Acceptance of liver pâté with reduced content of salt and sodium

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SUMMARY

The aim of this study was to produce liver pâté with reduced salt content that would have acceptable sensorial and textural properties. Sodium content in pâtés was reduced by excluding phosphate mixture (0.15%) and reducing the addition of sea or nitrite curing salts from 1.0% to 1.7%. The content of protein, fat, minerals and water was determined in control liver pâté, produced with 1.4% of curing salts. In all experimental groups of pâtés chemical parameters (content of sodium by ionoselective electrode and NaCl by the Volhard method), instrumentally measured fat and water exudation of the emulsions, colour and texture parameters were determined, along with evaluation of the sensory attributes (descriptive analysis). These pâtés with different types of salt, phosphate and levels of salt significantly differed in their chemical, instrumentally measured colour and texture parameters, and in sensory attributes (colour, saltiness, aroma, texture and overall acceptability). With respect to the colour of liver pâté, it is better to use curing salts, as pâtés have a pinker colour, while pâté with sea salt has a brighter colour. It is also reasonable to use the curing salts for better aroma intensity and overall acceptability. Pâtés with phosphate are less salty, they exclude less fat and water, and are more firm than those without phosphate, but too firm texture of pâté is not desirable. In pâtés salt can be reduced to 1.2% (curing salts) or 1.0% (sea salt), and consequently Na+ content decreased for 11%-27%, depending on type of salt and addition of phosphate mixture. Pâtés with 1.5% of curing salts and pâtés with 1.3%-1.5% of curing salts and phosphate most closely match (Linear discriminant analysis) the control group with the best overall acceptability (1.4% of curing salts).

Key words: *liver pâté, sea salt, curing salts, phosphates, reducing salt, colour, texture, sensory properties*

INTRODUCTION

There is an increasing tendency for a healthy and protective diet with less salt and sodium among consumers due to many negative effects on health (Purdy and Armstrong, 2007). The recommended salt intake (NaCl) is 5 to 6 g, and overdose represents a risk for hypertension or cardiovascular disease (Mackay and Menash, 2004; WHO, 2012a; WHOb, 2012; Inguglia et al., 2016). However, in the majority of the population, prejudice is still prevalent, that foods with less salt are not tasteful and do not decide for such a diet. Therefore, in several countries, plans for the gradual reduction of salt in the diet have been introduced, based on the cooperation of state authorities, the food industry and consumer groups, in order to achieve the ultimate goal of reducing salt in the diet, but only with a full understanding of the technological problems associated with salt reduction (Ministry of Health of the Republic of Slovenia, 2010). The functions of salt as a polyfunctional additive in meat processing are: sensory (taste, aroma, texture), technological (the binding of water and fat, solubilisation of myofibrillar proteins, increased cooking loss) and preserving (thermodynamic water activity) (Ruusunen and Puolanne, 2005; Kilcast and den Ridder,

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2007; Alahakoon et al., 2015). There are known approaches to reduce salt in meat products with minimal risk for changing the quality and stability of the product: reduction of added salt, use of salt substitutes, aroma enhancer and masking agents, optimising the physical form of salt and application of alternative processing techniques (Desmond, 2006; Weis et al., 2010; O'Flynn et al., 2014; Kentish and Feng, 2014; Alarcon-Rojo et al., 2015; Rodrigues et al., 2016).

The aim of this study was to produce liver pâté with reduced salt content, and acceptable sensorial and technological properties. Consequently, sodium content will be reduced by excluding phosphates and reducing the addition of sea or nitrite curing salts (sodium chloride and sodium nitrite) in the recipe.

Pâtés with less salt and without phosphate addition should be less stable and eliminate more water and fat. As a consequence, the degraded sensory quality, especially saltiness, aroma and texture of pâté has been expected. The intensity and stability of the pâté colour depended on the added salt type (better in the case of nitrite than sea salt) and their levels (better at higher levels). The addition of phosphate should mainly affect the texture of the liver pâté.

MATERIAL AND METHODS

Material and experimental design

Liver pâtés were produced with different types (sea and curing) and levels (1.0%-1.7%) of salt as well as with or without phosphates.

Control liver pâtés were made of 25% soft bacon, 23% pork fatty trim, 15% pig head meat with skin, 17% veal liver, 20% water, 0.2% seasoning mixture and curing salts (sodium chloride and sodium nitrite) in level of 1.4%. From the listed raw materials, curing and sea salts and phosphate mixture (further on phosphate), thirty one groups of liver pâtés were produced (Table 1); eight groups with curing salts (control sample with 1.4%), eight groups with sea salt (instead of curing salt), eight groups with curing salts and 0.15% of phosphate mixture and seven groups with sea salt and phosphate.

Additives and salts used in the experiment:

- curing salts (Vobo, Maribor, Slovenia): sodium chloride and E 250;
- sea salt (DK Sol, Koper, Slovenia);
- seasoning mixture Aroma mix Jetrna pašteta (Prava Aroma, Zrkovci, Slovenia): table salt (max. 73%), natural spices and extracts of spices;
- phosphate mixture Aroma Fos-K (Prava Aroma, Zrkovci, Slovenia): E 450, E 451.

Table 1. Type and levels of added salt (%) and experimental groups

Group	Salt addition (%)			
	curing salts	sea salt	curing salts + phosphate	sea salt + phosphate
1	1.00	1.00	1.00	1.00
2	1.10	1.10	1.10	-
3	1.20	1.20	1.20	1.20
4	1.30	1.30	1.30	1.30
5	1.40 (control)	1.40	1.40	1.40
6	1.50	1.50	1.50	1.50
7	1.60	1.60	1.60	1.60
8	1.70	1.70	1.70	1.70

- Samples were not analysed

During constant stirring, minced bacon, fatty trim, meat and skin from pig head together with sea/curing salts in defined level (Table 1) and water were heat treated until temperature of 70-80 °C. Cooked mass was transferred into Stephan UMC 5 electronic (Stephan Nahrungsmittel und Verfahrenstechnik, Germany) and homogenized for 2 min at 2400 × rpm. Then phosphate mixture (if needed) and seasoning mixture were added and homogenized at 2400 × rpm until temperature of 40 °C. At the end minced veal liver was added, the mixture was homogenized for 4 min at 3000 × rpm and then filled into plastic casings (diameter 35 mm). Prepared pâtés were pasteurized in a combi-appliance SelfCooking Center® 5 senses (Rational, Slovenia) according to the following temperature regime: 30 minutes at 40 °C, for the next 30 minutes at 60 °C and 30 minutes at 80 °C. Then the samples were cooled to room temperature and stored in a refrigerator at 4 °C until further analysis.

On cooled pâtés a series of chemical analyses were carried out, the level of NaCl and Na+ ions as well as basic chemical composition of the liver pâté were determined. The colour and texture parameters of pâtés were measured instrumentally; also the fat and water exudations (stability of the pâté batter) were determined. Sensory characteristics were assessed by a four-member panel of experienced examiners with an analytical descriptive test with a structured point scale in two sections. The data obtained in the experiment were arranged and statistically analysed.

Methods

Physico-chemical analysis: The moisture content of the control sample (with curing salts content of 1.4%) of liver pâté was determined on 5 g minced samples, 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 a solvent. NaCl was determined in all experimental groups of pâtés by the Volhard method (according to AOAC 935.47 Salt in meat; AOAC 1999). Data obtained were expressed on a wet matter basis.

Determination of the Na+ content: First, ionic strength adjustment (ISA) solution was prepared (0.01 M CH3CHOOLi). Approximately 5 g of sample was supplemented to 100 mL with the ISA solution, mixed on a magnetic stirrer for 20 minutes and suspension filtered. Filtrate (20.0 g) was diluted to 100 g with ISA solution. The potential of the diluted solution was measured with the Na+-ionoselective electrode calibrated with a calibration curve. In a solution with an appropriate ionic strength were four standard sodium chloride solutions with Na+ levels of 0.1, 1.0, 10.0 and 100 ppm prepared. The slope and section of the calibration curve were determined from the dependence of the voltage on the concentration log Na+.

Emulsion stability: Pâté batter from each group was analysed in duplicate for emulsion stability using the modified method of Kim et al. (2010). Approximately 30 g of the meat batter was weighed in glass tubes, covered and cooked in water bad at 80 ±1 °C for 30 min. Then, they were centrifuged at 1000 × g for 5 min. The separated fat was decanted and weighted, separated water was determined by measuring the height of the water in the glass tube and then calculated as a percentage of the original weight of batter.

Instrumental measurements of textural parameters were made by apparatus Texture Analyser TA.XT Plus (Stable Micro Systems Ltd., Surrey, UK) with a permissible load of 50 kg. On liver pâtés (without casings) the measuring force in compression was carried out, the ease with which a pâté can be applied in a thin, even layer (degree of spreadability or firmness) (Stable Micro Systems, 2018). The pâté was filled up to the top in plastic containers with a height of 3.5 cm and a diameter of 3.5 cm. As a contact attachment TTC spreadability rig HDP/SR (comprises of a male 90° cone probe and five precisely matched female perspex cone shaped product holders) was used; the samples were compressed to 2 cm of their original height at a crosshead speed of 3 mm/s. Firmness (spreadability) of the sample was recorded in four parallels.

For instrumental measurement of colour a CR-400 colorimeter (Konica Minolta Optics, Inc., Osaka, Japan; Illuminant C, 0° viewing angle) was used. The Comission Internationale de l'Eclairage (CIE; International Commission on Illumination) L* (lightness), a* (±, red to green) and b* (±, yellow to blue) values were determined on the surface of 1 cm thick 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 pâté slice.

Sensory analysis: To evaluate the sensory attributes of liver pâtés, a panel of four 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 et al., 2005). The analyses were performed by scoring the sensory attributes according to a 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 colour, perceived saltiness and texture, 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 samples (Marušić et al., 2014). Five attributes related to sensory characteristics of liver pâté were evaluated by the quantitative-descriptive analysis method. The attributes were grouped into appearance (colour), texture, taste (perceived saltiness), aroma and overall acceptability.

Data analysis: The data were tested for normal distributions using the UNIVARIATE procedure (SAS/STAT, Cary, USA). The differences according to type of salt and phosphate (SP) and according to different levels of added salt (L) were analysed through a general linear model procedure and Duncan test, with a 0.05% level of significance. Relations between sensory and texture properties were assessed by Pearson correlation coefficients using the CORR procedure. Multivariate analysis included principle component analysis (PCA) and linear discriminant analysis (LDA). Statistical analysis was performed using SPSS Statistics for Windows (version 20, IBM SPSS Inc., Chicago, IL, USA).

RESULTS AND DISCUSSION

Basic chemical composition of pâté

The content of protein, fat, minerals, water and salt was determined on control sample (with curing salts content of 1.4%) of liver pâté in six parallel observations. On average, 100 g of pâté contained water at 55.69 ±0.30 g, fat at 30.50 ±1.63 g, protein at 11.65 ±0.32 g, and salt at 1.40 ±0.09 g. On the basic of the standard deviations for each parameter obtained we could confirm the homogeneity of the samples. In the sea salt and curing salts water content was determined. Results obtained were used for calculation of the salt supplementation in a particular experimental group as the moisture content could have resulted in an inaccurate salt weight. The water content in the sea salt was 0.38% and in curing salts 0.04%.

Levels of NaCl and Na+ in pâtés

Pâtés with different levels of salt addition significantly (P ≤0.001) differed in content of NaCl and Na+ (Table 2); generally, levels of NaCl and Na+ in pâtés increased by increasing addition of salt. Content of NaCl in experimental groups with different type of salt/phosphate showed some significant differences at the following levels of added salt/phosphate – 1.1%, 1.2%, 1.4% and 1.6%. For the Na+ levels, significant differences were observed at the following levels of added salt/phosphate – 1.1%, 1.2%, 1.3%, 1.6% and 1.7%; generally the content of Na+ in the groups with phosphate addition was higher (P ≤0.05) compared to groups without added phosphates, with some exceptions.

The correlation analysis showed a positive, statistically very high significant and strong association between the levels of NaCl and Na+ in pâtés (R = 0.84, P <0.001). Moreover, levels of Na+ were higher in groups with phosphate at the same addition of salt compared to groups without phosphate addition (Figure 1).

Instrumentally measured colour values in liver pâtés

Instrumental measurement of colour shown that pâtés with sea salt were generally brighter (higher L* values), less red (lower a* values) and more yellow (higher b* values) compared to pâtés with curing salts (Table 3). Colour parameters of liver pâtés changed with different level of added salt, but definite trend of increasing/decreasing by increasing the addition of salt was not detected. The reason for this was probably in the heterogeneity of the samples, especially exudation of the jelly in pâtés with curing salts or the unevenness of the colour on the surface of the pâté is due to a rough emulsion.

Table 2. Effects of salt type, phosphate and salt addition on NaCl and Na+ content in liver pâtés (n = 62)

Parameter (mean ±sd)	Salt addition (%)	Type of salt and phosphate addition				
		curing salts	sea salt	curing salts + phosphate	sea salt + phosphate	P_{SP}
NaCl (%)	1.0	1.14 ±0.01^{eA}	1.01 ±0.02^{fC}	1.09 ±0.01^{dB}	1.12 ±0.00^{dAB}	**
	(%)	1.30 ±0.02^{d}	1.21 ±0.0^{2e}	1.18 ±0.05^{d}	-	Ns
	1.2	1.33 ±0.06^{d}	1.35 ±0.01^{d}	1.30 ±0.05^{c}	1.32 ±0.02^{c}	Ns
	1.3	1.40 ±0.01^{cAB}	1.42 ±0.03^{cdA}	1.33 ±0.04^{cB}	1.46 ±0.03^{bA}	*
	1.4	1.55 ±0.00^{b}	1.48 ±0.03^{c}	1.38 ±0.07^{c}	1.54 ±0.05^{b}	Ns
	1.5	1.60 ±0.02^{bAB}	1.67 ±0.04^{bA}	1.52 ±0.03^{bBC}	1.50 ±0.03^{bC}	*
	1.6	1.73 ±0.00^{a}	1.73 ±0.06^{b}	1.65 ±0.02^{a}	1.77 ±0.03^{a}	Ns
	1.7	1.70 ±0.00^{aB}	1.86 ±0.00^{aA}	1.67 ±0.07^{aB}	1.83 ±0.06^{aA}	*
	P_L	***	***	***	***	
Na^+ (g/kg)	1.0	4.32 ±0.10^{e}	4.62 ±0.15^{ef}	4.83 ±0.08^{e}	4.54 ±0.19^{d}	Ns
	1.1	5.15 ±0.02^{dA}	4.45 ±0.18^{fB}	5.43 ±0.20^{dA}	-	*
	1.2	4.86 ±0.20^{dB}	4.85 ±0.02^{eB}	5.85 ±0.14^{cA}	5.64 ±0.25^{cA}	**
	1.3	5.17 ±0.10^{dD}	5.52 ±0.13^{dC}	5.98 ±0.05^{cB}	6.53 ±0.10^{bA}	***
	1.4	5.83 ±0.18^{c}	5.87 ±0.23^{c}	6.37 ±0.04^{b}	6.28 ±0.34^{b}	Ns
	1.5	6.23 ±0.34^{c}	6.00 ±0.13^{bc}	6.39 ±0.10^{b}	6.74 ±0.01^{b}	Ns
	1.6	6.79 ±0.07^{bB}	6.28 ±0.02^{abC}	7.05 ±0.06^{aAB}	7.25 ±0.19^{aA}	**
	1.7	7.31 ±0.31^{aA}	6.42 ±0.18^{aB}	7.10 ±0.00^{aA}	7.38 ±0.05^{aA}	*
	P_L	***	***	***	***	

*n – number of observations; P_L – statistical probability of salt type and addition of phosphate effect; P_L – statistical probability of addition of salt effect; *** P ≤0.001 very highly statistically significant; ** P ≤0.01 highly statistically significant; * P ≤0.05 statistically significant; Ns – P >0.05 statistically not significant; means with different superscript letters ($^{a-f}$) within column differ significantly (P ≤0.05; significance of differences between levels of added salt); means with different superscript letters ($^{A-C}$) within raw differ significantly (P ≤0.05; significance of differences between salt type and addition of phosphate).*

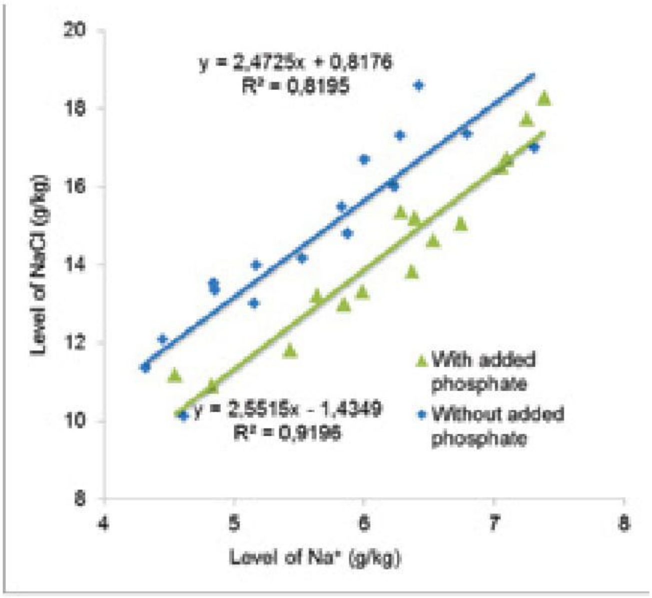


Figure 1. The relationship between NaCl and Na+ levels in the liver pâtés

Instrumentally measured firmness of liver pâtés

The firmness of the control pâté with curing salts and phosphates (at levels between 1.0% and 1.6%) was significantly higher (P <0.05) compared to other experimental groups (Table 4); this group required the maximum force to spread the sample. In average, pâtés with phosphate were more solid (firm) than those without phosphate addition (sea salt: 1.6 N, curing salts: 4.9 N).

Fat and water exudation in liver pâtés

In pâtés groups with addition of sea salt (excluding the addition of 1.1% salt) was observed significantly higher fat exudation than in the groups with added phosphate, but also slightly higher than in groups with curing salts, with or without phosphate. As a rule, the elimination of fat was significantly higher in groups without phosphate addition, regardless of the salt type (Table 4). The type of salt/phosphate did not affected (P >0.05) the water exudation, exception was salt addition between 1.0% and 1.2%, where the maximum amount of water was excreted in the control group (with curing salts and phosphate).

Sensory estimated properties of liver pâtés

Pâtés with different type and level of salt added differed significantly (P ≤0.001) in most of the sensory properties (Table 5).

On average, the colour of the pâtés with curing salts was more intense pink (higher values) com-

Table 3. Effects of salt type, phosphate and salt addition on NaCl and Na+ content in liver pâtés (n = 62)

Value (mean ±sd)	Salt addition (%)	Type of salt and phosphate addition				
		curing salts	sea salt	curing salts + phosphate	sea salt + phosphate	P_{SP}
*L**	1.0	72.4 ±0.2^{aB}	74.2 ±0.2^{aA}	70.1 ±0.6d^{eC}	72.8 ±0.6^{bB}	**
	1.1	72.6 ±0.2^{aA}	72.8 ±0.1^{cA}	71.6 ±0.8^{bB}	-	*
	1.2	72.2 ±0.2^{aB}	73.4 ±0.3^{bA}	72.6 ±0.3^{aB}	72.5 ±0.2^{bB}	***
	1.3	72.7 ±0.4^{aB}	72.9 ±0.2^{cB}	70.3 ±0.1^{cdC}	73.8 ±0.6^{aA}	***
	1.4	71.6 ±0.2^{bB}	74.3 ±0.1^{aA}	71.0 ±1.0^{bcB}	74.1 ±0.3^{aA}	***
	1.5	70.8 ±0.2^{cB}	72.2 ±0.4^{dA}	71.0 ±0.4^{bcB}	72.4 ±0.4^{bA}	***
	1.6	70.9 ±0.8^{cB}	73.3 ±0.2^{bA}	69.4 ±0.1^{eC}	70.2 ±0.4^{cB}	***
	1.7	71.3 ±0.3^{bcB}	72.7 ±0.2^{cA}	72.5 ±0.6^{aA}	68.9 ±0.4^{dC}	***
	P_L	***	***	***	***	
*a**	1.0	6.4 ±0.1f^{B}	6.3 ±0.3^{aB}	8.5 ±0.3^{abA}	6.3 ±0.2aB	***
	1.1	6.9 ±0.1^{eB}	5.6 ±0.0^{bC}	8.6 ±0.5^{aA}	-	***
	1.2	8.3 ±0.1^{bcA}	4.7 ±0.2^{fD}	7.8 ±0.1^{cdB}	6.3 ±0.1^{aC}	***
	1.3	8.1 ±0.1^{cdB}	5.4 ±0.0^{cC}	8.6 ±0.3^{aA}	5.0 ±0.1^{cD}	***
	1.4	8.5 ±0.1^{aA}	5.2 ±0.1^{cdC}	8.5 ±0.2^{aA}	5.6 ±0.1^{bB}	***
	1.5	8.0 ±0.1^{dA}	6.2 ±0.1^{aB}	8.1 ±0.1^{bcA}	5.8 ±0.1^{bC}	***
	1.6	8.1 ±0.2^{cdA}	4.8 ±0.2^{efD}	7.6 ±0.1^{dB}	5.7 ±0.2^{bC}	***
	1.7	8.5 ±0.3^{abA}	5.0 ±0.1^{deD}	6.4 ±0.1^{eB}	5.8 ±0.1^{bC}	***
	P_L	***	***	***	***	
*b**	1.0	15.6 ±0.1^{aBC}	16.1 ±0.2b^{cAB}	15.0 ±0.5^{bcC}	16.5 ±0.7^{cdA}	***
	1.1	15.6 ±0.5^{aA}	16.0 ±0.1^{cA}	14.2 ±0.8^{dB}	-	***
	1.2	14.5 ±0.2^{dC}	16.3 ±0.1^{bA}	15.0 ±0.1^{bcB}	16.4 ±0.2^{cdA}	***
	1.3	14.9 ±0.2b^{cdC}	16.1 ±0.2^{bcB}	15.1 ±0.2^{bcC}	17.5 ±0.1^{bA}	***
	1.4	15.1 ±0.2^{bcB}	16.3 ±0.1^{bA}	14.4 ±0.1^{cdC}	16.2 ±0.4^{dA}	***
	1.5	15.3 ±0.1^{abB}	16.9 ±0.2^{aA}	14.8 ±0.2^{cdC}	16.9 ±0.3^{cA}	***
	1.6	14.9 ±0.4^{cdD}	16.3 ±0.2^{bB}	15.6 ±0.7^{abC}	18.5 ±0.1^{aA}	***
	1.7	14.9 ±0.1^{cdD}	17.1 ±0.1^{aB}	15.9 ±0.2^{aC}	18.4 ±0.2^{aA}	***
	P_L	***	***	***	***	

Legend: see Table 2

pared to pâtés with sea salt. On the contrary pâtés with sea salt were brighter than pâtés with curing salts; all were estimated under value of 4, regardless of the level of salt addition. Colour of the pâtés with the curing salts and without phosphate was estimated higher than value 4 (with the exception of the addition of 1.0%) this means they were slightly darker than the optimal pink colour. As can be seen from the results in this study, the addition of phosphate generally did not significantly affect the perceived colour of the pâtés. Nitrite contributes to the colour stability of meat products during refrigerated storage and retail display (Doolaege et al., 2012). Therefore it is necessary to predict that with a lower level of nitrite, a more rapid change in the colour of the product occurs compared to the higher levels of nitrite addition.

Perceived saltiness of all groups of pâtés with salt addition below 1.2% was lower than optimal (less than 4 points). The liver pâtés with sea salt (and phosphate) were saltier than the pâtés with curing salts, with certain exceptions. By increasing the addition of both types of salt, perceived saltiness of pâté increased. This statement is in agreement with findings of Crehan et al. (2000) that salt reduction significantly affected the flavour of the frankfurters with a decrease in perceived saltiness and overall flavour. Perceived saltiness of pâtés with curing salts was optimal at addition level of 1.4%, pâtés with curing salts and phosphate at level of 1.3%, and pâtés with sea salt and sea salt with phosphate were optimal between addition levels of 1.2% and 1.3% of sea salt. On the assumption that the acceptable saltiness range of the liver pâté is between 3.5 and 4 values, then it is appropriate to add: 1.0% sea salt, 1.2% sea salt with phosphate, 1.2% curing salts and 1.0% curing salts with phosphate. Ruusunen et al. (2005) indicated that in the ground-meat patties addition of phosphate had no marked effect on perceived saltiness. However, on the liver pâtés in present study was found that the addition of phosphate reduced perceived saltiness. In both, sea and curing salts, the assessors perceived increased saltiness in phosphate-free pâtés compared to pâtés where phosphates were added.

Perceived saltiness was in positive, high and statistically very high significant association ($R = 0.67/0.78$; $P < 0.001$) with Na^+ and NaCl levels, as the levels of Na^+ and NaCl raised increased saltiness perceived.

Table 4. Effects of salt type, phosphate and salt addition on instrumentally measured texture and stability (fat and water exudation) of liver pâtés

Parameter (mean ±sd)	Salt addition (%)	Type of salt and phosphate addition				
		curing salts	sea salt	curing salts + phosphate	sea salt + phosphate	P_{SP}
Firmness (N) (n = 124)	1.0	5.5 ±0.4^{cdBC}	3.6 ±0.5^{bC}	13.9 ±4.2^{A}	9.2 ±0.7^{aB}	**
	1.1	4.3 ±0.7^{dB}	4.6 ±0.9^{bB}	12.1 ±2.5^{A}	-	***
	1.2	5.6 ±0.4^{cdB}	4.5 ±1.6^{bB}	11.3 ±3.2^{A}	4.3 ±1.7^{bB}	**
	1.3	7.4 ±0.9^{bcB}	3.8 ±1.1^{bC}	13.8 ±3.4^{A}	3.6 ±0.8^{bC}	***
	1.4	3.8 ±0.8^{dB}	3.8 ±0.3^{bB}	8.8 ±1.5^{A}	5.4 ±1.3^{bB}	**
	1.5	5.1 ±0.9^{cdB}	4.7 ±0.6^{bB}	11.7 ±3.8^{A}	9.2 ±2.9^{aAB}	*
	1.6	11.0 ±2.4^{aA}	3.6 ±1.1^{bB}	14.3 ±5.6^{A}	4.6 ±1.3^{bB}	**
	1.7	9.1 ±2.2^{abA}	7.4 ±0.8^{aAB}	5.0 ±0.8^{B}	6.1 ±1.4^{bB}	*
	P_L	***	**	Ns	**	
Fat exudation (%) (n = 62)	1.0	12.2 ±0.4^{bc}	14.8 ±0.9^{a}	9.5 ±2.5	9.3 ±1.0^{c}	Ns
	1.1	15.5 ±0.7^{aA}	11.9 ±0.8^{bB}	9.3 ±0.4^{C}	-	**
	1.2	9.4 ±0.5^{dB}	15.1 ±1.0^{aA}	7.7 ±2.0^{B}	10.8 ±1.5^{bcB}	*
	1.3	9.2 ±0.2^{d}	15.0 ±0.0^{a}	11.4 ±2.4	12.6 ±1.4^{b}	Ns
	1.4	10.7 ±1.4^{cd}	15.5 ±0.3^{a}	8.8 ±3.9	15.7 ±0.5^{a}	Ns
	1.5	12.3 ±1.1^{bc}	10.3 ±1.6^{b}	10.4 ±0.9	13.0 ±1.0^{b}	Ns
	1.6	12.0 ±0.7^{bcB}	14.7 ±0.2^{aA}	7.3 ±0.6^{C}	10.8 ±0.8^{bcB}	**
	1.7	12.7 ±0.4^{bA}	11.7 ±1.6^{bA}	6.7 ±0.3^{B}	6.7 ±1.1^{dB}	**
	P_L	***	**	Ns	**	
Water exudation (%) (n = 62)	1.0	5.7 ±1.2^{cdC}	9.8 ±0.1^{B}	18.7 ±1.0^{A}	9.0 ±1.3^{bcB}	***
	1.1	3.3 ±0.0^{dB}	10.8 ±3.6^{A}	15.4 ±1.2^{A}	-	*
	1.2	6.5 ±0.0^{cB}	13.2 ±2.5^{A}	14.7 ±2.2^{A}	6.6 ±2.3^{cB}	*
	1.3	8.1 ±0.0^{bc}	11.5 ±2.4	14.7 ±4.5	9.9 ±0.1^{abc}	Ns
	1.4	7.3 ±1.2^{bc}	13.3 ±0.0	13.8 ±5.6	13.1 ±0.0^{a}	Ns
	1.5	5.7 ±1.1^{cd}	7.4 ±1.3	13.1 ±4.6	12.1 ±1.2^{ab}	Ns
	1.6	11.5 ±2.3^{a}	6.5 ±2.3	14.7 ±2.5	13.2 ±2.4^{a}	Ns
	1.7	9.7 ±0.0^{ab}	8.3 ±0.1	9.9 ±2.3	8.2 ±0.1^{c}	Ns
	P_L	**	Ns	Ns	*	

Legend: see Table 2

Following the aroma intensity, the experimental groups with curing salts were estimated as the most intensive (with the exception of 1.0% of curing salts); the other three groups did not differ statistically. The intensity of the liver pâtés aroma with nitrite or sea salt with phosphates were not dependent on the addition of salt. The intensity of the pâtés aroma with added phosphate was less expressed compared to pâtés without phosphate.

Pâtés with curing salts were generally more tough in texture than pâtés with sea salt; pâtés with the addition of phosphate were tougher than phosphate-free pâtés ($P < 0.05$). For the instrumentally measured firmness and also for sensorially estimated texture of the pâtés with curing salts and phosphate could be said that they were significantly tougher than in the other experimental groups. In case when the salt addition is reduced and no phosphate is added, the instrumentally measured firmness was significantly reduced, than the reduction of the added salt (from 1.7 to 1.0%) means the texture estimated by 0.1% oz. 0.2% below the optimum texture. Ruusunen et al. (2005) seen that phosphates improve the firmness of meat patties; the same firmness

Table 5. Effects of salt type, phosphate and level of salt addition on the sensory properties of liver pâtés (n = 124)

Attribute (value) (mean ±sd)	Salt addition (%)	Type of salt and phosphate addition				
		curing salts	sea salt	curing salts + phosphate	sea salt + phosphate	P_{SP}
Colour (1-4-7)	1.0	3.0 ± 0.0^{eB}	2.4 ± 0.3^{C}	4.5 ± 0.0^{cA}	2.9 ± 0.3^{aB}	***
	1.1	4.3 ± 0.3^{dB}	2.9 ± 0.6^{C}	5.1 ± 0.3^{bA}	-	***
	1.2	5.4 ± 0.3^{bA}	2.4 ± 0.3^{D}	3.5 ± 0.0^{dB}	2.8 ± 0.3^{abC}	***
	1.3	4.1 ± 0.3^{dB}	2.4 ± 0.5^{C}	5.6 ± 0.5^{aA}	2.1 ± 0.3^{cC}	***
	1.4	4.8 ± 0.3^{cA}	2.5 ± 0.4^{B}	4.8 ± 0.5^{bcA}	2.4 ± 0.3^{bcB}	***
	1.5	6.0 ± 0.0^{aA}	2.9 ± 0.3^{C}	3.9 ± 0.3^{dB}	2.5 ± 0.0^{abcD}	***
	1.6	4.9 ± 0.3^{cA}	2.6 ± 0.3^{C}	3.9 ± 0.3^{dB}	2.5 ± 0.4^{abcC}	***
	1.7	5.4 ± 0.3^{bA}	2.1 ± 0.3^{C}	2.5 ± 0.0^{eB}	2.6 ± 0.3^{abB}	***
	P_L	***	Ns	***	*	
Saltiness (1-4-7)	1.0	3.1 ± 0.3^{eAB}	3.5 ± 0.4^{cA}	3.6 ± 0.5^{eA}	2.6 ± 0.3^{dB}	**
	1.1	3.8 ± 0.3^{cd}	3.6 ± 0.5^{c}	3.9 ± 0.3^{de}	-	Ns
	1.2	4.1 ± 0.3^{cA}	3.5 ± 0.4^{cC}	4.0 ± 0.0^{deAB}	3.6 ± 0.3^{cBC}	*
	1.3	3.5 ± 0.4^{deB}	4.5 ± 0.0^{bA}	4.0 ± 0.4^{deA}	4.3 ± 0.3^{bA}	***
	1.4	4.0 ± 0.0^{cB}	5.2 ± 0.3^{aA}	4.6 ± 0.3^{bcB}	3.8 ± 0.3^{bcC}	***
	1.5	4.9 ± 0.3^{bB}	5.5 ± 0.4^{aA}	4.3 ± 0.3^{cdC}	3.6 ± 0.5^{cD}	***
	1.6	5.6 ± 0.3^{aA}	5.6 ± 0.3^{aA}	4.8 ± 0.3^{bB}	6.0 ± 0.6^{aA}	***
	1.7	5.6 ± 0.3^{aB}	5.5 ± 0.0^{bB}	5.8 ± 0.3^{aB}	6.4 ± 0.3^{aA}	***
	P_L	***	***	***	***	
Aroma (1-7)	1.0	4.6 ± 0.3^{dBC}	5.1 ± 0.3^{abA}	5.0 ± 0.4^{AB}	4.5 ± 0.0^{C}	*
	1.1	5.3 ± 0.3^{bcA}	4.5 ± 0.0^{cB}	4.8 ± 0.3^{B}	-	**
	1.2	5.4 ± 0.3^{A}	4.8 ± 0.3^{bcB}	5.0 ± 0.4^{AB}	4.8 ± 0.3^{B}	*
	1.3	5.1 ± 0.5^{bcd}	4.9 ± 0.3^{bc}	4.8 ± 0.3	5.0 ± 0.4	Ns
	1.4	5.4 ± 0.3^{abA}	4.9 ± 0.3^{bcB}	4.8 ± 0.3^{B}	4.9 ± 0.3^{B}	**
	1.5	5.9 ± 0.3^{aA}	5.0 ± 0.4^{abB}	5.3 ± 0.3^{B}	5.0 ± 0.4^{B}	*
	1.6	5.4 ± 0.5^{abA}	$5.0 \pm 0.0a^{bAB}$	4.5 ± 0.4^{B}	4.8 ± 0.3^{B}	*
	1.7	4.8 ± 0.3^{cd}	5.4 ± 0.3^{a}	5.1 ± 1.1	4.6 ± 0.3	Ns
	P_L	***	**	Ns	Ns	
Texture (1-4-7)	1.0	3.8 ± 0.3^{cB}	3.9 ± 0.3^{bcB}	5.8 ± 0.5^{bcA}	5.9 ± 0.3^{aA}	***
	1.1	$3.3 \pm 0.6c^{B}$	4.6 ± 0.5^{aA}	5.3 ± 0.3^{cdA}	-	***
	1.2	5.0 ± 0.4^{bA}	4.9 ± 0.3^{aA}	5.0 ± 0.4^{dA}	3.8 ± 0.6^{cB}	**
	1.3	5.8 ± 0.3^{aA}	3.6 ± 0.3^{cB}	5.6 ± 0.3^{bcA}	3.1 ± 0.3^{dC}	***
	1.4	4.6 ± 0.8^{bB}	3.6 ± 0.5^{cC}	6.0 ± 0.0^{abA}	3.9 ± 0.5^{cBC}	***
	1.5	5.0 ± 0.4^{bB}	4.6 ± 0.3^{aB}	5.8 ± 0.3^{bcA}	$5.8 \pm 0.3a^{A}$	***
	1.6	6.1 ± 0.3^{aA}	4.9 ± 0.3^{aB}	6.4 ± 0.5^{aA}	4.6 ± 0.3^{bB}	***
	1.7	6.0 ± 0.0^{aA}	4.4 ± 0.6^{abB}	3.4 ± 0.5^{eC}	4.5 ± 0.4^{bB}	***
	P_L	***	***	***	***	
Overall acceptability (1-7)	1.0	4.5 ± 0.0^{dB}	$5.6 \pm 0.3a^{A}$	4.4 ± 0.5^{bcB}	$3.3 \pm 0.5c^{C}$	***
	1.1	5.1 ± 0.3^{b}	4.9 ± 0.3^{b}	4.6 ± 0.3^{bc}	-	Ns
	1.2	5.3 ± 0.3^{bA}	4.8 ± 0.3^{bB}	5.3 ± 0.3^{aA}	4.4 ± 0.3^{bB}	**
	1.3	5.0 ± 0.0^{bc}	$4.9 \pm 0.5b$	4.5 ± 0.4^{bc}	4.5 ± 0.0^{b}	Ns
	1.4	6.0 ± 0.0^{aA}	4.3 ± 0.3^{cD}	4.5 ± 0.0^{bcC}	5.0 ± 0.0^{aB}	***
	1.5	4.8 ± 0.3^{cd}	4.8 ± 0.3^{b}	4.9 ± 0.3^{ab}	4.8 ± 0.3^{ab}	Ns
	1.6	4.6 ± 0.3^{dA}	4.3 ± 0.3^{cAB}	3.8 ± 0.5^{dB}	3.0 ± 0.4^{cC}	***
	1.7	4.6 ± 0.3^{dA}	4.5 ± 0.0^{bcA}	3.7 ± 0.3^{cB}	3.3 ± 0.3^{cC}	***
	P_L	***	***	***	***	

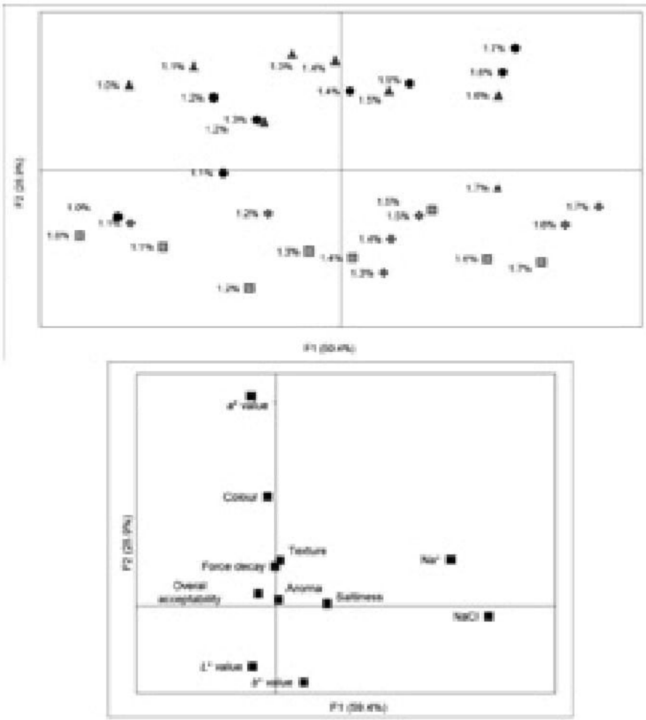
Legend: see Table 2

can be reached by ca. 40%, using basic potassium phosphate, less sodium than without phosphates. Also, in our study a higher firmness of pâtés with phosphate was detected by instrumental texture measurement. However, it should be noted that to firm texture is not desirable, since the product must be spreadably. Higher levels of added phosphate in meat products can cause a deterioration of the texture (rubbery), excessive water content or lead to the elimination of jelly (Schnack, 2007; Žlender, 2009). On the assumption that the tolerance of the texture was between 3.5 and 4.5 points, the sea salt is more suitable than the nitrite; acceptable texture was achieved by adding 1.2% curing salts, 1.0% sea salt and 1.2% sea and curing salts with phosphate.

The group of pâtés with 1.1% to 1.7% of curing salts, compared to the group with sea salt, achieved better overall acceptability. In general, the pâtés with added phosphate were poorly accepted (lower values) than those without phosphates, regardless of the salt type. Overall acceptability of the group with curing salts was found to be the best at the level of 1.4% of curing salts (control), group with curing salts and phosphate at 1.2% of curing salts, group with sea salt at 1.0% and group with sea salt and phosphate at 1.4% of sea salt. Therefore, with respect to the colour of liver pâté, it is better to use curing salt, as pâtés have a pinker colour, while pâté with sea salt has a brighter colour. It is also reasonable to use the curing salts for better aroma intensity and overall acceptability. Pâtés with phosphate are less salty, they exclude less fat and water, and are more firm than those without phosphate, but too firm texture of pâté is not desirable.

Multivariate analysis

Principle component analysis (PCA) and linear discriminant analysis (LDA) were performed to classify the experimental groups on the basis of their instrumental parameters and sensory attributes. PCA was performed to provide a data structure study over a reduced dimension, covering the maximum amount of the information present in the basic data. The loading values of the variables associated with the first three principal components were as followed: a* value, colour, firmness, texture, b* value and L* value were the dominant variables in the first principal component, which accounted for 32% of the total variance. The level of NaCl and Na+, as well as perceived saltiness dominated the second principal component that explained up to 26% of the total variance. Finally here, aroma and overall acceptability dominated the third principal component, which represented 14.5% of the total variance. The first three principal components thus accounted for 72.4% of the variation among the pâté samples analysed. Out of these thirteen parameters, fat and water exudation were recognised by PCA as being less important. Therefore, the remaining eleven parameters were included in the LDA.



Legend: SS – (■), group centroid) sea salt, SS/P – (◊) sea salt + phosphate, CS – (●) curing salts, CS/P – (▲) curing salts + phosphate

Figure 2. LDA using scores for properties chosen by PCA for the 31 groups of liver pâté with regard to type of salt/phosphate and level of salt added

Using LDA, four parameters were selected as the most discriminating variables: level of NaCl, a* value, level of Na+, L* value, perceived saltiness and b* value. The other four parameters (texture, overall acceptability, firmness and aroma) do not contribute significantly to better separation among the pâtés. When the LDA was applied to the data (124 samples, 11 variables), eleven discriminant functions were obtained. Function 1 explains 59.4% of the total variance, and function 2 explains 28.9%, other functions together explain 11.8% of the total variance. The scores of the samples for these two functions are plotted in Figure 1. As it can be seen, the CS (curing salts) 1.4% (the best overall acceptability), CS (curing salts) 1.5% and CS/P (curing salts + phosphate) 1.3%-1.5% samples are well separated from all of the other pâté groups. In the middle of upper right quadrant are well separated CS 1.6%-1.7 and CS/P 1.6% samples together, and in the upper left quadrant the group of five pâtés (CS 1.2%-1.3% and CS/P 1.0%-1.2%). As groups of SS (sea salt) and SS/P (sea salt+phosphate) pâtés originated on the lower side of graph mixing here with CS sample (1.0%) is understandable, as these pâtés have similar physico-chemical characteristics (very low level of nitrite, higher L* values and lower a* values), poor sensory estimated colour and acceptability. Overall, the accuracy of the placement of each sample into its corresponding group (pâté group) was 99.2%, with one sample (SS 1.6%) misplaced.

Figure 1 shows a plot of the attributes of the two functions. A group of variables was clearly distinguished that were included in function 1, far from the origin. This group essentially included variables connected with perception of salinity, with level of NaCl, Na+ and sensory estimated perceived saltiness placed farthest from the origin. Function 2 grouped a* value and colour; on the opposite side of function 2 there are L* value and b* value. Texture, firmness, overall acceptability and aroma were close to each other, showing high positive correlation.

CONCLUSION

On the basis of the results obtained, we could conclude that in the case of pâtés salt can be reduced to 1.2% (curing salts) or 1.0% (sea salt) so the minimum requirements for sensory acceptance are still preserved (texture between values 3.5 and 5.0, saltiness between 3.5 and 4.0, and overall acceptability above 4). In the pâtés with phosphate addition, the percentage of added salt can be reduced to 1.2% (sea or curing salts) under the same conditions. With decreasing of salt addition, consequently Na+ content decreased in pâtés with curing salts for 24% (without phosphate) and for 12% (with phosphate), also for 27% with sea salt (without phosphate) and for 11% (with phosphate). Multivariate analysis suggests groups of pâté that, according to their characteristics, most closely match the control group with 1.4% of curing salts added: group with 1.5% of curing salts and groups with 1.3%, 1.4% and 1.5% of curing salts and without phosphate mixture.

REFERENCES

Alahakoon, A.U., D.D. Jayasena, S. Ramachandra, C. Jo (2015): Alternatives to nitrite in processed meat: Up to date. Trends in Food Science & Technology 45, 37-49.

Alarcon-Rojo, A.D., H. Janacua, J.C. Rodriguez, L. Paniwnyk, T.J. Mason (2015): Power ultrasound in meat processing. Meat Science 107, 86-93.

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 935.47 (1999): 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 991.36 (1997): Official methods of analysis (16th ed.). Washington, Association of Official Analytical Chemists.

Bertino, M., G.K. Beauchamp, K. Engelman (1982): Long-term reduction in dietary sodium alters the taste of salt. American Journal of Clinical Nutrition 36, 1134-1144.

Crehan, C.M., D.J. Troy, D.J. Buckley (2000): Effects of salt level and high hydrostatic pressure processing on frankfurters formulated with 1.5 and 2.5% salt. Meat Science 55, 123-130.

Desmond, E. (2006): Reducing salt: A challenge for the meat industry. Meat Science 74, 188-196.

Desmond, E. (2007): Reducing salt in meat and poultry products. In: Reducing salt in foods: Practical strategies. Cambridge, Woodhead Publishing Limited, CRC Press LLC

Doolaege, E.H.A., E. Vossen, K. Raes, B. De Meulenaer, R. Verhe, H. Paelinck, S. De Smet (2012): Effect of rosemary extract dose on lipid oxidation, colour stability and antioxidant concentrations in reduced nitrite liver pates. Meat Science 90, 925-931.

Golob, T., M. Jamnik, J. Bertoncelj, U. Doberšek (2005): Sensory analysis: methods and assessors. Acta Agriculturae Slovenica 85, 55-66.

Inguglia, E.S., Z. Zhang, B.K. Tiwari, J.P. Kerry, C.M. Burgess (2016): Salt reduction strategies in processed meat products – A review. Trends in Food Science & Technology 59, 70-78.

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.

Kentish, S., H. Feng (2014): Applications of power ultrasound in food processing. Annual Review of Food Science and Technology 5, 263-284.

Kilcast, D., C. den Ridder (2007): Sensory issues in reducing salt in food products. In: Reducing salt in foods: Practical strategies. Cambridge, Woodhead Publishing Limited, CRC Press LLC

Kim, H.Y., E.S. Lee, J.Y. Jeong, J.H. Choi, Y.S. Choi, D.J. Han, M.A. Lee, S.Y. Kim, C.J. Kim (2010): Effect of bamboo salt on the psysicochemical properties of meat emulsion systems. Meat Science 86, 960-965.

Mackay, J., G. Mensah (2004): The Atlas of Heart Disease and Stroke. Geneva, World Health Organization (WHO). Available online:

http://www.who.int/cardiovascular_diseases/resources/atlas/en/ (accessed on 6 September 2018).

Ministry of Health of the Republic of Slovenia (2010):

National action plan for reducing the salt consumption in the diet of the population of Slovenia for the period 2010-2020 (Nacionalni akcijski načrt za zmanjševanje uživanja soli v prehrani prebivalcev Slovenije za obdobje 2010-2020). Ljubljana, Ministry of Health of the Republic of Slovenia (Ministrstvo za zdravje Republike Slovenije). Available online:

http://www.mz.gov.si/fileadmin/mz.gov.si/pageuploads/javna_razprava_2015/Resolucija_o_nac_programu_prehrane_in_in_tel_dejavnosti_jan_2015.pdf (accessed on 6 September 2018).

O'Flynn, C.C., M.C. Cruz-Romero, D.Troy, A.M. Mullen, J.P. Kerry (2014): The application of high-pressure treatment in the reduction of salt levels in reduced-phosphate breakfast sausages. Meat Science 96, 1266-1274.

Purdy, J., G. Armstrong (2007): Dietary salt and the consumer: reported consumption and awareness of associated health risks. In: Reducing salt in foods: Practical strategies. Cambridge, Woodhead Publishing Limited, CRC Press LLC

Rodrigues, F.M., A. Rosenthal, J.H. Tiburski, A.G. Cruz (2016): Alternatives to reduce sodium in processed foods and the potential of high pressure technology. Food Science and Technology (Campinas) 36, 1-8.

Ruusunen, M., E. Puolanne (2005): Reducing sodium intake from meat products. Meat Science 70, 531-541.

Ruusunen, M., J. Vainionpää, M. Lyly, L. Lähteenmäki, M. Niemistö, R. Ahvenainen, E. Puolanne (2005): Reducing the sodium sontent in meat products: The effect of the formulation in low-sodium ground meat patties. Meat Science 69, 53-60.

Schnack, K.T. (2007): Funkcija i primjena hidrokoloida u mesnoj industriji. Meso: Prvi hrvatski časopis o mesu 9, 70-73.

Stable Micro Systems (2018): The texture analysis applications directory. Issue 6. Available online:

http://www.masontechnology.ie/files/documents/TAHDFood.pdf (accessed on 6 September 2018).

Weiss, J., M. Gibis, V. Schuh, H. Salminen (2010): Advances in ingredient and processing systems for meat and meat products. Meat Science 86, 196-213.

WHO (2012a): Effect of reduced sodium intake on cardiovascular disease, coronary heart disease and stroke. Geneva, World Health Organization (WHO). Available online:

http://apps.who.int/iris/bitstream/10665/79322/1/9789241504904_eng.pdf (accessed on 6 September 2018).

WHO (2012b): Guideline: Sodium intake for adults and children. Geneva, World Health Organization (WHO). Available online:

http://apps.who.int/iris/bitstream/10665/77985/1/9789241504836_eng.pdf (accessed on 6 September 2018).

Žlender, B. (2009): Smanjenje koncentracije soli u mesnim proizvodima. Meso: Prvi hrvatski časopis o mesu 11, 189-195.

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Prihvatljivost jetrene paštete sa smanjenim sadržajem soli i natrija

SAŽETAK

Cilj ovog istraživanja bio je proizvesti jetrenu paštetu sa smanjenim sadržajem soli i prihvatljivim senzorskim svojstvima i prihvatljivom teksturom. Sadržaj natrija u paštetama smanjen je dodavanjem manje količine fosfatnih aditiva (0,15 %) i smanjenjem količine morske ili nitritne soli za salamurenje s 1,7 % na 1,0 %. U kontrolnom uzorku jetrene paštete proizvedene s 1,4 % soli za salamurenje određen je sadržaj bjelančevina, masti, minerala i vode. Osim ocjene senzorskih svojstava (deskriptivna analiza), za sve skupine uzoraka paštete određeni su kemijski parametri (sadržaj natrija utvrđen je ion selektivnim elektrodama, a NaCl-a Volhardovom metodom), dok su razdvajanje masti i vode u emulziji te parametri boje i teksture mjereni instrumentima. Paštete proizvedene uporabom različitih vrsta i količina soli te fosfata značajno su se razlikovale u kemijskom sastavu, parametrima boje i teksture mjerenima instrumentima te senzorskim svojstvima (boja, slanost, aroma, tekstura i ukupna prihvatljivost). S obzirom na boju jetrene paštete, bolje je koristiti sol za salamurenje jer ona pašteti daje ružičastu boju, dok je uz uporabu morske soli boja paštete svjetlija. Sol za salamurenje utječe i na intenzitet arome te ukupne prihvatljivosti. Paštete proizvedene s fosfatima manje su slane, dovode do manjeg razdvajanja masti i vode, a čvršće su od pašteta proizvedenih bez fosfata, iako se prečvrsta tekstura paštete ne smatra poželjnom. Sadržaj soli u pašteti može se smanjiti na 1,2 % (sol za salamurenje) ili 1,0 % (morska sol), pri čemu se, ovisno o vrsti soli i dodatku fosfatnih aditiva, sadržaj Na+ smanjuje za 11 % - 27 %. Paštete koje sadrže 1,5 % soli za salamurenje i paštete koje sadrže 1,3 % - 1,5 % soli za salamurenje i fosfata najsličnije su (linearna diskriminantna analiza) kontrolnoj skupini s najboljom ukupnom prihvatljivošću (1,4 % soli za salamurenje).

Ključne riječi: *jetrena pašteta, morska sol, sol za salamurenje, fosfati, smanjenje sadržaja soli, boja, tekstura, senzorska svojstva*

Akzeptanz von Leberpastete mit reduziertem Salz- und Natriumgehalt

ZUSAMMENFASSUNG

Ziel dieser Untersuchung bestand darin, eine Leberpastete mit einem reduzierten Anteil von Salz, akzeptablen sensorischen Eigenschaften und einer angemessenen Textur herzustellen. Der Anteil von Natrium in den Pasteten wurde durch die Zugabe von geringeren Mengen an Phosphatadditiven (0,15 %) und durch Reduktion der Menge von Meeressalz oder Nitritpökelsalz von 1,7 % auf 1,0% erreicht. In der Kontrollprobe der Leberpastete, hergestellt mit 1,4% Pökelsalz, wurde der Gehalt von Proteinen, Fetten, Mineralstoffen und Wasser festgelegt. Neben der Beurteilung der sensorischen Eigenschaften (deskriptive Analyse), wurden für alle Gruppen der Leberpasteteproben die chemischen Parameter festgelegt (der Gehalt von Natrium wurde anhand von ionenselektiven Elektroden und von NaCl nach der Volhard-Methode festgelegt), während die Trennung von Fetten und Wasser in der Emulsion und die Parameter Farbe und Textur durch Instrumente gemessen wurden. Die Pasteten, die mit diversen Sorten und Anteilen von Salzen und Phosphaten hergestellt wurden, unterschieden sich erheblich in ihrer chemischen Zusammensetzung, in den Farb- und Texturparametern, gemessen mit Instrumenten, und den sensorischen Eigenschaften (Farbe, Salzigkeit, Aroma, Textur und allgemeine Akzeptanz). In Anbetracht der Farbe der Leberpastete empfiehlt es sich, Pökelsalz zu verwenden, weil es der Pastete eine rosige Farbe verleiht, während die Verwendung von Meeressalz eine hellere Farbe der Pastete verursacht. Das Pökelsalz wirkt sich auch auf die Intensität eines besseren Aromas und die Akzeptanz im Allgemeinen aus. Die mit Phosphaten zubereiteten Pasteten sind weniger salzig, verursachen eine geringere Trennung von Fetten und Wasser und sind fester als die Pasteten, die ohne Phosphate hergestellt wurden, obwohl eine zu feste Textur bei Pasteten nicht wünschenswert ist. Der Anteil der Salze in der Pastete kann auf 1,2% (Nitritsalz) oder 1,0% (Meeressalz) reduziert werden, wobei, abhängig von der Art des Salzes und der Zugabe von Phosphatadditiven, der Anteil von Na+ um 11 % - 27 % reduziert wird. Pasteten mit einem Anteil von Nitritsalz von 1,5 % und Pasteten mit 1,3 % - 1,5 % Pökelsalz und zugegebenen Phosphaten sind mit der Kontrollgruppe, die die beste Akzeptanz gezeigt hat (1,4% Nitritsalz), am vergleichbarsten (lineare Diskriminanzanalyse).

Schlüsselwörter: *Leberpastete, Meeressalz, Pökelsalz, Phosphate, Reduktion des Salzgehalts, Farbe, Textur, sensorische Eigenschaften*

Aceptabilidad del paté de hígado con el contenido reducido de la sal y del sodio

RESUMEN

El fin de este trabajo fue producir el paté de hígado con el contenido de la sal reducido y con las características sensoriales y la textura aceptables. El contenido del sodio en los patés es reducido con añadir menos aditivos de fosfato (0,15 %) y con la cantidad reducida de la sal para salmuera de 1,7 % a 1,0 %. Se determinó el contenido de las proteínas, de las grasas, de los minerales y del agua en la muestra de control del paté de hígado. Además de la calificación de las características sensoriales (por el análisis descriptivo), se determinaron los parámetros químicos para todos los grupos de las muestras del paté (el contenido del sodio fue determinado por los electrodos selectivos de iones y el NaCl por el método de Volhard), mientras la separación de grasas y del agua en la emulsión y los parámetros del color y de la textura fueron medidos con los instrumentos. Los patés producidos con diferentes tipos y cantidades de sal y de los fosfatos difirieron significativamente en su composición química, en los parámetros del color y de textura medidos por los instrumentos y en las características sensorial (el color, la salinidad, el aroma, la textura y la aceptabilidad general). Teniendo en cuenta el color del paté de hígado, es mejor usar la sal para salmuera porque le da el color rosado, mientras la sal marina causa que el color del paté sea más claro. La sal para salmuera afecta también la intensidad del aroma y la aceptabilidad general. Los patés producidos con los fosfatos son menos salados, llevan a la separación reducida de las grasas y del agua y son más firmes que los patés producidos sin el uso de los fosfatos, aunque la textura demasiado firme del paté no es deseable. El contenido de la sal en el paté puede reducirse a 1,2 % (sal para salmuera) o 1,0 % (sal marina), donde el contenido del Na+ disminuye un 11 % - 27 % , dependiendo del tipo de la sal y de los aditivos de fosfato añadidos. Los patés con el contenido de la sal para salmuera de 1,5% y los patés que contienen 1,3 % - 1,5 % de la sal para salmuera y los fosfatos son más similares (análisis discriminante lineal) al grupo del control con la mejor aceptabilidad general (1,4% de sal para salmuera).

Palabras claves: *paté de hígado, sal marina, sal para salmuera, fosfatos, reducción del contenido de sal, color, textura, características sensoriales*

Accettabilità del pâté di fegato con minor contenuto di sale e sodio

RIASSUNTO

La presente ricerca aveva come obiettivo quello di produrre un pâté di fegato con minor contenuto di sale e con accettabili proprietà sensoriali e di consistenza. Il contenuto di sodio nei pâté è stato ridotto aggiungendo una piccola quantità di additivi fosfatici (0,15 %) e riducendo la quantità del sale e dei nitriti per salamoia dall'1,7% all'1,0%. Nel campione di controllo del pâté, prodotto utilizzando l'1,4% di sale da salamoia, è stato stabilito il contenuto di proteine, grassi, minerali e acqua. A parte la valutazione delle proprietà sensoriali (analisi descrittiva), per tutti i gruppi di campioni di pâté sono stati accertati anche i parametri chimici (il contenuto di sodio è stato accertato mediante elettrodi ionoselettivi, il contenuto di NaCl con il metodo Volhard), mentre la separazione dei grassi e dell'acqua in emulsione e i parametri riguardanti il colore e la consistenza sono stati accertati con misurazione strumentale. I pâté prodotti utilizzando diversi tipi e quantità di sale e fosfati sono risultati significativamente differenti per composizione chimica, parametri del colore e della consistenza accertati con misurazione strumentale e proprietà sensoriali (colore, salinità, aroma, consistenza e accettabilità generale). Circa il colore del pâté di fegato, è meglio utilizzare il sale da salamoia perché conferisce al prodotto un colore rosa, mentre l'uso di sale marino dà al pâté una sfumatura più chiara. Il sale da salamoia incide anche sull'intensità dell'aroma e sull'accettabilità generale del prodotto. I pâté prodotti utilizzando fosfati sono meno salati, si riduce la separazione tra grassi e acqua e hanno una consistenza più compatta dei pâté prodotti non utilizzando fosfati, sebbene la troppa compattezza nei pâté non sia una caratteristica desiderabile. Il contenuto di sale nel pâté può essere ridotto all'1,2 % (sale da salamoia) o all'1,0 % (sale marino), laddove, in base al tipo di sale e all'aggiunta di additivi fosfatici, il contenuto di Na+ viene ridotto dell'11 % - 27 %. I pâté che contengono l'1,5 % di sale da salamoia e i pâté che contengono l'1,3 % - 1,5 % di sale da salamoia e di fosfati sono i più simili (analisi discriminatoria lineare) al gruppo di controllo con la migliore accettabilità generale (1,4 % di sale da salamoia).

Parole chiave: *pâté di fegato, sale marino, sale da salamoia, fosfati, riduzione del contenuto di sale, colore, consistenza, proprietà sensoriali*

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