Possibility of partial replacement of sodium chloride with potassium chloride and ammonium chloride in chicken ćevapčići (kebabs)

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Abstract. The goal of this study was to investigate the influence of reducing sodium chloride content in chicken ćevapčići (kebabs) by partial replacement of sodium chloride with potassium chloride and ammonium chloride, with the target of achieving the optimal salty taste. The trial consisted of five groups. In the control group of chicken ćevapčići, only sodium chloride was added. In group 1, one third of sodium chloride was replaced with potassium chloride; in group 2 one half of the sodium chloride was replaced with potassium chloride; in group 3, one third of sodium chloride was replaced with ammonium chloride. In group 4, sodium chloride was half reduced and one quarter of ammonium chloride in the relation to control group was added. Sensory evaluation was performed by ten trained assessors using numeric scales. Evaluations of colour acceptability and consistency showed there were no statistical differences (P≥0.05) between the ćevapčići. The most expressed saltiness was evaluated in the control ćevapčići group due to it having the largest amount of added sodium chloride, as well in group 3 ćevapčići, wherein one third of the sodium chloride was replaced with ammonium chloride.

1. Introduction

Sodium chloride is the first of the known food preservatives ever to be used, particularly where meat is concerned, and has remained in use to this day. The main source of sodium in food products is derived from sodium chloride i.e., table salt, and its consumption and intake significantly exceeds nutritional recommendations. This is particularly the case in modern, highly industrialised human societies. Salt is the prototypical stimulus for salty taste [1] and it improves the sensory properties of food by increasing saltiness, decreasing bitterness and increasing sweetness and other congruent flavour effects [2].

Overconsumption of sodium through food is the main cause of essential human hypertension [3], as well as cardiovascular disorders. In 2012, the World Health Organisation (WHO) adopted new guidelines concerning the intake of salt and potassium, which recommends a daily intake of less than 2,000 mg of sodium or 5 grams of salt and less than 3,510 mg of potassium for adults [4]. The American Heart Association recommends no more than 2,300 mg of sodium per day and moving toward no more than 1,500 mg per day for most adults [5].
One of the most common foods with high amounts of sodium are meat products. Of the total daily amount of table salt ingested into the body through usual amounts of food, approximately 20% originates from meat products [6].

Minced meat products are extremely popular among all cultures, due to their specific aroma and taste, especially when these types of meats are prepared on a grill. In recent times, people are increasingly using minced meat made from poultry, the first choice being chicken meat. In addition to containing proteins with high biological value, fats and essential amino acids, vitamins and minerals, poultry meat is also rich in vitamin B complex, specifically thiamine, riboflavin, niacin and pantothenic acid [7]. One of the methods used to reduce the salt content of meat products is through the partial substitution of sodium chloride with other chloride salts (KCl, CaCl and MgCl₂) [8, 9]. Potassium chloride is the most common substitute for sodium chloride; however, complete substitution of sodium chloride is not an option, as even with 50% substitution, many studies indicate that this results in an increase in bitter taste and a decrease in salinity.

The goal of this paper was to investigate the possibility of reducing the sodium content in meat preparations i.e., chicken čevapčići (kebabs), by partially substituting sodium chloride with potassium chloride and ammonium chloride.

2. Materials and Methods

The experiment consisted of five sample groups of chicken čevapčići (kebabs) produced with different salt mixtures. The composition of chicken čevapčići is presented in Table 1. Chicken čevapčići were prepared from chilled chicken minced meat category I (breast 70%, drumstick and thigh without skin 30%).

In the control group (C) only sodium chloride was added in an amount of 8.5 g which is common for this type of product. In group 1, one third of sodium chloride was replaced with potassium chloride, while in group 2 one half of the sodium chloride was replaced with potassium chloride. In group 3, one third of sodium chloride was replaced with ammonium chloride. In group 4, sodium chloride was half reduced and one quarter of ammonium chloride in the relation to control group was added.

### Table 1. Composition of chicken čevapčići (g)

| Sample groups | Chicken minced meat | Sodium Chloride | Potassium chloride | Ammonium chloride |
|---------------|-------------------|----------------|------------------|-------------------|
| C             | 491.5             | 8.5            | -                | -                 |
| 1             | 491.5             | 5.66           | 2.84             | -                 |
| 2             | 491.5             | 4.25           | 4.25             | -                 |
| 3             | 491.5             | 5.66           | -                | 2.84              |
| 4             | 493.6             | 4.25           | -                | 2.13              |

2.1. Sensory evaluation

Sensory evaluation was performed by ten trained assessors [10] using numeric scales. Colour acceptability, consistency, saltiness acceptability and taste acceptability were evaluated with a 1-5-point scale, where 1 was at least acceptable and 5 was the most acceptable attribute. Saltiness intensity was evaluated with a 1-5-point scale, whereby 5 was the most expressed attribute and 1 was the least expressed attribute. Preparation and presentation of the samples to the assessors (number, coding and randomization) as well as the fitting out of the serving area (isolation of panellists, lighting conditions) were performed according to [11]. The final ranking was done according to the sum of all sensory evaluation results, where the best scored chicken čevapčići was ranked first and the worst ranked in fifth place.
2.2. Statistical evaluation
The obtained results were statistically evaluated using Microsoft Excel 2010 and are presented as mean ± SD. Statistical differences between means of the examined parameters were determined at the levels 0.05 and 0.01 by Student’s t-test.

3. Results and discussion
The results of the sensory evaluation of chicken ĉevapčići are presented in Table 2. Samples of chicken ĉevapčići from all experimental groups were evaluated as having high colour acceptability and consistency and between means, there were no statistically significant differences (p > 0.05).

The mean saltiness acceptability of control ĉevapčići (4.40 ± 0.54) was significantly higher (p < 0.05) than that of group 3 ĉevapčići (3.25 ± 1.03), which had the lowest saltiness acceptability. Group 3 ĉevapčići had the most expressed saltiness (4.35 ± 0.78). Group 4 ĉevapčići were significantly less salty (p < 0.05), as were group 2 ĉevapčići (p < 0.01), than those from group 3. The results obtained were in accordance with results published by Lilić et al. [12] for meat balls. They found significant differences in saltiness intensity between control and groups 2 and 4 for burgers (p < 0.05), but the saltiness of ĉevapčići did not accord to saltiness differences of meatballs from groups 2 and 3 (p < 0.01).

Due to the ĉevapčići from the control group being produced only with added sodium chloride, the bitter taste was the least expressed in this product. However, in ĉevapčići where sodium chloride was replaced with larger amounts of potassium chloride i.e. ammonium chloride (group 2: 3.20 ± 1.14 and group 4: 3.15 ± 1.36), bitter taste was intensified compared to the control ĉevapčići, evaluated as 1.75 ± 1.12 (p < 0.05). In group 2 ĉevapčići, half of the sodium chloride was replaced with potassium chloride, resulting in increasing bitter taste intensity, leading to lower overall acceptability of the product. The presented results are in accordance with the results obtained by De Almeida et al. [13] and Inguglia et al. [14], who concluded that the partial substitution of sodium chloride with potassium chloride had a negative impact on product taste, because of bitter taste. Despite that, Lilić et al. [12] found no statistically significant differences between samples of meatballs from the control and experimental groups produced with the same salt mixtures as samples in this trial.

The highest taste acceptability was achieved by ĉevapčići from the control group (4.45 ± 0.57). The taste acceptability of group 2 ĉevapčići (3.45 ± 0.52), in which sodium chloride was partially substituted with potassium chloride, and taste acceptability of group 4 ĉevapčići (3.25 ± 1.31), in which half the amount of sodium chloride was added, and to which ammonium chloride in the amount of a quarter of the amount of salt added to the control group was added, was statistically significantly lower than the taste acceptability of the control ĉevapčići (p < 0.05). Group 3 ĉevapčići, in which a third of the sodium chloride was substituted with ammonium chloride, were awarded the lowest taste acceptability (3.15 ± 0.87), which was a statistically significant difference compared to the control group (P < 0.01). The results obtained were in accordance with results of Rašeta et al. [15], who reported very similar numeric evaluation for taste acceptability and statistical significances.

Overall acceptability of ĉevapčići from the control group (4.45 ± 0.52) was statistically higher (p < 0.01) compared to the overall acceptability of ĉevapčići from groups 2 and 4 (3.10 ± 1.07 and 3.05 ± 1.29, respectively), and statistically significantly higher (p < 0.05) compared to the overall acceptability of group 3 ĉevapčići (3.25 ± 0.78). There were no statistically significant differences (p > 0.05) between the overall acceptability of control and group 1 ĉevapčići (3.85 ± 0.78).

Despite the significance of the differences in terms of certain sensory attributes, the samples of chicken ĉevapčići taken from all experimental groups were sensorially acceptable in terms of saltiness, taste, colour, consistency and salt and bitter taste intensity.

Based on the results of this study, it can be concluded that chicken ĉevapčići with reduced sodium chloride and/or potassium chloride content could be prepared by the partial substitution of sodium chloride with potassium chloride and ammonium chloride.
Table 2. Sensory evaluation of chicken čevapčići, Mean ± SD, n = 10

| Colour acceptability | Consistency | Saltiness acceptability | Saltiness intensity | Taste acceptability | Bitter taste intensity | Overall acceptability |
|----------------------|-------------|-------------------------|---------------------|--------------------|-----------------------|-----------------------|
| C                    | 4.65±0.55   | 4.45±0.65               | 4.40±0.54a          | 4.05±0.82a         | 4.45±0.57ax           | 1.75±1.12g            |
| 1                    | 4.40±0.80   | 4.20±0.75               | 4.20±0.90           | 4.00±1.00          | 2.65±1.10             | 3.85±0.78             |
| 2                    | 4.50±0.63   | 3.80±0.68               | 3.65±1.18           | 3.00±0.81b         | 3.45±0.52b            | 3.20±1.14b           |
| 3                    | 4.55±0.57   | 3.80±0.71               | 3.25±1.03b          | 3.55±0.78a,γ       | 3.15±0.87γ           | 2.80±1.10             |
| 4                    | 4.65±0.63   | 4.00±0.89               | 3.50±1.10           | 3.15±1.16b         | 3.25±1.31b            | 3.15±1.36b           |

(a,b) Values (mean±SD) in columns with different superscript letters are significantly different (P≤0.05)
(x,y) Values (mean±SD) in columns with different superscript letters are significantly different (P≤0.01)

4. Conclusion

Despite the significance of the differences in terms of certain sensory attributes, the experimental chicken čevapčići taken from all groups were sensorially acceptable in terms of saltiness, taste, colour, consistency and salt and bitter taste intensity. Partial replacement of sodium chloride with other chloride salts, potassium chloride and ammonium chloride, in the different ratios did not influence colour acceptability or consistency. However, use of these salts had direct impacts on the salt intensity, bitterness and overall impression. The čevapčići with salt replacements had less intensity of saltiness, except čevapčići with a large amount of added ammonium chloride, in which the saltiness was the most expressed and that were more bitter than control čevapčići, which resulted in low sensory evaluation scores for taste and overall acceptability.

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