OPEN ACCESS Potravinarstvo Slovak Journal of Food Sciences

potravinárstvo® Slovak Journal of Food Sciences

Potravinarstvo Slovak Journal of Food Sciences
vol. 12, 2018, no. 1, p. 279-284
doi: https://doi.org/10.5219/908
Received: 19 February 2018. Accepted: 16 March 2018.
Available online: 21 March 2018 at www.potravinarstvo.com

ISSN 1337-0960 (online)

EVALUATION OF SELECTED QUALITY PARAMETERS OF REDUCED SALT FRANKFURTERS

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ABSTRACT
Higher salt content in foods brings health risks associated with hypertension and leads to an increased risk of strokes and fatal vascular diseases. For this study, a frankfurter was chosen as a frequently consumed meat product. In repetitions, four groups of products were produced with different salt contents (2.0% and 1.4%) and the kind of meat used (CPF – Control Pork Frankfurters, RPF – Reduced salt Pork Frankfurters, CBF – Control Beef Frankfurters, RBF – Reduced salt Beef Frankfurters). Basic chemical parameters (dry matter, fat and salt content), colour parameters (CIE L*, a* and b*) and basic sensory analysis were performed before (UT – untreated) and after heat treatment (HT – heat treated). The lower salt content and the type of meat used have a significant effect (p <0.05) on the colour of the products. In almost all parameters frankfurters with pork meat scored better than frankfurters with beef meat. The lower salt content and the type of meat used proved to have affected the colour of the products. After heat treatment there were found statistical significant differences in saltiness between control and salt reduced group (UT, p = 0.0098; HT p = 0.0001). Sensory results were better with pork and higher salt. A more key role than salt content in frankfurters is played by the type of meat. Debrecener´s frankfurter was selected for this study, and its formula can serve as a good example for the manufacturers that there is no need to worry about one third salt mixture reduction in the recipe on frankfurters sensory analysis.

Keywords: sensory analysis, colour, lightness, beef, pork

INTRODUCTION
At present, the salt content in foods is hot topic. Excessive intake of sodium in the diet, however, brings health risks associated with hypertension and leads to an increased risk of strokes and fatal vascular diseases **(He and MacGregor, 2010)**. Unfortunately, the Czech Republic is in the income of salt content and the occurrence of diseases with this problem associated with the leading countries. However, sodium chloride and sodium nitrite have a key role in meat production.

Based on this evidence, most of European countries, under the World Health Organization policies, have adopted strategies for dietary salt reduction towards meeting the recommended intake of 5g salt per day as around 90% of the sodium in our diets comes in this form **(WHO, 2013)**. After the bread and cereals group, the largest source of sodium (salt) in the European diet is processed meat products **(Kloss et al., 2015)**.

In Europe, North America and Australia, around 70% of consumed salt comes from processed foods, among which 20% is derived from meat products **(Ruusunen and Puolanne, 2005)**. More specifically, 77% of sodium intake is obtained from packaged and restaurant food, 12% occurs naturally in foods and 11% comes from adding salt to food while cooking or while eating at the table. In fresh foods like meat, vegetables, and fruit, salt is naturally present in small quantities, but when processed, salt levels tend to increase exponentially.

The major issue when using lower salt concentrations in processed meat products is to be able to maintain the product quality characteristics without affecting the shelf-life or the economic viability of the product **(Desmond, 2006)**.

From a culinary perspective, salt is predominantly used to enhance food flavour, making even unpalatable food taste better. However, taste and preservation are not the only reasons for the use of high levels of sodium in foods. The sodium level is generally kept high due to the additional functional roles it provides. The presence of salt (1.5% – 2.5% w/w) in meat products (i) solubilizes meat proteins, (ii) activates extraction of proteins, enhancing hydration, and water holding capacity (WHC) **(Ruusunen and Puolanne, 2005)**, (iii) increases product cooking yield and juiciness **(Desmond, 2006)**, (iv) increases the viscosity of meat batters, thereby allowing formation of heat-stable emulsions, such as frankfurters **(Terrell, 1983)** and (iv) decreases fluid loss **(Offer and Trinick, 1983)**.

A problem with low-salt meat products is that, along with saltiness, reducing sodium will also affect product texture and flavour intensity. For example, increased muscle protein (i.e. visual lean meat content) reduces the perceived saltiness in meat products. When fat content is high, lower salt additions provide a more stable structure than in low-fat products. However, lowering the salt content to 1.4% NaCl in cooked sausages and to 1.75% in lean meat products has been shown to be possible while keeping an acceptable perceived saltiness, firmness, water-binding and fat retention (**Tobin et al., 2013**). Colour and material of surface of particular packaging of visual factors influences consumers **(Géci et al., 2017)**. Meat products are a common item in our diet. In today's meat processing industry, the role of economy and quality plays a key role. The meat industry is pushed to the lowest price by the retail chain, which reduces the meat content of the products **(Fekete et al., 2016)**. It is therefore desirable to modify the recipes to improve its qualitative and nutritional value. Scientific trends are moving towards enhancing hygienic quality using antimicrobial agents **(Kročko et al., 2017)** and antioxidants **(Bobko et al., 2017).** There are no limits on salt content in foodstuffs and therefore in meat products in the Czech Republic. Nutrition claims (low sodium/salt content, very low sodium/salt content, low sodium/salt content, no sodium/salt content) have been established within the European Union.

Scientific hypothesis

The aim of this study was to examine the importance of reducing the salt content of meat products according to the type of meat used on some quality parameters. Salt content and the type of meat used have probably an effect on the colour of product and final taste. The aim was also to assess the effect of heat treatment.

MATERIAL AND METHODOLOGY

The frankfurters were produced in three repetitions according to the quality standard of ON 57 7127 (Debrecínský párek as known as Debrecener´s frankfurter, beef H3 or H4, pork V4, pork V5 or V6 according to Czech Meat Processors Association) in the pilot plant CZ 22067 (approved by the State Veterinary Administration, Czech Republic) of Mendel University in Brno. A total of four groups of products were produced with different salt contents (C – control for 2.0%, R – reduced salt group for 1.4% NaCl) and the type of meat used (CPF – Control Pork Frankfurters, RPF – Reduced salt Pork Frankfurters, CBF – Control Beef Frankfurters, RBF – Reduced salt Beef Frankfurters). A debrecener is a pork and beef sausage of uniform fine texture and reddish-orange colour, named after the Hungarian city of Debrecen. Beef contain This frankfurter is spiced with paprika and other seasonings like garlic, pepper, cumin and ginger. Usually they contain tiny pieces of pork fat as well. They are usually lightly smoked and filled in ovine intestines. Standard machines used in industrial production (cutter, filler, smoker) were used. For CPF and RPF, beef from the recipe (35%) was replaced by pork lean production meat (80% muscles: 20% fat). Raw meat was kept in 2 °C and second day was coarsely ground to obtain meat emulsion in cutter (Seydelmann, Germany) and filled (HTS 150, Germany) in ovine intestine (20/22) and treated (74 °C, 18 min) in smoker (Bastramat, Germany). The salt content was in RPF and RBF recipes reduced by a total of 0.6% NaCl.

Quality evaluation of frankfurters

For quality determination were used methods of chemical and sensory analysis. For the instrumental measurement of the surface colour, the CIE colour space was used. Frankfurters was measured and evaluated in the fifth day (approx. halftime of its shelf life) before (UT – untreated) and after heat treatment (HT – heat treated). A standard convection oven (Rational, Germany) and heating mode (80 °C, 90% humidity, 10 minutes) were used for heat treatment.

Chemical analysis

The dry matter (g.100 g^{-1}), the fat content (g.100 g^{-1}) and the salt content (g.100 g^{-1}) after homogenization of the sample (250 g) in mixer for each group (CPF, RPF, CBF and RBF) were analyzed (AOAC, 2005). All analysis was undertaken in duplicate.

Colour measurement

Colour space L*, a* and b* was determined by CM 3500d spectrophotometer (Konica Minolta, Japan). The samples were measured (D 65, 6500°K) on the surface with SCE (Specular Component Exluded) and 8 mm slot in triplicate (3 pairs and in 2 batches). Heat treated frankfurters (HT) were left to cool down (20-25 °C) and measured as well as untreated (UT). Colour variation was determined as total colour difference ΔE^*_{ab} **(Saláková, 2012)**.

Sensory analysis

Sensory analysis was evaluated by an 8-member trained panel of academic staffs (3 men, 5 women) in special room under ČSN ISO 6658 (560050) condition. Sensory analysis was undertaken at special sensory laboratory with ten chambers (Department of Food Technology). All panel´s members buy and consume frankfurters regularly. For each frankfurter, assessors were asked to indicate their score on a 100mm line scale ranging from 0 at the left to 100 at the right. Descriptors expressed as the hedonic scores, where 0 is the sign minimum and 100 is maximum of pleasure. Sensoric descriptors were ranked as follows: appearance, colour, texture, juiciness, aroma, saltiness and taste (for overall taste) and used for untreated (UT) and heat treated (HT) frankfurters as the most common forms of consumption of this product. First were analyssed untreated frankfurters (UT), then after interval (10 min) and after heat treatment were immediately offered other frankfurters (HT) to the assessors. Water and non-salted bread were used as neutralizers. Samples were identified by a four-digit code. The sample groups were offered randomly to the assessors.

Statistical analysis

Data collected from experiments were analysed by analysis of variance (one-way ANOVA) and Tukey´s test to compare the treatment and groups according to it´s salt content and used meat by programme STATISTICA 12. Samples were considered significant at 95% confidence level (p <0.05) and data were tested for normality by Shapiro–Wilk test.

RESULTS AND DISCUSSION

The experimental products of all groups did not differ much from the products from the market network. This is due to the use of high-quality recipes without meat substitutes. Frankfurters with lower salt **(Table 1)** content had a higher dry matter compared to the control group. This was significant (p <0.05) for the group with beef in recipe (RBF). The difference between the groups accounted for less than 5%, which apparently did not represent a significant loss item. The difference in fat content is given by using the type of meat. Even though pork lean meat was used as a substitute for beef in CPF and RPF variants, this difference in results is obvious **(Table 1)**. The salt content was influenced by the composition of the recipe and by the intervention of the goals of the experiment. Nevertheless, it is evident that with the higher water losses given by the higher dry matter are frankfurters with lower salt content, there is also a higher salt content in the sausage. It is obvious that the current higher losses of water given by the higher frankfurters´ dry matter are associated with it´s a lower salt content. Therefore, the salt content of the completed product is also higher in these variants (30-40% in RPF and RBF) than in control variants (5% in CPF and CBF). This was independent of the beef or pork content **(Table 1)**, because there were no significant differences (p >0.05) between CPF and CBF or CBF and RBF groups of samples.

Untreated frankfurters (UT) with less salt and only with pork (RPF) were significantly (p <0.05) the lightest (L* = 45.80) of all samples. Most darker were heat treated (HT) beef frankfurters (CBF) (L* = 41.21). Coordinates a* for red colour and b* for yellow colour had different values before and after heat treatment **(Table 2)**. The higher a* values for the red colour of untreated frankfurters (UT) was recorded in variants with beef (CBF and RBF) and after heat treatment in control groups (CPF and CBF). Yellowness (b*) were highest in untreated frankfurters (UT) and it´s variants with reduced content of salt (RPF and RBF).

The lower salt content and the type of meat used have a significant effect (p <0.05) on the colour of the products **(Table 2)**.

Frankfurters of all groups become darker (Table 2) after heat treatment. The hightest total colour difference ΔE^*_{ab} (5.96) after treatment (Table 3) was in variants with beef meat (CBF and RBF) and when comparing control variants (CF ΔE^*_{ab}) with variants with reduced salt content (RF). Differences were higher in untreated groups (UT).

Table 4 shows the sensory assessment of frankfurters and their comparison between frankfurters with pork meat and frankfurters with beef meat. There were not found statistical differences in colour between control and salt reduce group in both group of samples (with pork and beef). After heat treatment there were found statistical significant differences in saltiness between control and salt reduced group. In almost all parameters frankfurters with pork meat scored better than frankfurters with beef meat **(Table 4)**. The perception of saltiness in the meat products is influenced by other factors than simply the salt content. It is for example the proportion of fat, water content, texture etc. **(Kameník et al., 2017)**. **Aaslyng et al. (2014)** reported that salt reduction from 2.2% to 1.7% did not alter the sensory properties in sausages. **Tobin et al. (2012)** that reported salts below 1.5% had a negative effect on consumer acceptability, with 2.5% salt concentrations franks being the most preferred by consumers.

Many current innovations in the processed meat field focus on healthier reformulations, namely improving the

Table 1 Basic chemical analysis of frankfurters with different salt and meat content.

Content (g.100 g^{-1})	Group of samples			
	CPF ($\bar{x}$ ±SD)	RPF ($\bar{x}$ ±SD)	CBF ($\bar{x}$ ±SD)	RBF ($\bar{x}$ ±SD)
Dry matter	39.54 ±1.93^{a}	41.50 ±1.50^{ab}	43.09 ±0.52^{b}	44.08 ±0.19^{c}
Fat	19.38 ±0.19^{c}	20.22 ±1.73^{d}	16.45 ±0.39^{a}	18.29 ±0.36^{b}
NaCl	2.05 ±0.11^{b}	1.65 ±0.10^{a}	2.10 ±0.08^{b}	1.51 ±0.19^{a}

Note: CPF – Control Pork Frankfurters, RPF – Reduced salt Pork Frankfurters, CBF – Control Beef Frankfurters, RBF – Reduced salt Beef Frankfurters; Means with different superscripts in the same rows show significant differences (p <0.05).

Table 2 Instrumental measurement of frankfurter´s colour surface depending on different salt and meat content.

Parameter	Treatment	Group of samples			
		CPF ($\bar{x}$ ±SD)	RPF ($\bar{x}$ ±SD)	CBF ($\bar{x}$ ±SD)	RBF ($\bar{x}$ ±SD)
L* (D 65)	UT	43.82 ±0.52^{a}	45.80 ±1.16^{b}	42.97 ±0.50^{a}	45.10 ±1.08^{b}
	HT	42.48 ±0.93^{b}	43.57 ±0.78^{c}	41.21 ±0.96^{a}	42.12 ±0.53^{b}
a* (D 65)	UT	27.45 ±1.02^{b}	26.50 ±1.01^{a}	29.71 ±0.39^{d}	28.57 ±0.28^{c}
	HT	26.47 ±0.72^{b}	25.42 ±0.70^{a}	26.54 ±0.48^{b}	25.45 ±0.39^{a}
b* (D 65)	UT	32.43 ±2.18^{ab}	35.34 ±2.05^{c}	31.45 ±2.18^{a}	34.36 ±2.08^{bc}
	HT	28.43 ±1.48^{ab}	30.73 ±1.93^{c}	27.28 ±1.40^{a}	29.58 ±1.95^{bc}

Note: UT – untreated, HT – heat treated; CPF – Control Pork Frankfurters, RPF – Reduced salt Pork Frankfurters, CBF – Control Beef Frankfurters, RBF – Reduced salt Beef Frankfurters; Means with different superscripts in the same rows show significant differences (p <0.05)

Table 3 Total colour differences ΔE^*_{ab} frankfurters according to different salt and meat content.

		Treatment	
	Groups	**UT**	**HT**
ΔE^*_{ab} (CIE1976)	CPF RPF	3.65	2.75
	CBF RBF	3.79	2.70
	PORK BEEF	2.50	1.78
	PORK	4.78	
	BEEF	5.96	
	CF RF	3.71	2.72
	CF	4.84	
	RF	5.77	

Note: UT – untreated, HT – heat treated; CPF – Control Pork Frankfurters, RPF – Reduced salt Pork Frankfurters, CBF – Control Beef Frankfurters, RBF – Reduced salt Beef Frankfurters; Means with different superscripts in the same rows show significant differences (p <0.05).

Table 4 Sensory analysis of frankfurters with different salt and meat content.

		Group of samples			
Descriptor	**Treatment**	**CPF ($\bar{x}$ ±SD)**	**RPF ($\bar{x}$ ±SD)**	**CBF ($\bar{x}$ ±SD)**	**RBF ($\bar{x}$ ±SD)**
Appearance	UT	81.88 ±10.91	80.50 ±13.61	74.88 ±10.91	73.50 ±13.61
	HT	91.56 ±6.28^{a}	88.31 ±6.23^{ab}	84.56 ±6.28^{b}	81.31 ±6.26^{c}
Colour	UT	86.13 ±5.23^{a}	87.00 ±5.15^{a}	75.13 ±5.23^{b}	76.00 ±5.18^{b}
	HT	87.44 ±6.16^{a}	88.44 ±6.32^{a}	76.44 ±6.16^{b}	77.44 ±6.30^{b}
Texture	UT	86.31 ±8.28^{a}	85.88 ±8.47^{a}	68.31 ±8.28^{b}	67.88 ±8.45^{b}
	HT	89.50 ±5.07^{a}	84.75 ±7.98^{a}	71.50 ±5.07^{b}	66.75 ±7.91^{b}
Juiciness	UT	78.31 ±14.90^{a}	72.81 ±13.80^{a}	54.31 ±14.90^{b}	48.81 ±13.88^{b}
	HT	90.31 ±4.54^{a}	78.56 ±4.20^{b}	66.31 ±4.50^{c}	54.56 ±4.13^{d}
Aroma	UT	86.38 ±6.51	85.69 ±5.88	83.38 ±6.51	82.69 ±5.86
	HT	90.13 ±4.11^{a}	85.00 ±5.38^{b}	87.13 ±4.11^{ab}	82.00 ±3.34^{b}
Saltiness	UT	84.38 ±10.66^{a}	79.19 ±8.67^{ab}	78.38 ±10.66^{ab}	73.19 ±8.63^{b}
	HT	89.19 ±6.65^{a}	77.63 ±7.01^{b}	83.19 ±6.65^{ab}	71.63 ±7.04^{b}
Taste	UT	89.06 ±7.66	85.81 ±8.02	92.44 ±7.05	89.81 ±8.07
	HT	90.25 ±4.82^{a}	81.13 ±7.25^{b}	94.25 ±4.82^{a}	85.13 ±7.29^{ab}

Note: UT – untreated, HT – heat treated; CPF – Control Pork Frankfurters, RPF – Reduced salt Pork Frankfurters, CBF – Control Beef Frankfurters, RBF – Reduced salt Beef Frankfurters; Means with different superscripts in the same rows show significant differences (p <0.05); Descriptors expressed as the hedonic scores, where 0 is the sign minimum and 100 is maximum of pleasure.

nutritional quality and reducing adverse effects of processed meat consumption **(Shan et al., 2017)**. Given that processed meat is a significant contributor to consumers' intake of salt and saturated fat, nutrients which are consumed more than the recommended level in many developed countries, one strategy is to reduce salt and/or fat content of those processed products with particularly high salt or fat content **(Bolger et al., 2017**; **Desmond, 2006**). From this point of view should be the best variant with reduced salt content and containing beef. Our results show that, although different from other variants, this difference did not pose a complication for the manufacturers. The consumer would not have noticed the difference.

Some strategies for innovations can be done by, for instance, not only directly lowering the amount of salt and fat in the recipe, which is the first possibillity. Some authors **(Horita et al., 2016)** describe using a salt substitute (e.g. potassium chloride or herbs), or by using animal fat replacements (e.g. starch or oil from non-animal sources). This way is complicated because of the possible impact on the sensory quality of the product. Some frankfurters are made with more apparent amount and kind of spices, so potential cover-up of such substances can occur. In this experiment we used above-mentioned recipe. From this perspective, Debrecen frankfurters can potentially be used for wider innovations. Another strategy involves the incorporation of healthy ingredients (e.g. vitamins and minerals, omega 3 fatty acids, probiotics, co-enzyme Q10, and dietary fibre) into processed meat **(López-López, et al. 2009)**. These ingredients can be introduced indirectly through animal feeding or directly during processing. Other strategy involves reducing or replacing chemical-based preservatives, such as nitrites/nitrates **(Shan et al., 2017, (Sindelar et al., 2007)**. It is true that consumers are generally interested in the content of substances in food hazardous to health. Nitrites are thus negatively perceived by different consumer groups. However, nitrite replacement is a complicated intervention in the product recipe regarding its sensory and microbiological quality.

CONCLUSION

The reduction of salt content and the substitution of meat was reflected in the quality parameters of meat products. Frankfurters without beef only with pork meat were juicier and had higher aroma and more enjoyable appearance and colour after heat treatment. The products did not differ from the usual ones that can be bought in stores.

Reducing the salt content in consumers´ of known meat products is a way to rationally reduce sodium in food. Rather than developing new recipes or making a major legislation-regulated adjustment, recommendations should be made for manufacturers. Together with an assessment of such an adjustment, could be a guideline, especially for smaller producers in the regional market. This can better meet the demands of different consumer groups and will not require legislation or major interventions in large-scale meat production.

REFERENCES

AOAC, 2005. Official methods of analysis. Washington, DC: Association of Official Analytical Chemists.

Aaslyng, M. D., Vestergaard, C., Koch, A. G. 2014. The effect of salt reduction on sensory quality and microbial growth in hotdog sausages, bacon, ham and salami. *Meat Science*, vol. 96, no. 1, p. 47-55. https://doi.org/10.1016/j.meatsci.2013.06.004

ČSN ISO 6658 (560050), 2010. Sensory Analysis - Methodology – General Condition.

Bobko, M., Haščík, P., Kročko, M., Trembecká, L., Mendelová, A., Tkáčová, J., Czako, P., Tóth, T. 2017. Effect of grape seed extract on quality of raw-cooked meat products. *Potravinarstvo Slovak Journal of Food Sciences*, vol. 11, no. 1, p. 517-521. https://doi.org/10.5219/79

Bolger, Z., Brunton, N. P., Lyng, J. G., Monahan, F. J. 2017. omminuted meat products — consumption, composition, and approaches to healthier formulations (Review). *Food Reviews International*, vol. 33, no. 2, p. 143-166. https://doi.org/10.1080/87559129.2016.1149861

Desmond, E. 2006. Reducing salt: A challenge for the meat industry. *Meat Science*, vol. 74, no. 1, p. 188-196. https://doi.org/10.1016/j.meatsci.2006.04.014

Fekete, T., Šnirc, M., Belej, L., Golian, J., Zajác, P., Čapla, J. 2016. Identification of differences in chemical composition among whole stick and sliced nitran salamis trough principal component analysis. *Potravinarstvo Slovak Journal of Food Sciences*, vol. 10, no. 1, p. 170-175. https://doi.org/10.5219/568

Géci, A., Nagyová, L., Rybanská, J. 2017. Impact of sensory marketing on consumer´s buying behaviour. *Potravinarstvo Slovak Journal of Food Sciences*, vol. 11, no. 1, p. 709-717. https://doi.org/10.5219/835

He, F. J., MacGregor, G. A. 2010. Reducing population salt intake worldwide: From evidence to implementation. *Progress in Cardiovascular Diseases*, vol. 52, no. 5, p. 363-382. https://doi.org/10.1016/j.pcad.2009.12.006

Horita, C. N., Farías-Campomanes, A. M., Barbosa, T. S., Esmerino, E. A., Gomes da Cruz, A., Bolini, H. M. A., Meireles, M. A. A., Pollonio, M. A. R. 2016. The antimicrobial, antioxidant and sensory properties of garlic and its derivatives in Brazilian low-sodium frankfurters along shelf-life. *Food Research International*, vol. 84, p. 1-8, https://doi.org/10.1016/j.foodres.2016.02.006

Kameník, J., Saláková, A., Vyskočilová, V., Pechová, A., Haruštiaková, D. 2017. Salt, sodium chloride or sodium? Content and relationship with chemical, instrumental and sensory attributes in cooked meat products. *Meat Science*, vol. 131, p. 196-202. https://doi.org/10.1016/j.meatsci.2017.05.010

Kloss, L., Meyer, J. D., Graeve, J., Vetter, W. 2015. Sodium intake and its reduction by food reformulation in the European Union — A review, *NFS Journal*, vol. 1, p. 9-19. https://doi.org/10.1016/j.nfs.2015.03.001

Kročko, M., Bobko, M., Ducková, V., Čanigová, M., Haščík, P., Tkáčová, J. 2017. Effect of thyme and oregano aqueous tea infusions on the lipid oxidation and sensory characteristics of frankfurkters sausages. *Potravinarstvo Slovak Journal of Food Sciences*, vol. 11, no. 1, p. 602-605. https://doi.org/10.5219/798

López-López, I., Cofrades, S., Jiménez-Colmenero, F. 2009. Low-fat frankfurters enriched with n − 3 PUFA and edible seaweed: Effects of olive oil and chilled storage on physicochemical, sensory and microbial characteristics. *Meat Science*, vol. 83, no. 1, p. 148-154. https://doi.org/10.1016/j.meatsci.2009.04.014

ON 57 7127 (Debrecínský párek). Industry standard, 1977. (In Czech)

Offer, G., Trinick, J. 1983. On the mechanism of water holding in meat: The swelling and shrinking of myofibrils. *Meat Science*, vol. 8, no. 4, p. 245-281. https://doi.org/10.1016/0309-1740(83)90013-X

Ruusunen, M., Puolanne, E. 2005. Reducing sodium intake from meat products. *Meat Science*, vol. 70, no. 3, p. 531-541. https://doi.org/10.1016/j.meatsci.2004.07.016

Saláková, A. 2012. Instrumental measurement of texture and color of meat and meat products. *Maso International*, no. 2, p. 107-117.

Shan, L. C., De Brún, A., Henchion, M., Li, Ch., Murrin, C., Wall, P. G., Monahan, F. J., 2017. Consumer evaluations of processed meat products reformulated to be healthier – A conjoint analysis study. *Meat Science*, vol. 131, p. 82-89. https://doi.org/10.1016/j.meatsci.2017.04.239

Sindelar, J. J., Cordray, J. C., Olson, D. G., Sebranek, J. G., Love, J. A. 2007. Investigating quality attributes and consumer acceptance of uncured, no-nitrate/nitrite-added commercial hams, bacons, and frankfurters. *Journal of Food Science.*, vol. 72, no. 8, p. 551-559. https://doi.org/10.1111/j.1750-3841.2007.00486.x

Terrell, R. N. 1983. Reducing the sodium content of processed meats. *Food Technology*, vol. 37, no. 7, p. 66-71.

Tobin, B. D., O'Sullivan, M. G., Hamill, R. M., Kerry, J. P. 2012. Effect of varying salt and fat levels on the sensory and physiochemical quality of frankfurters. *Meat Science*, vol. 92, no. 4, 659-666. https://doi.org/10.1016/j.meatsci.2012.06.017

Tobin, B. D., O'Sullivan, M. G., Hamill, R. M., Kerry, J. P. 2013. The impact of salt and fat level variation on the physiochemical properties and sensory quality of pork breakfast sausages. *Meat Science*, vol. 93, no. 2, p. 145-15. https://doi.org/10.1016/j.meatsci.2012.08.008

WHO 2013. Mapping salt reduction initiatives in the WHO European Region, World Health Organisation. Regional Office for Europe.

Acknowledgments:
This research was carried out in Biotechnology Pavilion M, financed by the OP VaVpI CZ.1.05/4.1.00/04.0135 project at the Department of Food Technology at Mendel University.

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