keywords: *iodized sea salt, dry-cured pork loin, oxidation reactions, sensory properties*

INTRODUCTION

Iodine is an essential trace element. Sufficient supply of iodine is essential for human health; low and too high intake of iodine is associated with various thyroid diseases (Štimec et al., 2009). Štimec et al. (2009) noted that the measures to ensure an adequate supply of iodine in the human diet due to reducing salt intake and salt content in industrially processed foods have to be necessary examined, especially mandatory iodizationon of salt (today 25 mg of KI/kg of salt), the use of iodized salt in the food industry and/or mandatory iodination some other basic foodstuffs. In the meat industry for cured meats sea salt is usually used and for some products as 'pečenice' iodized or table salt is used. For the most of pasteurized and sterilized meat products nitrite salt is used. The main ingredient of nitrite salt is non-iodized (evaporated) salt because iodine ions could cause some interactions of nitrite with other components. The aim of this study was to obtain our own data on the compulsory use of iodized salt in the food industry, and does the use of iodized salt affects the physico-chemical parameters and sensory characteristics of dry-cured meat products. Iodide is a strong reducing agent and iodate powerful oxidant. Thus, it is theoretically possible that the reactions in foods which contain iodine and its salts, may cause colour reaction, to increase the extent of oxidation reactions and, consequently, reduced shelf life, reduce the bioavailability of the iodine and other nutritionally

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important substances (Winger et al., 2008).

It is assumed that the use of iodized salt instead of sea salt, which is normally used, has an effect on the colour; fat oxidation and the sensory quality of dry-cured meats products.

MATERIAL AND METHODS

Material and experimental design

A total of 24 fresh pork loins (rib and centre loin cuts) were included in this study (Figure 1).

The weights of the fresh loins imported from Hungary were between 2.57 and 2.85 kg, and directly measured pH values were 5.88 ± 0.08. The traditional technology for production of dry-cured pork loin includes the salting of the pork loins (internal temperature 1 °C to 2 °C) with sea salt (and sugar, garlic, pepper, additives E250, E252, E300, E301, E316; at temperature 1 to 6 °C for 7 to 12 days) (stage i), inserting the loins in natural casings followed by elastic mesh, post-salting (over 7 days at temperatures of 1 °C and 6 °C), and surface drying at temperature of 20 °C to 22 °C for at least 12 h (stage ii). This is followed by the drying/ripening at 10 °C to 16 °C, for a total of at least 12 weeks (stages iii and iv). Therefore, three experimental groups of dry-cured pork loins were included: SS (produced from fresh loins with not-iodized sea salt), ISS (produced from fresh loins with iodized sea salt), and C (produced from fresh loins with evaporated non-iodized salt, as control). In Italy, this kind of product is named 'lombo' or 'lonzino' as well as pork 'breasola' (Fig. 1). Recipe for the production of dry-cured pork loin is presented in Table 1. Information about components used was as follow: sea salt – non-iodized sea salt, producer CIS Italia and distributer Salinen Austria, iodized sea salt – producer DK sol d.o.o. (minimum content of NaCl 97%, 26 do 39 mg of potassium iodide/kg), evaporated non-iodized salt – GUSTOSAL Speise unjodiert, producer Salinen Austria AG and distributer VOBO d.o.o., DEXTRODYN 20.200 – dextrose monohydrate, minimum 99.5% in dry substance, producer AGRANA STARCH, distributer VOBO d.o.o., FIXAL P – 100% E252, producer FRUTAROM ITALY SRL, FIXAL S – 50% E250, 50% salt, producer FRUTAROM ITALY SRL.

Contents of iodine in different types of salt were informative determined by Neotron, analytical and technical services (Modena, Italy), and were expressed as I: evaporated non-iodized salt contains 0.033 ± 0.005 mg/kg, non-iodized sea salt 0.018 ± 0.005 mg/kg and iodized sea salt 15.00 ± 0.005 mg/kg. Method was marked as 05 (ICP- J_Br) 2012 and can be described as inductively coupled plasma mass spectrometry for iodine determination.

Data on the mass and total mass loss of pork loin during production stages were presented in table 2. Product was finished in approximately 110 days; total mass loss in all three experimental groups was between 45.2% and 46.7%.

Figure 1. *Dry-cured pork loin (left) and slices of dry-cured pork loin (right).*

Table 1. *Recipe for production of dry-cured pork loin.*

Component	Addition (g/100 g of raw meat)
Different type of salt	3.10
DEXTRODYN 20.200	0.30
FIXAL S	0.30
FIXAL P	0.02
Ascorbate, E301	0.10
Milled black pepper	0.05
Milled white pepper	0.05
Aroma of garlic	0.03

Table 2. *Data on the mass and total mass loss of dry-cured pork loins during production stages (N = 5).*

Production stage		Total mass of samples in each experimental group (kg)		
	Date	C	SS	ISS
(i) after salting	25.2.2017	20.8	21.2	20.4
(ii) filling	7.2.2017	20.4	20.6	19.8
(iii) end of drying	29.3.2017	17.1	17.1	16.5
(iv) end of ripening	16.6.2017	11.4	11.3	11.1
Total mass loss (%)	0.05	45.2	46.7	45.6

N – number of samples in each group; C – evaporated non-iodized salt, control; SS – non-iodized sea salt; ISS – iodized sea salt.

METHODS

Physico-chemical analysis

The moisture content of the samples was determined on 5 g minced samples that were dried in an oven at 105 °C (according to Association of Official Analytical Chemists (AOAC) 950.46; AOAC 1997). The total protein content (crude protein, N × 6.25) was determined by the Kjeldahl method (according to

AOAC 928.08; AOAC 1997), and the ash content was determined by mineralization of the samples at 550 °C (according to AOAC 920.153; AOAC 1997). The fat content was determined by the method described as AOAC Official Method 991.36. Fat (crude) in Meat and Meat Products (AOAC 1997), and the total lipids were extracted using hot treatment with petroleum ether as solvent. NaCl was determined by the Volhard method (according to AOAC 941.18; AOAC 1997). Data from the chemical analyses were expressed on a wet matter basis.

The pH value was measured directly using a combined glass-gel spear electrode (type 03, Testo pH electrode) with a thermometer (type T, Testo penetration temperature probe) connected to a pH meter (Testo 230, Testo). The pH meter was calibrated with pH 4 and pH 7 buffers, and re-calibrated after every 20 readings. The calibration and reading were carried out at 4 °C, to ± 0.01 pH unit. The pH was measured twice, in the middle of each sample of dry-cured pork loin.

A CR 200b colorimeter (Minolta; Illuminant C, 0° viewing angle) was used to determine the Comission Internationale de l'Eclairage (CIE; International Commission on Illumination) L* (lightness), a* (±, red to green) and b* (±, yellow to blue) values on the surface of 1 cm slice. A white ceramic tile with the specifications of Y = 93.8, x = 0.3134, y = 0.3208 was used to standardise the colorimeter. The CIE L*, a*, b* colour values were measured at four different locations on the surface of sample.

Lipid oxidation was monitored by measuring the thiobarbituric acid reactive substances (TBARs) and peroxide number. The TBARs were determined using a modified extraction method described by (Witte et al., 1970). The procedure was precisely described in the study of Penko et al. (2015). The TBARs were measured at 532 nm using a spectrophotometer (Shimadzu,UV-160 A) and were calculated as mg malondialdehyde/kg of product. The peroxide number was determined by the method described as AOAC Official Method 965.33 and defined as the amount of peroxide oxygen (mmol)/ kg of fat.

The thermodynamic water activity (aw value) was measured with the instrument CX-1 (Campbell Scientific, Great Britain). The homogenized samples were transferred to the vessel for measuring aw activity and heated to the working temperature of the instrument. The CX-1 was previously calibrated with saturated aqueous saline solutions with known thermodynamic activity.

Sensory evaluation: To evaluate the sensory qualities, a panel of six qualified and experienced panellists in the field of meat products was appointed and trained in accordance with international standard (ISO 8586: 2012), with the sensory properties of coded (blinded) samples tasted in a standard sensory laboratory. The same panel evaluated all of the samples. On the basis of a preliminary tasting, for the purpose of the evaluation, the panel applied the analytical-descriptive test (Golob, Jamnik, Bertoncelj, & Kropf, 2005). The analyse was performed by scoring the sensory attributes according to a non-structured scale from 1 to 7 points, where a higher score indicated greater expression of a given sensory attribute. The exceptions here were for the toughness and saltiness, which were evaluated by scoring on a structured scale of 1 to 4 to 7 (1-4-7). Here, a score of 4 points was considered optimal, with scores of 4.5 or higher indicating greater expression of a property, and those of 3.5 or lower indicating insufficient expression of a property. All the samples, slices of 1.5 mm thickness, were evaluated at 20–22 °C in the sensory panel room. About 50 mL of water and 20 g of unsalted bread were provided to assessors between successive loin samples (García-González et al., 2006; Marušić et al., 2014).

Sixteen traits related to sensory characteristics of dry-cured products were evaluated by the quantitative-descriptive analysis method. The traits were grouped into appearance (red colour, homogeneous red colour and marbling), odour (typical for dry-cured loin, rancid, mouldy and yeast odour), texture (toughness, juiciness, doughy, melting and fibrous texture), taste (saltiness) and flavour (cured loin flavour, rancid and pungent flavour).

Data analysis: Experimental data were evaluated statistically using the computer program SAS/STAT (SAS Software, 1999). Basic statistical parameters were calculated by the MEANS procedure. Data were tested for normal distribution and analysed by the GLM (General Linear Model) procedure. The statistical model included the main effect of treatment group (produced from fresh loin with not-iodized sea salt (SS), produced from fresh loin with iodized sea salt (ISS), and produced from fresh loin with evaporated non-iodized salt, as a control (C). Experiment was carried out on five repetitions of pork loins; effect was not significant and therefore excluded from model. Means for experimental groups were obtained using the Duncan procedure and were compared at the 5% probability level. Relations between sensory properties were assessed by Pearson correlation coefficients using the CORR procedure (SAS Software, 1999).

Table 3. *Basic chemical composition of dry-cured pork loins produced with different types of salt (N = 5).*

Parameter determined (g/100 g)	Salt added (average mean ± standard deviation)			SE	P_S
	C	SS	ISS		
Protein	39.33 ± 3.87	40.82 ± 3.89	39.90 ± 3.31	3.70	0.817
Fat	11.50 ± 3.17	9.66 ± 2.68	11.40 ± 1.88	2.63	0.485
Moisture	39.17 ± 2.50	39.32 ± 3.54	39.61 ± 2.93	3.02	0.972
Ash	9.07 ± 1.15	9.39 ± 1.28	8.57 ± 1.63	1.37	0.411
NaCl	4.78 ± 0.18	4.78 ± 0.24	4.54 ± 0.60	0.39	0.549

N – number of samples in each group; C – evaporated non-iodized salt, control; SS – non-iodized sea salt; ISS – iodized sea salt; SE – standard error of mean; P_S *– statistical probability of salt addition effect.*

RESULTS AND DISCUSSION

Basic chemical composition

On average, the protein content of dry pork loins was 40.02 ± 3.49 g/100 g, moisture 39.37 ± 2.80 g/100 g, fat 10.45 ± 2.59 g/100 g, ash 9.01 ± 1.36 g/100 g, and salt 4.70 ± 0.38 g/100 g with non-significant differences between groups with different types of salt added (Table 1). Data on composition in this study are in relatively good agreement with those of Aliño et al. (2009), who reported higher moisture (45 g/100 g), protein (45 g/100 g), and fat (14 g/100 g) content, as well a slightly lower salt content (4.1 g/100 g). In contrast, Stadnik and Dolatowski (2013) and Hernández et al. (1999) reported quite higher content of moisture at the end of ripening (53 and 58.5 g/100 g) for the same kind of product. Obviously, in different regions, different consumer habits dictate various moisture contents and texture properties of products of the same type.

The average pH value of dry pork loins was 6.24 ± 0.12; differences between all dry-cured loin groups were not significant (Table 4). With increasing time of ripening, Stadnik and Dolatowski (2013) observed a slight increase in pH value (from 5.8 to 6.0) at the end of 28-day ripening period for the dry-cured fermented pork loins.

According to the product specification, the end of ripening of dry-cured pork loins is bound to 45% mass loss. This is also the reason for a noticeable reduction in aw values in all dry-cured loin groups after 110 days of ripening (0.832-0.842; Table 4). Decrease in aw is mainly due to the water loss; it is also a consequence of microstructural and compositional modifications in the product during ripening, since the isoelectric point is reached. This characteristic reduces water-holding capacity and water is expelled from the sarcomere. This water is easily evaporated and thus reduces aw (Martín-Sánchez et al., 2011). As for moisture content also for aw value was found relatively different data, from 0.951 (14 days), 0.943 (21 days), 0.929 (28 days) (Stadnik and Dolatowski, 2013), and 0.915 for commercial product (Aliño et al., 2009).

The colour of dry-cured loins is mainly due to the presence of heme pigments, primarily nitrosomyoglobin and metmyoglobin (Campus et al., 2008). No significant differences were observed in the mean values of L* (lightness) and a* (redness) between the three groups of loins salted with three different types of salt (Table 4). The b* values in SS group were lower than those in C and ISS groups. On average, the L*, a*, and b* values in this study (31.06 ± 2.38, 8.09 ± 1.16, 5.19 ± 0.86) were lower for L* and b* values an higher for a* values than those observed by other authors (Aliño et al., 2009). This behaviour could be probably due to higher pH values of raw material.

Table 4. *Instrumentally measured pH and aw values, as well as colour L*, a* and b* values in dry-cured pork loins produced with different types of salt (N = 5).*

Value	Salt added (average mean ± standard deviation)			SE	P_S
	C	SS	ISS		
pH	6.18 ± 0.05	6.31 ± 0.05	6.21 ± 0.18	0.11	0.196
a_w	0.84 ± 0.01	0.83 ± 0.03	0.84 ± 0.02	0.02	0.522
L*	31.55 ± 2.15	30.19 ± 2.55	31.46 ± 2.33	2.35	0.219
a*	7.87 ± 0.85	7.86 ± 1.06	8.54 ± 1.43	1.14	0.193
b*	5.36 ± 0.99^a	4.72 ± 0.66b	5.48 ± 0.73^a	0.80	0.029

N – number of samples in each group; C – evaporated non-iodized salt, control; SS – non-iodized sea salt; ISS – iodized sea salt; SE – standard error of mean; P_S *– statistical probability of salt addition effect; means with a different superscript within rows* $^{(a,b)}$ *differ significantly (p ≤0.05; significance of differences between the types of added salt).*

The effect of processing on the lipid oxidation in dry-cured pork loins was evaluated using diverse oxidation parameters. Table 5 shows peroxide values (measures the amount of hydroperoxides formed as primary oxidation products at the initial stages of lipid oxidative reactions) and TBARs in dry-cured loins produced with different types of salt.

Peroxide value is the most common method for measuring hydroperoxides. Peroxides are of transitory nature and are primary products, intermediate in the formation of hydroxyl and carbonyl compounds (Kanner, 1994). There were no differences in peroxide value between experimental groups (Table 5), the levels samples were low probably due to the peroxide breakdown during long production period. However, malonaldehyde (MDA) is only one of the compounds that originate from the peroxide breakdown. MDA can also be degraded via oxidation and the lower TBAR value in dry-cured loins could be due to their degradation or further reactions amongst the aldehydes themselves or with free amino released from muscle proteins during the drying process (Antequera et al., 1992). This could be the reason for lower TBAR number in SS and ISS groups compared to control, with non-iodized salt. Guillén-Sans and Guzmán-Chozas (1998) ascertain that there are a number of interfering factors influencing the TBAR results in meat such as acids, esters, sugars, imides and amides, amino acids, and oxidized proteins.

Table 5. *Content of lipid oxidation products in dry-cured pork loins produced with different types of salt (N = 5).*

Value	Salt added (average mean ± standard deviation)			SE	P_S
	C	SS	ISS		
Peroxide	0.32 ± 0.12	0.21 ± 0.07	0.25 ± 0.26	0.18	0.559
TBAR	0.49 ± 0.04^{a}	0.44 ± 0.03^{b}	0.42 ± 0.06^{b}	0.01	0.008

N – number of samples in each group; C – evaporated not-iodized salt, control; SS – non-iodized sea salt; ISS – iodized sea salt; SE – standard error of mean; P_S – statistical probability of salt addition effect; means with a different superscript within rows (^{a,b}) differ significantly (p ≤0.05; significance of differences between the types of added salt).

On the basis of results of oxidation parameters it could be concluded that iodine cannot accelerate lipid oxidation, moreover it showed to be a potent inhibitor of lipid oxidation. Our results on lipid oxidation are in agreement with findings of Osinchak et al. (1992) and Hęś et al. (2012); their results showed no catalytic effect of iodine salts on lipid oxidation in fish muscle and stored processed meats.

Table 6 shows the professional panel data for the sensory analysis of the dry-cured pork loins, with the basic statistical parameters calculated regarding the sample, as means, standard deviation and standard error of the mean (SE). The sensory profile of dry-cured pork loins can be divided into the assessment of four profiles: appearance, odour, texture, taste and flavour. On average, the addition of different type of salts significantly (P < 0.05) affect appearance properties, odour (except yeast odour), toughness and fibrous texture, as well as cured loin and rancid flavour. The ISS group

Table 6. *Sensory attributes of dry-cured pork loins with different types of salt evaluated by descriptive analysis with professional panel (N = 5).*

Property (1-7)	Salt added (average mean ± standard deviation)			SE	PS
	C	SS	ISS		
Red colour	5.9 ± 0.3^{b}	6.1 ± 0.4^{b}	6.3 ± 0.3^{a}	0.3	0.004
Homogeneous red colour	5.8 ± 0.4^{b}	6.1 ± 0.3^{a}	6.0 ± 0.4^{a}	0.4	0.002
Marbling	1.7 ± 0.4^{b}	1.6 ± 0.2^{b}	2.1 ± 0.5^{a}	0.4	≤0.001
Odour typical for dry-cured loin	5.2 ± 0.6^{a}	5.0 ± 0.5^{a}	4.3 ± 1.1^{b}	0.4	≤0.001
Rancid odour	1.0 ± 0.0^{b}	1.0 ± 0.1^{b}	1.1 ± 0.2^{a}	0.1	0.007
Mouldy odour	1.1 ± 0.2^{c}	1.3 ± 0.4^{b}	1.6 ± 0.6^{a}	0.5	≤0.001
Yeast odour	1.0 ± 0.1	1.0 ± 0.1	1.1 ± 0.2	0.1	0.206
Toughness (1-4-7)	4.4 ± 0.4^{b}	4.6 ± 0.4^{a}	4.1 ± 0.4^{a}	0.4	≤0.001
Juiciness	5.4 ± 0.3	5.3 ± 0.3	5.4 ± 0.3	0.3	0.702
Doughy texture	3.6 ± 0.6	3.5 ± 0.5	3.7 ± 0.7	0.6	0.344
Melting texture	5.4 ± 0.4	5.4 ± 0.3	5.5 ± 0.6	0.4	0.265
Fibrous texture	2.0 ± 0.4a	2.0 ± 0.3^{a}	1.8 ± 0.3^{b}	0.3	0.027
Saltiness (1-4-7)	5.1 ± 0.4	5.0 ± 0.5	4.9 ± 0.8	0.6	0.386
Cured loin flavour	5.2 ± 0.3^{a}	5.1 ± 0.4^{a}	4.6 ± 0.7^{b}	0.5	≤0.001
Rancid flavour	1.0 ± 0.1^{b}	1.1 ± 0.2^{b}	1.4 ± 0.^{4a}	0.3	≤0.001
Pungent flavour	4.8 ± 0.2	4.8 ± 0.3	4.7 ± 0.5	0.4	0.693

N – number of samples in each group; C – evaporated non-iodized salt, control; SS – non-iodized sea salt; ISS – iodized sea salt; SE – standard error of mean; P_S – statistical probability of salt addition effect; means with a different superscript within rows (^{a,b}) differ significantly (p ≤0.05; significance of differences between the types of added salt).

showed more intense and even red colour on cross section, better marbling, typical odour for dry-cured loin estimated as hardly acceptable with more perceived rancidity and mouldy odour, better texture (toughness and fibrousness), lower saltiness and hardly acceptable flavour because of noticeable rancidity flavour compared to control group (evaporated non-iodized salt). On the contrary, there are a few differences in sensory profile between SS group and control group, samples with non-iodized sea salt showed significantly homogeneous colour on cross section, more expressed mouldy odour and worse toughness than samples with evaporated non-iodized salt (control).

Some of sensory properties were connected, e.g. marbling and toughness ($R = -0.529$, $P < 0.001$), and cannot be attributed to addition of iodized salt. It is also important to emphasize the relatively poor assessed odour (assessors cannot describe off odours), saltiness and flavour (in some cases rancid and for all samples intense pungent flavour) of the products. In general, this is probably due to the use of a relatively poor quality of raw material (e.g. pH values too high). The dry-cured meat samples were made under the real conditions of the meat industry, under the supervision of the company's technologists.

So far, we have had great difficulty in finding studies that reported about sensory attributes in dry-cured meat product or meat product produced with iodized/non-iodized salt, so it is not possible to compare results here with those from similar studies.

CONCLUSION

In this study, the effect of iodized salt used in the production of dry-cured meats was evaluated. Hypothesis was that iodine and its salts may increase the extent of oxidation reactions in final products. Introducing iodized sea salt (with declared 26 to 39 mg potassium iodide/kg and determined 15 mg of I/kg) showed no catalytic effect of iodine salts on lipid oxidation in dry-cured meats. Some changes in sensory properties were observed, but they cannot be attributed to addition of iodized salt. Many important factors, primarily related to the quality of the raw material, influenced the course of fermentation and drying of the meat product, and probably overestimated the effect of iodized salt on the oxidation processes. In the future, the experiment will be repeated in laboratory conditions, with substantially more precisely defined and guided conditions.

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REFERENCES

Aliño, M., R. Grau, F. Toldrá, E. Blesa, M.J. Pagán, J.M. Barat (2009): Influence of sodium replacement on physicochemical properties of dry-cured loin. Meat Science 83, 423-430.

AOAC 920.153 (1997): Official methods of analysis (16th ed.). Washington, Association of Official Analytical Chemists.

AOAC 928.08 (1997): Official methods of analysis (16th ed.). Washington, Association of Official Analytical Chemists.

AOAC 950.46 (1997): Official methods of analysis (16th ed.). Washington, Association of Official Analytical Chemists.

AOAC 965.33 (1990): Official methods of analysis (15th ed.). Arlington, Association of Official Analytical Chemists.

AOAC 991.36 (1997): Official methods of analysis (16th ed.). Washington, Association of Official Analytical Chemists.

Campus, M., M. Flores, A. Martínez, F. Toldrá (2008): Effect of high pressure treatment on color, microbial and chemical characteristics of dry cured loin. Meat Science 80, 1174-1181.

García-González, D.L., P. Roncales, I. Cilla, S. Del Río, J.P. Poma, R. Aparicio-Ruiz (2006): Interlaboratory evaluation of dry-cured hams (from France and Spain) by assessors from two different nationalities. Meat Science 73, 521-528.

Guillén-Sans, R., M. Guzman-Chozas (1998): The thiobarbituric acid (TBA) reaction in foods: A review. Critical Reviews in Food Science and Nutrition 38, 315-330.

Hernández, P., J.L. Navarro, F. Toldrá (1999): Lipolytic and oxidative changes in two Spanish pork loin products: dry-cured loin and pickled-cured loin. Meat Science 51, 123-128.

Hęś, M., K. Waszkowiak, K. Szymandera-Buszka (2012): The effect of iodine salts on lipid oxidation and changes in nutritive value of protein in stored processed meats. Meat Science 92, 139-143.

ISO 8586 (2012): Sensory analysis – General guidance for the selection, training and monitoring of assessors-Part 1: Selected assessors. International Organization for Standardization: 28 pp.

Kanner, J. (1994): Oxidative processes in meat and meat products: quality implications. Meat Science 36, 169-189.

Martín-Sánchez, A.M., C. Chaves-López, E. Sendra, E. Sayas, J. Fenández-López, J.Á. Pérez-Álvarez (2011): Lipolysis, proteolysis and sensory characteristics of a Spanish fermented dry cured meat product (salchichón) with oregano essential oil used as surface mold inhibitor. Meat Science 89, 35-44.

Marušić, N, S. Vidaček, T. Janči, T. Petrak, H. Medić (2014): Determination of volatile compounds and quality parameters of traditional Istrian dry-cured ham. Meat Science 96, 1409-1416.

Osinchak, J.E., H.O. Hultin, O.T. Zajicek, S.D. Kelleher, C.H. Huang (1992): Effect of NaCl on catalysis of lipid oxidation by the soluble fraction of fish muscle. Free Radical Biology and Medicine 12, 35-41.

Paliquot, C., A. Hautfenne (1992): Standard Methods for the Analysis of Oils, Fats and Derivatives. 7th ed. Oxford, Blackwell Scientific Publications: 73-211.

Penko, A., T. Polak, M. Lušnic Polak, T. Požrl, D. Kakovič, B. Žlender, L. Demšar (2015): Oxidative stability of n-3-enriched chicken patties under different package-atmosphere conditions. Food Chemisry 168, 372-382.

Stadnik, J., Z.J. Dolatowski (2013): Changes in selected parameters related to proteolysis during ageing of dry-cured pork loins inoculated with probiotics. Food Chemistry 139, 67-71.

Štimec, M., H. Kobe, K. Smole, P. Kotnik, A. Širca-Čampa, M. Zupančič, T. Battelino, C. Kržišnik, N. Fidler Mis (2009): Adequate iodine intake of Slovenian adolescents is primarily attributed to excessive salt intake. Nutrition Research 29, 888-896.

Winger, R.J., J. Konig, D.A. House (2008): Technological issues associated with iodine fortification of foods. Trends in Food Science & Technology 19, 94-101.

Witte, V.C., G.F. Krause, M.E. Bailey (1970): A new extraction method for determining 2-thiobarbituric acid values of pork and beef during storage. Journal of Food Science 35, 582-585.

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Utjecaj jodirane soli na fizikalno-kemijske parametare i senzorska svojstva sušenog svinjskog karea

SAŽETAK

Morska sol se u mesnoj industriji najčešće upotrebljava u pripremi suhomesnatih proizvoda, pri čemu se za pasterizaciju i sterilizaciju većine mesnih proizvoda upotrebljava nitritna sol, dok se jodirana (kuhinjska) sol upotrebljava za manji broj proizvoda. Glavni sastojak nitritne soli je nejodirana sol (dobivena isparavanjem). Cilj ovog istraživanja bio je ispitati utječe li uporaba morske ili jodirane morske soli umjesto nejodirane soli (dobivene isparavanjem) na fizikalno-kemijske parametre i senzorska svojstva suhomesnatih proizvoda. U tu smo svrhu uzorke sušenog svinjskog karea podijelili u tri pokusne skupine: skupina uzoraka od svježeg karea pripremljena uporabom nejodirane morske soli, skupina pripremljena uporabom jodirane morske soli i kontrolna skupina pripremljena uporabom nejodirane soli dobivene isparavanjem. Provedene analize sušenog svinjskog karea obuhvaćale su fizikalno-kemijsku analizu osnovnog sastava, mjerenje produkata lipidne oksidacije (reaktivni spojevi tiobarbiturne kiseline i peroksidni broj), određivanje termodinamičke aktivnosti vode, instrumentalnu analizu boje provedenu uporabom kromometra Minolta CR-200b i senzorsku analizu provedenu primjenom metoda kvantitativne deskriptivne analize. Iako je uvođenje jodirane morske soli (s označenom količinom kalijevog jodida po kg od 26 do 39 mg i njegovom utvrđenom količinom po l/kg od 15 mg) pokazalo da jod ne ubrzava oksidaciju lipida i boje, u senzorskom ocjenjivanju značajki je u usporedbi s kontrolnom skupinom (nejodirana sol dobivena isparavanjem) utvrđeno da jodirana sol uzrokuje neugodan miris i loš okus sušenog svinjskog karea.

Ključne riječi: *jodirana morska sol, sušeni svinjski kare, oksidacija, senzorska svojstva*

Auswirkung von Jodsalz auf die physikalisch-chemischen Parameter und sensorischen Eigenschaften von getrocknetem Schwienekarree

ZUSAMMENFASSUNG

Meersalz wird in der Fleischindustrie vorwiegend für die Zubereitung von haltbaren getrockneten Fleischerzeugnissen verwendet, wobei für die Pasteurisierung und Sterilisierung Pökelsalz verwendet wird, während jodhaltiges Speisesalz bei einem geringeren Anteil der Produkte zum Einsatz kommt. Der Hauptbestandteil von Pökelsalz ist nicht jodiertes Salz (das durch Verdampfung gewonnen wird). Ziel dieser Untersuchung war es zu prüfen, ob sich der Einsatz von Meersalz oder jodhaltigem Meersalz anstatt von nicht jodiertem Salz (das durch Verdampfung gewonnen wird) auf die physikalisch-chemischen Parameter und die sensorischen Eigenschaften von haltbaren getrockneten Fleischprodukten auswirkt. Zu diesem Zweck wurden die Proben des getrockneten Schweinekarrees in drei Gruppen eingeteilt: die erste Gruppe umfasste Proben von frischem Karree, das mit nicht jodiertem Meersalz zubereitet wurde, die zweite Gruppe wurde durch Verwendung von jodiertem Meersalz zubereitet und die Kontrollgruppe durch Verwendung von nicht jodiertem Salz, das durch Verdampfung gewonnen wurde. Die durchgeführten Analysen des getrockneten Schweinekarrees umfassten eine physikalisch-chemische Analyse der wichtigsten Inhaltsstoffe, die Messung der Produkte der Lipidoxidation (reaktive Verbindungen der Thiobarbitursäure und die Peroxidzahl), die Bestimmung der thermodynamischen Wasseraktivität, die instrumentelle Farbanalyse anhand des Chronometers Minolta CR-200b und die sensorische Analyse anhand *der Methode der quantitativen deskriptiven Analyse. Obwohl sich bei der Einführung von jodhaltigem Meersalz (mit einem ausgewiesenem Anteil von Kaliumjodid von 26 bis 39 mg pro kg und dem festgelegten Anteil von 15 mg pro l/kg) zeigte, dass Jod die Oxidation der Lipide und der Farbe nicht beschleunigt, wurde bei der sensorischen Bewertung der Eigenschaften im Vergleich zu der Kontrollgruppe (nicht jodiertes Salz, das durch Verdampfung gewonnen wurde) festgestellt, dass jodhaltiges Salz einen unangenehmen Geruch und ein schlechtes Aroma des getrockneten Schweinekarrees verursacht.*

Schlüsselwörter: *jodhaltiges Meersalz, getrocknetes Schweinekarree, Oxidation, sensorische Eigenschaften*

La influencia de la sal yodada sobre los parámetros físico-químicos y sobre las características sensoriales de la chuleta de cerdo curada

RESUMEN

*En la industria cárnica la sal marina está usada principalmente en la preparación de los productos crudo-curados, donde la sal de nitrito se usa para la pasteurización y la esterilización de la mayoría de los productos cárnicos, mientras la sal yodada (de la mesa) está utilizada para un menor número de productos. El ingrediente principal de la sal de nitrito es la sal sin yodo (obtenida por evaporación). El objetivo de esta investigación fue examinar si el uso de la sal marina o la sal yodada en vez de la sal sin yodo (obtenida por evaporación) influye sobre los parámetros físico-químicos y sobre las características sensoriales de los productos cárnicos crudo-curados. Con ese fin las muestras de la chuleta de cerdo curada fueron divididas en tres grupos experimentales: el grupo de las muestras de la chuleta fresca preparada con la sal marina sin yodo, el grupo de las muestras preparadas con la sal marina y el grupo de control con las muestras preparadas usando la sal sin yodo obtenida por evaporación. Los análisis de las chuletas de cerdo curadas incluían el análisis físico-químico de la composición básica, la medición de los productos de oxidación de lípidos (compuestos reactivos del ácido tiobarbitúrico y el valor de peróxido), la determinación de la actividad termodinámica del agua, el análisis de color instrumental con el uso del cronómetro Minolta CR-200b y el análisis sensorial hecho por el método del análisis descriptivo cuantitativo. Aunque la introducción de la sal de mar yodada (con la cantidad indicada de yoduro de potasio de 26 a 39 mg por kg y su cantidad determinada de 15 mg por l/kg) mostró que el yodo no acelera la oxidación de los lípidos ni del color, en la evaluación de las características sensoriales en comparación con el grupo de control (la sal sin yodo obtenida por evaporación) fue determinado que la sal yodada causa el olor y el sabor desagradables de la chuleta de cerdo curada.****Palabras claves:*** *sal de mar yodada, chuleta de cerdo curada, oxidación, características sensoriales*

L’impatto del sale iodato sui parametri chimico – fisici e sulle proprietà sensoriali del carré di maiale essiccato

RIASSUNTO

Nell’industria alimentare, il sale marino è spesso utilizzato nella preparazione dei prodotti essiccati a base di carne, laddove per la pastorizzazione e la sterilizzazione della maggior parte dei prodotti essiccati a base di carne si usano i nitriti, mentre il sale iodato (sale da cucina) si usa per un minor numero di questi prodotti. L’ingrediente principale dei nitriti è il sale non iodato (ottenuto mediante evaporazione). Questo studio ha cercato di stabilire se l’uso del sale marino o del sale marino iodato al posto del sale non iodato (ottenuto mediante evaporazione) incida o meno sui parametri chimico – fisici e sulle proprietà sensoriali dei prodotti essiccati a base di carne. A questo fine abbiamo suddiviso i campioni di carré di maiale essiccato in tre gruppi: nel gruppo di campioni di carré fresco preparato con sale marino non iodato, nel gruppo di campioni trattati con sale marino iodato e nel gruppo di controllo di prodotti trattati con sale non iodato ottenuto mediante l’evaporazione. Le analisi svolte sui campioni di carré di maiale essiccato hanno compreso l’analisi chimico – fisica della composizione di base, la misurazione dei prodotti dell’ossidazione lipidica (composti reattivi dell’acido tiobarbiturico e numero dei perossidi), la determinazione dell’attività termodinamica dell’acqua, l’analisi strumentale del colore svolta usando il colorimetro Minolta CR-200b e l’analisi sensoriale svolta mediante l’applicazione del metodo dell’analisi quantitativa descrittiva. Sebbene sia stato dimostrato che, a seguito dell’introduzione del sale marino iodato (con un tenore dichiarato di ioduro di potassio da 26 a 39 mg/kg e la sua quantità accertata per l/kg di 15 mg), lo iodio non accelera l’ossidazione dei lipidi e del colore, nella valutazione delle proprietà sensoriali è stato accertato che, rispetto al gruppo di controllo (sale non iodato ottenuto mediante evaporazione), il sale iodato incide sull’odore e sul sapore del carré di maiale essiccato, rendendoli sgradevoli.

Parole chiave: *sale marino iodato, carré di maiale essiccato, ossidazione, proprietà sensoriali*