EVALUATION OF SELECTED QUALITY PARAMETERS OF REDUCED SALT FRANKFURTERS

Miroslav Júzl, Alena Saláková, Martina Müllerová, Klára Kozohorská

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 (Debreckinsky 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 Excluded) 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*a* (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 assessed 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 RBF groups of samples.

Untrained 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).

Frankfurters of all groups become darker (Table 2) after heat treatment. The highest total colour difference $\Delta E^*_{ab}$ (5.96) after treatment (Table 3) was in variants with beef meat (CBF and RBF) and when comparing control variants (CF $\Delta E^*_{ab}$) 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. (Kamenik 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) | CPF (X ±SD) | RPF (X ±SD) | CBF (X ±SD) | RBF (X ±SD) |
|----------------------|-------------|-------------|-------------|-------------|
| Dry matter           | 39.54 ±1.93ᵃ | 41.50 ±1.50ᵇ | 43.09 ±0.52ᵇ | 44.08 ±0.19ᶜ |
| Fat                  | 19.38 ±0.19ᶜ | 20.22 ±1.73ᵈ | 16.45 ±0.39ᵃ | 18.29 ±0.36ᵇ |
| NaCl                 | 2.05 ±0.11ᵇ  | 1.65 ±0.10ᵃ  | 2.10 ±0.08ᵇ  | 1.51 ±0.19ᶜ  |

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

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 ($p < 0.05$).
complication for the manufacturers. The consumer would and containing beef. Our results show that, although (Bolger et al., 2017) strategy is to reduce salt and saturated fat, nutrients which are consumed more than meat is a significant contributor to consumers’ intake of salt and (Desmond, 2006)–heat treated; CPF – 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.

| Descriptor | Groups | UT | HT |
|------------|--------|----|----|
| Appearance | CPF    | 81.88 ±10.91 | 80.50 ±13.61 | 74.88 ±10.91 | 73.50 ±13.61 |
|            | RPF    | 91.56 ±6.28 | 88.31 ±6.23 | 84.56 ±6.28 | 81.31 ±6.26 |
| Colour     | CPF    | 86.13 ±5.23 | 87.00 ±5.15 | 75.13 ±5.23 | 76.00 ±5.18 |
|            | RPF    | 87.44 ±6.16 | 88.44 ±6.32 | 76.44 ±6.16 | 77.44 ±6.30 |
| Texture    | CPF    | 86.31 ±8.28 | 85.88 ±8.47 | 68.31 ±8.28 | 67.88 ±8.45 |
|            | RPF    | 89.50 ±5.07 | 84.75 ±7.98 | 71.50 ±5.07 | 66.75 ±7.91 |
| Juiciness  | CPF    | 78.31 ±14.90 | 72.81 ±13.80 | 54.31 ±14.90 | 48.81 ±13.88 |
|            | RPF    | 90.31 ±4.54 | 78.56 ±4.20 | 66.31 ±4.50 | 54.56 ±4.13 |
| Aroma      | CPF    | 86.38 ±6.51 | 85.69 ±5.88 | 83.38 ±6.51 | 82.69 ±5.86 |
|            | RPF    | 80.13 ±4.11 | 85.00 ±5.38 | 87.13 ±4.11 | 82.00 ±3.34 |
| Saltiness  | CPF    | 84.38 ±10.66 | 79.19 ±8.67 | 78.38 ±10.66 | 73.19 ±8.63 |
|            | RPF    | 89.19 ±6.65 | 77.63 ±7.01 | 83.19 ±6.65 | 71.63 ±7.04 |
| Taste      | CPF    | 90.25 ±4.82 | 81.13 ±7.25 | 94.25 ±4.82 | 85.13 ±7.29 |

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.

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

| Treatment | CIE1976 | CIE1976 |
|-----------|---------|---------|
| CPF       | 3.65    | 3.79    |
| RPF       |         |         |
| CBF       |         |         |
| RBF       |         |         |
| PORK      | 2.50    | 1.78    |
| BEEF      |         |         |
| Control Beef Frankfurters, CBF | 4.78 |
| Reduced salt Beef Frankfurters, RBF | 5.96 |
| Control Pork Frankfurters, RPF | 3.71 |
| Reduced salt Pork Frankfurters, CPF | 4.84 |

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). 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 possibility. 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 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.

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 nitrates/nitrites (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, nitrate 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.

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Contact address:
Miroslav Juzl, Mendel University in Brno, Faculty of AgriSciences, Department of Food Technology, Zemedelska 1, 613 00 Brno, Czech Republic, E-mail: miroslav.juzl@mendelu.cz
Alena Salakova, Mendel University in Brno, Faculty of AgriSciences, Department of Food Technology, Zemedelska 1, 613 00 Brno, Czech Republic, E-mail: alena.salakova@mendelu.cz
Martina Müllerová, Mendel University in Brno, Faculty of AgriSciences, Department of Food Technology, Zemedelska 1, 613 00 Brno, Czech Republic, E-mail: xmulle15@node.mendelu.cz
Klára Kozohorská, Mendel University in Brno, Faculty of AgriSciences, Department of Food Technology, Zemedelska 1, 613 00 Brno, Czech Republic, E-mail: nezvalovak@gmail.com