

Effect of partial replacement of NaCl with KCl on physical and sensory traits of dry-cured loin

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Abstract

The aim of this study was to investigate the effect of partial replacement of NaCl with KCl on the physical and sensory properties of dry-cured loin. The dry-cured loins were prepared after three treatments, where treatment C served as a control without NaCl replacement, while in treatments F1 and F2, 25 and 37.5 % NaCl was replaced by KCl, respectively. A significant difference ($P < 0.05$) was found in the water activity of the dry-cured loins at all stages between treatments C and F2 and at most stages between treatments C and F1. The study revealed a significantly higher ($P < 0.05$) pH after salting in treatment F2 (5.79) compared to control treatment C (5.58), but no significant differences were found between treatments during the rest of production until the end of storage in vacuum. It was found that there were no significant differences in color values between treatments at all stages of production and storage in vacuum. Among the 17 descriptive sensory traits, significant differences were found only for color uniformity, salty taste and aromatic plant aroma intensity. In contrast, likeability sensory traits like texture and taste likeability, maturity impression, aroma richness and overall likeability were significantly better rated in the control treatment. Considering the adverse effects on likeability sensory traits, replacing NaCl with KCl does not seem to be sufficiently justified. Therefore, further studies are needed as taste improvement could also be achieved by mixing substitutes with a more favourable effect on flavor and other technological indicators, still resulting in lower sodium content.

Keywords: sodium reduction, dry-cured loin, sodium chloride, potassium chloride, sensory traits, physical properties

Introduction

As the demand for meat and meat products has increased, the range of products available to consumers has gradually developed. The development of a large number of products has led to the

use of more and more additives and to an increase in the quantities of additives added to meat products. The oldest, best known and most widely used additive in the meat industry is salt, i.e. sodi-

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um chloride (NaCl) due to numerous functional, technological and sensory effects that have been abundantly documented in the literature (Inguglia et al., 2017; Matthews and Strong, 2005; Petit et al., 2019; Taormina, 2010; Žlender, 2009). The beneficial effects of salt were more pronounced in the past before refrigeration was widely used in meat processing (Petit et al., 2019). Currently, there are countless actions at the level of states, organizations and associations that aim to reduce the salt content, more specifically the sodium content, in all foods. The reason is quite simple: increased sodium intake (mainly from salt) is associated with various health problems such as kidney disease, osteoporosis, stomach cancer, and an increase in blood pressure, which is the most pronounced and important cause of heart disease, heart failure, and strokes (He et al., 2019; Petit et al., 2019). Accordingly, the World Health Organization (WHO, 2012) and EFSA (European Food Safety Authority) NDA Panel et al. (2019) consider an intake of 2 g sodium and 5 g salt per day to be safe and adequate for the adult population in the EU. However, in most European countries the intake is 7 to 12 g of salt per day (European Commission, 2012), and the second most important source of salt is processed meat products, which account for about 10 to 20 % of the total salt intake (EFSA NDA Panel et al., 2019). The sodium content of dry-cured meat products is often higher than that of sausages or heat-treated meat products, and consumption of 100 g of dry-cured ham can constitute up to 160 % of the recommended daily intake (Kos et al., 2021).

In recent decades, several applicable strategies have been developed to reduce the sodium content of foods. These can be summarized as follows: direct salt reduction, complete or partial replacement of salt with low-sodium ingredients, modification of salt properties, use of flavor enhancers, and combination of previous methods with some innovative technologies such as ultrasound, high-pressure treatment, or pulsed electric fields (Inguglia et al., 2017; Pinton et al., 2021; Žlender, 2009). These strategies have found their commercial application, but there are also certain limitations such as changes in enzyme activity and progression of proteolysis and lipolysis, changes in taste and texture, reduced microbiological effect and shift in product acceptance (Inguglia et al., 2017; Lorenzo et al., 2015; Petiti et al., 2019; Ursachi et al., 2020; Taormina, 2010). A

meta-analysis on reduced-salt foods conducted by Jaenke et al. (2017) optimistically concludes that salt content in meat products can be reduced by up to 70 % through such strategies without significantly affecting consumer acceptance. Within the partial salt replacement strategy, KCl has been most used as it has similar properties to NaCl and potassium intake has not been associated with the development of hypertension and cardiovascular disease (Castro and Raij, 2013). A literature review by Vidal et al. (2020) suggested that replacement of NaCl with other chloride salts had no adverse effects on the microbial status of dry-cured meat products. On the other hand, the addition of KCl to dry-cured meat was associated with an increase in bitter taste at a 50 % replacement rate (Lorenzo et al., 2015), but there were also studies reporting an overall positive effect (Vidal et al., 2020). Most of these experiments focused on salting without curing salts. Therefore, the aim of this study was to determine the effect of partially replacing 25 and 37.5 % NaCl with KCl on physical and sensory traits in dry-cured loin production while adding 25 % curing nitrite salts in all treatments.

Material and Methods

Processing of dry-cured pork loins

Sixty samples of fresh pork loins with an average weight of $482.3 \text{ g} \pm 12.83 \text{ g}$ were obtained from a local slaughterhouse near Zagreb and randomly divided into three batches of 20 loins each. The loins from the first batch were cured with NaCl (75 %) and nitrite curing salt (25 %; 99.5 % NaCl, 0.5 % NaNO_2) and served as control (treatment C), while the other batches were cured in the same way, partially replacing NaCl with other salts. Thus, the second batch was cured with 50 % NaCl and 25 % KCl (treatment F1) and the third batch with 37.5 % NaCl and 37.5 % KCl (treatment F2). The loins in each batch were weighed and 3 % of the salt mixture was added along with 0.2 % ground black pepper (*Piper nigrum*), 0.1 % granulated dried garlic (*Allium sativum*) and 0.05 % ground bay leaf (*Laurus nobilis*). Salting was carried out at a temperature of 2 to 4 °C and a relative humidity (RH) of over 80 % for a total of 7 days. After salting, the loins were brushed, washed, and placed in a chamber for cold smoking at temperatures below 20 °C and RH between 70 and 85 % for two days. After smoking,

the loins were transferred to a room with a temperature of 7 to 12 °C and RH between 60 and 81 %, where a drying-ripening process took place for the next 25 days. Samples were taken after salting (7th day), at the end of drying (21st day) and after ripening (35th day). After ripening, the dry-cured loins were vacuum packed and stored at 4 °C for the next 130 days. At the end of the process (165th day in total), five dry-cured loins from each batch were used for sensory analysis. At each sampling point, a total of three randomly selected loin samples of each batch were analyzed.

Physical analysis

Water activity and pH measurements were determined in duplicates at each sampling time on loin samples prepared by chopping them to 0.5 x 0.5 x 0.5 cm cubes. Water activity was determined using a HygroPalm HP23- AW -A portable analyzer equipped with an HC2- AW probe (Rotronic AG, Bassersdorf, Switzerland). pH was measured on chopped samples homogenized with distilled water (1:1) using a HI98191 pH/ORP/ISE meter equipped with a HI72911B electrode (Hanna Instruments, USA). Color measurements were made in triplicate on perpendicular cut after 30 min of blooming by Minolta Chroma meter CR -410 (Konica Minolta, Japan) with D65 standard illumination and 50 mm aperture which outputs CIE L*a*b* values.

Sensory analysis

Sensory analysis was performed at the end of the study after storage of dry-cured loins in vacuum (165th day of production). A total of eleven trained panellists within the age range of 25–48 years participated with a gender ratio of 45.5 % (F): 54.5 % (M). Panellists had received general training to gain consensus on the traits and the use of the scale prior to the test according to the methodology proposed by ISO (ISO 8586:2012). Sensory analysis was performed in a separate room with controlled temperature, free from noise and odor, with normal white light and panellists were placed in private booths during the sensory evaluation. Samples were prepared by first removing the outer, drier layer of the dry-cured loins and cutting the inner portion into approximately 3 mm thick slices with a knife. The samples were then placed on white colored opaque paper plates and marked with three-digit codes. The modified quantitative descriptive analysis test was used (Kemp et al.,

2009), and each panellist received three samples in two helpings (two from each treatment), which were presented to the panellists in random order. Panellists were required to indicate the intensity/expression of the traits on a scale of 0 to 9 (where 0 indicated complete absence of intensity/expression, while 9 indicated the highest intensity/expression). Panellists were asked to take bread and water after tasting each sample to neutralize the palate between samples.

Statistical analysis

Statistical data analysis was performed with SAS Studio (SAS Institute Inc., USA; version 3.8, 2020) using the PROC GLM procedure to compare the results of water activity, pH, and color measurements, while the PROC MIXED procedure was used in the analysis of the modified quantitative descriptive analysis results with the panellist as a random effect. The Tukey post-hoc test was used to compare the treatments at the P = 0.05 significance level.

Results and Discussion

The change in water activity (aw) during the production of dry-cured loins is shown in Figure 1. Cured loins of treatment F2 had the highest water activity at all stages of production, while the dry-cured loins of treatment C had the lowest water activity. There was a statistically significant difference (P<0.05) in the water activity of the dry-cured loins at all stages between treatments C and F2 and between treatments C and F1, except after salting, where no significant difference was found. There was no significant difference in the water activity of the dry-cured loins of treatments F1 and F2, except on day 21.

In a comparable study by Aliño et al. (2009), where they replaced NaCl with KCl, similar results were found. The treatments with the highest KCl content in the salt mixtures (50 % and 70 %) also had the highest water activity at the end of production. According to the authors, the water activities of the treatments with 50 % and 70 % KCl at the end of production were 0.933 and 0.932, respectively, which are almost identical values comparable to the values of the F2 treatment from this study. Slightly different results were presented in a dry-cured ham study where salt was replaced by KCl, but no significant differences were found. The salt mixture in an experimental treatment consist-

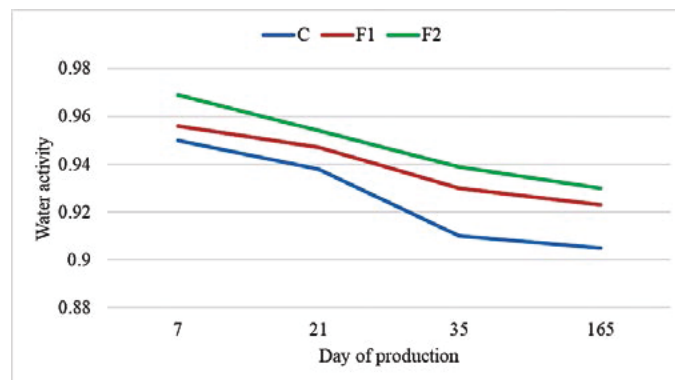


Figure 1 Demonstration of changes in water activity during dry-cured loin production per treatments C: 75 % NaCl + 25 % nitrite curing salt; F1: 50 % NaCl + 25 % KCl + 25 % nitrite curing salt; F2: 37.5 % NaCl + 37.5 % KCl + 25 % nitrite curing salt

ed of 50 % NaCl and 50 % KCl, and the water activity determined at the end of production was 0.933, while the control group (100 % NaCl) had a water activity of 0.935 (Aliño et al. 2010).

From the comparison of the studies on dry-cured loin meat, we can conclude that a higher KCl content in the salt mixtures leads to higher values of water activity at the end of production. The difference in water activity values between products with added KCl and products with NaCl is most likely the result of a higher molar mass of KCl (74.55 g/mol) compared to NaCl (58.44 g/mol). This means that when compounds of the same mass are added, as was the case in this study, there will be fewer KCl molecules added than NaCl, i.e. there will be fewer dissolved K^+ and Cl^- ions than Na^+ and Cl^- , and the water activity of the product will be higher when KCl is added.

The addition of salt and other additives

will decrease the water activity due to the increase in solutes in the meat, which is further increased by drying. Water activity affects the enzymatic activity and growth of microorganisms and therefore has a direct impact on the durability of the product. According to the legislation on meat products in Croatia (NN 62/2018), the water activity in dry-cured meat products must not exceed 0.930, which indicates that the dry-cured loins from F1 and F2 treatment are at the limit of what is allowed. This is particularly interesting considering that all the dry-cured loins took the same amount of time to produce. So it can be concluded that products with the addition of KCl need to be produced for a longer time in order to comply with regulatory requirements and to achieve satisfactory microbiological safety, which may have an unfavorable financial impact.

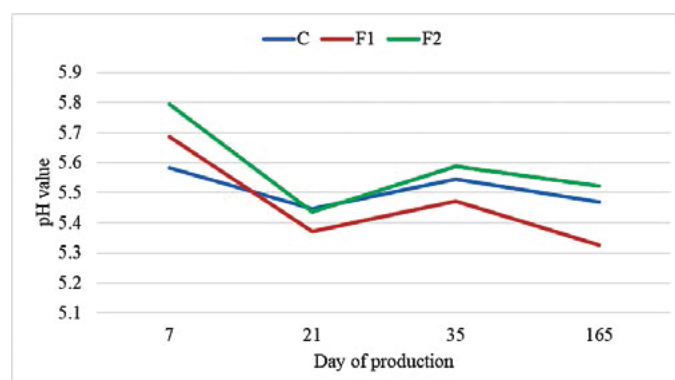


Figure 2 Demonstration of changes in pH values during dry-cured loin production per treatments C: 75 % NaCl + 25 % nitrite curing salt; F1: 50 % NaCl + 25 % KCl + 25 % nitrite curing salt; F2: 37.5 % NaCl + 37.5 % KCl + 25 % nitrite curing salt

Figure 2 shows that the pH changed during the production process of the dry-cured loins with the characteristics of a slight decrease and an increase during the maturation phase, and that the pH decreased slightly afterwards, during storage in vacuum. The study revealed a significantly higher ($P < 0.05$) pH after the salting period in treatment F2 (5.79), compared to control treatment C (5.58). There were no significant differences between treatments during the rest of production, but after vacuum storage a significantly lower ($P < 0.05$) pH was observed in treatment F1 (5.32) compared to treatments C (5.47) and F1 (5.52). The absence of significant differences in pH during dry-cured ham production is shown by Keeton (1984), where the replacement of NaCl by KCl had no effect on the changes in pH even at the 100 % level. Zhang et al. (2020) presented slightly different results in a study of dried pork shoulder in which NaCl was partially replaced by 15 % $MgCl_2$, 15 % $CaCl_2$ and 15 % $ZnCl_2$, where they found a more rapid decrease in pH in the experimental group. In the same study, no significant differences of pH were observed in the 15 % KCl treatment compared to the control treatment (100 % NaCl). Considering all, it can be concluded that the partial replacement of NaCl

with KCl had slight effect on pH change during production, mostly seen at early stages of production, and during storage in vacuum.

Tables 1 show the results indicating the change in the color values L^* , a^* and b^* in the production of dry-cured loin when KCl is used as a substitute for NaCl. It was found that there were no significant differences in color indicators between treatments during all stages of production and storage in vacuum. These results could be explained by the addition of 25 % nitrite salt of the total salt addition, as the color of cured and dried meat is mainly due to the influence of haem, nitrosylmyoglobin and metmyoglobin (Campus et al., 2008) and the resulting color is less susceptible to change during storage. Despite the absence of added nitrite, Aliño et al. (2009) and Aliño et al. (2010) found that there were no statistically significant differences in the color values L^* , a^* and b^* of dry-cured loin and ham in treatments where NaCl was replaced with different proportions of KCl, $CaCl_2$ and $MgCl_2$, which is similar to the results of this study. It can be concluded that the addition of KCl to salt mixtures up to 37.5 % had no effect on the color characteristics of dry-cured loin.

Table 1 Changes of color traits L^* , a^* and b^* during dry-cured loin production per treatments

Dan of production	Tretmant ¹		
	C	F1	F2
Color - L^*			
7	49.92 ± 0.33	48.99 ± 1.20	48.58 ± 0.59
21	49.65 ± 0.54	48.92 ± 0.32	49.20 ± 0.24
35	49.55 ± 1.67	47.37 ± 0.61	46.98 ± 0.88
165	45.36 ± 1.22	44.08 ± 0.61	46.09 ± 0.59
Color - a^*			
7	16.36 ± 0.35	17.16 ± 0.49	17.90 ± 0.51
21	17.85 ± 0.31	17.35 ± 0.31	16.99 ± 0.28
35	15.12 ± 1.10	15.48 ± 0.54	15.49 ± 1.03
165	17.10 ± 0.47	17.53 ± 0.27	18.56 ± 0.51
Color - b^*			
7	8.28 ± 0.23	8.45 ± 0.11	8.84 ± 0.15
21	8.53 ± 0.15	8.39 ± 0.12	8.05 ± 0.14
35	8.27 ± 0.70	7.78 ± 0.38	8.16 ± 0.58
165	8.73 ± 0.53	8.54 ± 0.17	9.38 ± 0.25

1C: 75 % NaCl + 25 % nitrite curing salt; F1: 50 % NaCl + 25 % KCl + 25 % nitrite curing salt; F2: 37.5 % NaCl + 37.5 % KCl + 25 % nitrite curing salt

Figure 3 shows the results of the sensory analysis of the dry-cured loins using the quantitative descriptive analysis. The study revealed few statistically significant differences between treatments, more specifically 3 of the 17 descriptive traits differed significantly. These characteristics were: color uniformity, salty taste, and intensity of aromatic plants. Thus, the dry-cured loins of the F2 treatment had significantly more expressed ($P < 0.05$) color uniformity than the C treatment, while the dry-cured loins of the F2 treatment were significantly less salty compared to the control treatment. In both cases, the dry-cured loins of the F1 treatment were not significantly different from the F2 treatment or the C control. A statistically significant difference in aroma intensity was also found but between the F1 and F2 treatments. In contrast, no significant differences were found in other descriptive visual, olfactory, gustatory, or textural characteristics. The results of this study partially confirm the findings presented previously. Thus, the dry-cured loins subjected to salt treatment with NaCl substitution up to 45 % did not show significant differences ($P < 0.05$) in color, texture, taste and general quality characteristics compared to the control samples and were even preferred by the evaluators at 99 % confidence level in terms of aroma property (Armenteros et al., 2009a). Similarly, Lorenzo et al., (2015) found that statistical analysis revealed no significant differences in color and odor intensity or hardness of dry-cured

tenderloins with the addition of 50 % KCl. However, the authors note that a significant difference was found in saltiness and bitterness, with the 50 % KCl treatment being less salty and more bitter. In the present study, no difference was observed in bitter taste, which could be due to lower KCl addition (37.5 %) than in the study by Lorenzo et al. (2015). Previous studies on other meat products indicate that replacement of NaCl with KCl at higher levels of 50 % has a significant effect on reducing salty taste and increasing bitter taste (Li et al. 2016; Wu et al., 2014). Accordingly, the results of Gou et al. (1996) correspond with that, concluding that bitter taste is perceived at substitution with KCl of 50 and 60 %, while the effects on texture or color are not perceived at these substitution levels.

The effects of NaCl replacement with KCl on the likeability sensory traits of the dry-cured loins are shown in the Figure 4. It was determined that texture and taste likeability, maturity impression, aroma richness and overall likeability were significantly better rated in control treatment than those of the experimental groups. For most of these traits, the significant differences were found even at 25 % KCl substitution. The only trait that was rated better in the F2 treatment than in the control group was cross-section likeability, which, although not significant, was consistent with the higher color uniformity of the F2 treatment. The main problem with substituting KCl for NaCl is the effect on taste and texture, as noted by Gou et al.

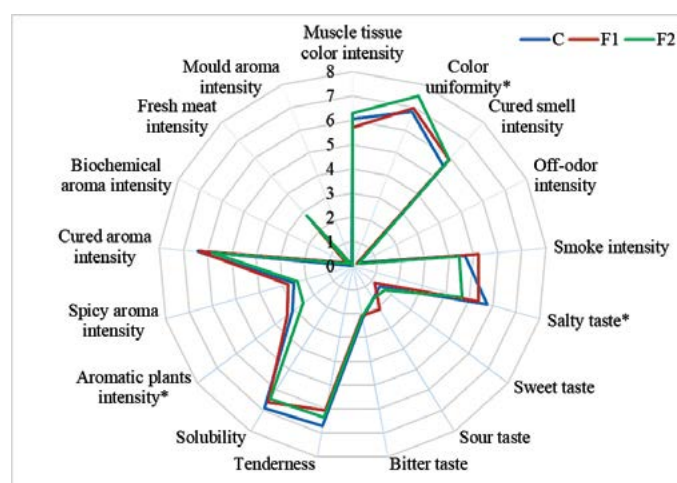


Figure 3 Sensory traits of dry-cured loins per treatments

: trait designated with an asterisk () means significant difference between treatments ($P < 0.05$)

C: 75 % NaCl + 25 % nitrite curing salt; F1: 50 % NaCl + 25 % KCl + 25 % nitrite curing salt; F2: 37.5 % NaCl + 37.5 % KCl + 25 % nitrite curing salt

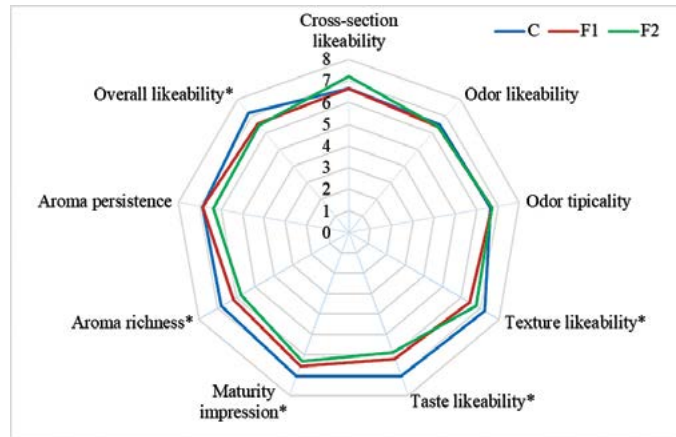


Figure 4. Likeability sensory traits of dry-cured loins per treatments

: trait designated with an asterisk () means significant difference between treatments ($P < 0.05$)

C: 75 % NaCl + 25 % nitrite curing salt; F1: 50 % NaCl + 25 % KCl + 25 % nitrite curing salt; F2: 37.5 % NaCl + 37.5 % KCl + 25 % nitrite curing salt

(1996), and this is confirmed in the present study. Interestingly, previous studies have shown that the proteolysis index, peptide nitrogen content and amino acid nitrogen levels did not change with the increased KCl content in salt mixtures up to 70 % (Wu et al., 2014). This suggests that partial replacement of NaCl with KCl has no effect on cathepsin activity (Wu et al., 2014). Similar findings were made for aminopeptidase activity (Armenteros et al., 2009a), as KCl exerts a very similar influence to NaCl. Thus, there are more underlying mechanisms that influence human sensory perception. The processing of salted meat products is characterized by the development of oxidative reactions in the lipid fraction, which could have a great influence on sensory properties. The general concept involves the generation of reactive species from fatty acids by initiators, chain reactions and the formation of final degradation products. Under controlled conditions, the progression of lipolysis and lipid oxidation leads to the development of characteristic properties of the salted products at the end of processing (Vidal et al., 2020). However, substitution of NaCl with KCl (up to 70 %) in the salt mixture did not result in significant differences in the free fatty acid profile of dry-cured sirloin (Armenteros et al., 2009b). However, another study showed a different result for salt mixtures containing CaCl_2 and MgCl_2 (Armenteros et al., 2009a). The release of SFA and MUFA during pork loin processing was reduced in dry-cured loin

containing 45 % NaCl, 25 % KCl, 20 % CaCl_2 and 10 % MgCl_2 compared to the control (100 % NaCl) and other treatments with other chloride salts. The authors argued that the observed differences in the composition of FFA could be attributed to the Mg_2^+ content. As for the evolution of lipid oxidation of pork loin during processing, Zhang et al. (2015) found remarkable differences between treatments at different stages of processing.

As stated by Vidal et al. (2020), the influence of the substitution of NaCl by chloride salts seems to cause minor changes in the evolution of lipolytic reactions of salted meat products, especially in products prepared with KCl. Reducing the amount of NaCl in the salt mixture does not necessarily slow down the progress of lipid oxidation. On the contrary, the use of other substitutes might prove more effective. Similarly, L-histidine and L-lysine caused a 53.79 % reduction in Na content of dry-cured loins, delayed lipid oxidation, and caused slightly higher lipolysis in loins, resulting in higher free fatty acid content and phospholipase activity at the end of maturation (Zhang et al., 2015). Other alternative substances such as organic acid salts (sodium lactate, potassium lactate, and sodium diacetate), small peptides (L-ornithyltaurine or L-ornithyl-b-alanine and the methyl and ethyl esters of glycine), flavor enhancers (monosodium glutamate, disodium inosinate, yeast extract, and hydrolyzed vegetable proteins) could also be used as NaCl substitutes in whole-meat products (Vidal

et al., 2020). Although the present study showed that the substitution of up to 37.5 % KCl has a unfavorable effect on sensory likeability traits further studies are needed as taste improvement could also be achieved by mixing substitutes with different flavor and other technological effects, still resulting in lower sodium content.

Conclusion

Based on the above, we can conclude that the effects of partial replacement of NaCl by KCl on water activity, pH and some descriptive sensory traits of dry-cured loins were determined. The effect on the color of dry-cured loins was not determined. It is worth mentioning that the positive side of such an exchange is mainly related to the lower sodium content. This may have a positive effect on health, which is becoming increasingly

important for consumers. On the other hand, the water activity in dry-cured loins in the experimental treatments is at the limit of what is allowed and may pose a risk to microbiological safety, which may have a negative financial impact on producers. Considering the adverse effects on likeability sensory traits, replacing NaCl with KCl does not seem to be sufficiently justified. Therefore, further research is needed to reduce the adverse effects of sodium reduction to an acceptable level. This can be achieved by blending different ingredients with positive effect on taste and other technological traits, but still resulting in a lower sodium content.

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Učinak djelomične zamjene NaCl s KCl na fizikalna i senzorska svojstva suhe pečenice

Sažetak

Cilj ovog istraživanja bio je istražiti učinak djelomične zamjene NaCl s KCl na fizikalna i senzorska svojstva suhih pečenica. Za potrebe istraživanja pripremljena su tri tretmana suhih pečenica, pri čemu je tretman C služio kao kontrola bez zamjene NaCl, dok je u tretmanima F1 i F2 zamijenjeno 25, odnosno 37,5 % NaCl s KCl. Utvrđena je značajna razlika ($P < 0,05$) u aktivitetu vode pečenica u svim fazama proizvodnje između tretmana C i F2 i u većini faza između tretmana C i F1. Istraživanjem je utvrđena značajno veća ($P < 0,05$) pH vrijednost nakon soljenja u tretmanu F2 (5,79) u usporedbi s kontrolnim tretmanom C (5,58), ali nisu pronađene značajne razlike između tretmana tijekom ostatka proizvodnje do kraja skladištenja u vakuumu. Utvrđeno je da nema značajnih razlika u vrijednostima boje između tretmana u svim fazama proizvodnje i skladištenja u vakuumu. Među 17 opisnih senzorskih svojstava, značajne razlike su pronađene samo u ujednačenosti boje, slanom okusu i intenzitetu arome aromatičnog bilja. Nasuprot tome, dopadljivost teksture i okusa, dojam zrelosti, bogatstvo arome i ukupna dopadljivost značajno su bolje ocijenjeni u kontrolnom tretmanu. Uvažavajući nepovoljan učinak na svojstva dopadljivosti,

čini se da zamjena NaCl s KCl nije dovoljno opravdana. Stoga su potrebna daljnja istraživanja o poboljšanju okusa što bi se moglo postići miješanjem nadomjestaka s povoljnijim učinkom na okus i druge tehnološke pokazatelje, uz postizanje nižeg sadržaja natrija u proizvodu.

Ključne riječi: smanjenje natrija, suha pečenica, NaCl, KCl, senzorska svojstva, fizikalna svojstva

Auswirkung des teilweisen Ersatzes von NaCl durch KCl auf die physikalischen und sensorischen Eigenschaften von getrocknetem Schweinekarree

Zusammenfassung

Ziel dieser Studie war es, die Auswirkung eines teilweisen Ersatzes von NaCl durch KCl auf die physikalischen und sensorischen Eigenschaften von getrocknetem Schweinekarree zu untersuchen. Die getrockneten Schweinekarreestücke wurden nach drei Behandlungen zubereitet, wobei die Behandlung C als Kontrolle ohne NaCl-Ersatz diente, während bei den Behandlungen F1 und F2 25 bzw. 37,5 % NaCl durch KCl ersetzt wurden. Es wurde ein signifikanter Unterschied ($P < 0,05$) in der Wasseraktivität der getrockneten Schweinekarreestücke in allen Stadien zwischen den Behandlungen C und F2 und in den meisten Stadien zwischen den Behandlungen C und F1 festgestellt. Die Studie ergab einen signifikant höheren ($P < 0,05$) pH-Wert nach dem Salzen bei der Behandlung F2 (5,79) im Vergleich zur Kontrollbehandlung C (5,58), aber es wurden keine signifikanten Unterschiede zwischen den Behandlungen während der restlichen Produktion bis zum Ende der Lagerung im Vakuum festgestellt. Es wurde festgestellt, dass es keine signifikanten Unterschiede in den Farbwerten zwischen den Behandlungen in allen Phasen der Produktion und der Lagerung im Vakuum gab. Von den 17 beschreibenden sensorischen Merkmalen wurden nur für die Farbgleichmäßigkeit, den salzigen Geschmack und die Intensität des aromatischen Pflanzenaromas signifikante Unterschiede festgestellt. Im Gegensatz dazu wurden die sensorischen Eigenschaften wie Textur und Geschmack, Reifeeindruck, Aromareichhaltigkeit und allgemeine Schmackhaftigkeit bei der Kontrollbehandlung signifikant besser bewertet. In Anbetracht der nachteiligen Auswirkungen auf die sensorischen Merkmale der Schmackhaftigkeit scheint der Ersatz von NaCl durch KCl nicht ausreichend gerechtfertigt zu sein. Daher sind weitere Studien erforderlich, da eine Geschmacksverbesserung auch durch die Mischung von Ersatzstoffen erreicht werden könnte, die sich günstiger auf den Geschmack und andere technologische Indikatoren auswirken und dennoch zu einem niedrigeren Natriumgehalt führen.

Schlüsselwörter: Natriumreduktion, getrocknetes Schweinekarree, Natriumchlorid, Kaliumchlorid, sensorische Merkmale, physikalische Eigenschaften

El efecto del reemplazo parcial del NaCl por el KCl sobre las propiedades físicas y sensoriales de la carne rostizada seca

Resumen

El objetivo de este estudio fue investigar el efecto del reemplazo parcial del NaCl por el KCl sobre las propiedades físicas y sensoriales de la carne rostizada seca. Para fines de la investigación, fueron preparados tres tratamientos de la carne rostizada seca, donde el tratamiento C sirvió como el control sin reemplazo del NaCl, mientras que en los tratamientos F1 y F2 fue reemplazado 25% y 37,5% del NaCl por el KCl. Fue encontrada una diferencia significativa ($P < 0,05$) en la actividad del agua en las carnes rostizadas

en todas las fases de la producción entre los tratamientos C y F2 y en la mayoría de las fases entre los tratamientos C y F1. El estudio encontró un valor de pH significativamente mayor ($P < 0,05$) después de la salazón en el tratamiento F2 (5,79), en comparación con el tratamiento control C (5,58), pero no fueron encontradas diferencias significativas entre los tratamientos durante el resto de la producción hasta el final del almacenamiento en vacío. Fue determinado que no hubo diferencias significativas en los valores de color entre los tratamientos en todas las etapas de la producción y del almacenamiento en vacío. Entre las 17 propiedades sensoriales descriptivas, fueron encontradas diferencias significativas solamente en la uniformidad del color, del sabor salado y en la intensidad del aroma de las hierbas aromáticas. En cambio, la atracción de la textura y del sabor, la impresión de madurez, la riqueza del aroma y la atracción general fueron calificadas significativamente mejor en el tratamiento control. Teniendo en cuenta el efecto negativo sobre las propiedades de atracción, la sustitución del NaCl por el KCl no parece suficientemente justificada. Por lo tanto, es necesario investigar más para mejorar el sabor, lo que podría lograrse mezclando los sustitutos con un efecto más favorable sobre el sabor y otros indicadores tecnológicos, al tiempo que se logra menor contenido de sodio en el producto.

Palabras claves: reducción de sodio, carne rostizada seca, NaCl, KCl, propiedades sensoriales, propiedades físicas

Effetto della parziale sostituzione dell'NaCl con il KCl sulle proprietà fisiche e sensoriali del lonzino

Riassunto

L'obiettivo di questa ricerca consisteva nell'esaminare l'effetto della parziale sostituzione dell'NaCl (cloruro di sodio) con il KCl (cloruro di potassio) sulle proprietà fisiche e sensoriali dei lonzini (lonza di maiale essiccata). Per le esigenze della ricerca sono stati predisposti tre trattamenti di essiccazione del lonzino, laddove il trattamento identificato con la lettera C è servito come trattamento di controllo senza la sostituzione dell'NaCl, mentre nei trattamenti F1 e F2 la sostituzione parziale dell'NaCl con il KCl è stata rispettivamente del 25 e del 37,5 %. La ricerca ha evidenziato una significativa differenza ($P < 0,05$) nell'attività dell'acqua del lonzino in tutte le fasi di produzione tra i trattamenti C e F2 e nella maggior parte delle fasi tra i trattamenti C e F1. La ricerca ha altresì evidenziato un valore pH significativamente maggiore ($P < 0,05$) dopo la salatura nel trattamento F2 (5,79) rispetto al trattamento di controllo C (5,58), ma non sono state evidenziate significative discrepanze tra i trattamenti nel corso delle altre fasi della produzione, fino allo stoccaggio in sottovuoto. Non sono state, poi, rilevate significative differenze nei valori cromatici tra trattamenti in tutte le fasi di produzione e di stoccaggio sottovuoto. Tra le 17 proprietà descrittive sensoriali, sono state accertate differenze soltanto nell'uniformità del colore, nella sapidità e nell'intensità dell'aroma delle erbe aromatiche. Di contro, la gradevolezza della texture (consistenza) e del gusto, l'impressione di stagionatura, la ricchezza d'aroma e la generale gradevolezza del prodotto hanno avuto una miglior valutazione nel trattamento di controllo. Considerato l'effetto sfavorevole sulla caratteristica della gradevolezza, sembra che la sostituzione dell'NaCl con il KCl non sia sufficientemente giustificata. Si rendono, pertanto, necessari ulteriori ricerche sul miglioramento gustativo che potrebbe ottenersi mescolando prodotti succedanei che abbiano un effetto favorevole sul gusto e sugli altri indicatori tecnologici e garantiscano un minor contenuto di sodio nel prodotto.

Parole chiave: riduzione del sodio, lonzino, NaCl, KCl, proprietà sensoriali, proprietà fisiche