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Reducing sodium chloride content by partial replacement with potassium chloride or ammonium chloride in pork stew

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A b s t r a c t: The goal of this study was to investigate the influence of reducing sodium chloride content in pork stew by partial replacement of sodium chloride with potassium chloride or ammonium chloride, with a target to achieve optimal salty taste. The trial consisted of five groups. In the control pork stew, 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, sodium chloride was reduced by half and one quarter of ammonium chloride was added compared to the control stew, and in group 4, sodium chloride was reduced by 62.5%, and the same weight of ammonium chloride as sodium chloride was added. Sensory evaluation was performed by ten trained assessors using numeric scales. Evaluations of colour acceptability and consistency were without statistical differences (P≥0.05). The most expressed saltiness was evaluated in group 1 due to it having the largest amount of added sodium chloride. Ammonium chloride added in the pork stew in group 3 intensified saltiness of the product, even though the sodium chloride level was a half that of the control group. Taste acceptability was directly correlated with saltiness acceptability and evaluated as better in group 2 and group 4 stews. Statistically significant differences in taste acceptability were established between group 2 and group 3 stews (P≤0.01), between control and group 2 stews (P≤0.05), and between group 3 and group 4 stews (P≤0.05).

Keywords: *pork stew, sodium chloride reduction, potassium chloride, ammonium chloride.*

Introduction

Sodium chloride (NaCl) is the primary, most common food additive that gives a salty taste and prolongs shelf life of food. Taste perception of food is unitary and composed of anatomically independent sensory systems that emphasise the role of general taste perception, and it is associated with the food flavour as well as with trigeminal sensations (*Rolls et al., 2010*). Salt contributes to food consistency, masks metallic tastes and off notes and rounds out overall impressions of food (*Gillette, 1985*). Although salt is very important in food, dietary sodium intake in almost all cases is above the recommended level, and it is the most common cause of essential hypertension in humans and consequential cardiovascular disorders (*Weinberger et al.*, 2001).

Dietary sodium intake can be reduced in several ways such as a sodium restricted diet, sodium reduction by stealth, use of salt substitutes and other approaches (*Liem et al., 2011*). The most common way to reduce sodium content in food is to use NaCl substitutes such as other chloride salts, particularly potassium chloride (*Guàrdia et al.,* 2006*)*. Diet salts, containing mixtures of sodium chloride and potassium chloride are already available on the market.

Due to the aforementioned problems, foods, especially meat products, are often a subject of investigation to reduce their sodium content. There are many scientific studies about sodium reduction in pasteurised and sterilised meat products such as in cooked sausages and in meat products that are not thermally treated such as dry fermented sausages and dry meats. Nowadays, ready-to-eat food and prepared meals have become an important choice for people due to busy lifestyles and lack of time. Beside restaurants, the meat industry, for these purposes, produces various, mainly canned, prepared meals containing meat and vegetables.

The need to reduce sodium in meat products and generally in food will be an aim of the food industry in the future; fast food chains will also have to address this issue, even if people think the amount of salt consumed *via* fast food is not so large (*Moran*

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et al., 2017). Nonetheless, use of salt replacers presents a difficult problem because of degradation of desirable sensory characteristics, including texture and, of course, salty taste (*Kamenik et al.,* 2017*; Kang et al.,* 2014).

The goal of this study was to investigate the influence of reducing the sodium chloride content in pork stew by partial replacement of sodium chloride with potassium chloride or ammonium chloride, with a target to achieve optimal salty taste.

Materials and Methods

The trial consisted of five sample groups of pork stew with the compositions presented in Table 1. In the control group of pork stew, only sodium chloride was added. In group 1, one third of the 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, sodium chloride was reduced by half and one quarter of ammonium chloride in the relation to control group was added, and in group 4, sodium chloride was reduced by 62.5% of the amount added into control stew, and an equal weight of ammonium chloride as sodium chloride was added.

Meal preparation

Minced onion was fried in the sunflower oil for 20 minutes, and after that red pepper, salts and pork (pork shoulder, category II), cut into pieces were added, as well as water. Stew was cooked for 80 minutes.

Sensory evaluation

Sensory evaluation was performed by ten trained panellists (*SRPS ISO 8586*, 2015) using numeric scales. Colour acceptability, consistency, saltiness acceptability and taste acceptability were evaluated with a 1–5 point scale, where 1 was the least acceptable and 5 was the most acceptable attribute. Saltiness intensity was evaluated with a 1–5 point scale, wherein 5 was the most expressed attribute and 1 was the least expressed attribute. Preparation and presentation of the stew samples to the assessors (number, coding and randomisation) as well as the fitting out of the serving area (isolation of panellists, lighting conditions) were performed according to *Baltic and Karabasil* (2011). The final ranking was performed according to the sum of all sensory evaluation results, where the best scored stew was ranked in 1st place and the worst in 5th place.

Statistical evaluation

The results obtained 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 of 0.05 and 0.01 by Student's t-test.

Results and discussion

Results of sensory evaluation of colour acceptability, consistency, saltiness acceptability, saltiness intensity and taste acceptability of pork stew are presented in Table 2.

Colour acceptability and consistency were evaluated with very high scores and were very similar between the examined groups of stews, without statistical differences (P≥0.05). Evaluations for colour acceptability ranged from 4.65 for group 3 to 4.95 for group 2 stew. Evaluations for consistency were also high and were in the range from 4.70 (groups 3 and 4) to 4.80 (group 2). Partially replacing chloride salt with other salts, potassium chloride (groups 1 and 2) or ammonium chloride (groups 3 and 4) had no negative effect on these sensory parameters (colour or consistency).

Saltiness was the least acceptable in group 3 pork stew (2.90) and was statistically significantly

Table 1. Composition of pork stew

Group	Onion, g	Sunflower oil, ml	Meat, g	Water, ml	Sodium chloride, g	Potassium chloride, g	Ammonium chloride, g
Control	500	50	500	500	16.00	–	–
1	500	50	500	500	10.66	5.33	–
2	500	50	500	500	8.00	8.00	–
3	500	50	500	500	8.00	–	4.00
4	500	50	500	500	6.00	–	6.00

Table 2. Sensory evaluation of pork stew, Mean±SD, n = 10

	Colour acceptability	Consistency	Saltiness acceptability	Saltiness intensity	Taste acceptability
Control	4.75±0.40	4.75±0.40	3.10±0.86 ^{a}	4.60±0.66 ^{x}	3.60±0.54^{a}
1	4.80±0.40	4.75±0.40	3.85±0.81	2.70±1.19 ^{y}	3.75±0.72
2	4.95±0.15	4.80±0.40	4.35±0.90 $^{b, x}$	2.10±0.70 $^{a, y}$	4.50±0.92^{b,x}
3	4.65±0.55	4.70±0.51	2.90±1.04 ^{y}	3.30±1.00 $^{b, y}$	2.95±1.11^{c,y}
4	4.75±0.40	4.70±0.46	3.65±1.03	2.30±0.46 $^{a, y}$	4.20±0.68^{d}

Legend: $^{(a,b,c,d)}$ Values (mean±SD) with different superscript letters are significantly different (P≤0.05);
$^{(x,y)}$ Values (mean±SD) with different superscript letters are significantly different (P≤0.01)

greater (P≤0.01) compared to saltiness of the group 2 stew (4.35). Also saltiness acceptability of group 2 stew was evaluated as better (P≤0.05) than the control stew (3.10). The most expressed saltiness (intensity) was evaluated in the control stew (4.60) due to it having the largest amount of added sodium chloride, and it was significantly higher than those from other stew groups (P≤0.01). The lowest intensity of salty taste was determined in group 2 stew (2.10), in which sodium chloride was reduced by half, and in the group 4 stew (2.30), in which sodium chloride was reduced by 62.5% and ammonium chloride was added. Ammonium chloride added to the group 3 pork stew intensified the saltiness of the product, even though the sodium chloride content was half that of the control stew. Saltiness intensity was evaluated as higher in group 3 stew than in stews 2 and 4 (P≤0.05).

Taste acceptability was directly correlated with saltiness acceptability and evaluated as being greater (i.e., more acceptable) in group 2 stews (4.50) and group 4 stews (4.20) than in stews from other groups. Statistically significant differences were established for this attribute between group 2 and group 3 stews (P≤0.01), between control and the group 2 stews (P≤0.05) and between group 3 and group 4 stews (P≤0.05).

The prepared pork stews were ranked in the following order: 1st place – group 2; 2nd place – group 4; 3rd place – group 1; 4th place – group 3; and 5th place – the control group.

Conclusion

Colour and consistency of the pork stews were not influenced by reducing sodium chloride content and adding potassium chloride or ammonium chloride.

Saltiness was the most expressed in the control group stew due to it having the largest amount of added sodium chloride, and this parameter was significantly higher than in other groups (P≤0.01). More intense saltiness of the group 3 stew, even though sodium chloride was reduced by half compared to the control stew, could be due to ammonium chloride having a synergistic effect on the saltiness of sodium chloride.

Taste acceptability was directly correlated with saltiness acceptability and evaluated more favourably in the group 2 and group 4 stews. Statistically significant differences were established for this attribute between group 2 and group 3 stews (P≤0.01), between control and the group 2 stews (P≤0.05) and between group 3 and group 4 stews (P≤0.05).

The results obtained showed that pork stew presents a good matrix for sodium chloride/sodium content reduction. All samples of pork stew were sensorially acceptable, even those in which sodium chloride was reduced by half and in which sodium was reduced by 62.5% in the relation to the control stew. The great significance of these results is achieving a better sodium:potassium ratio in this product.

Mogućnost redukcije sadržaja natrijum hlorida u svinjskom paprikašu parcijalnom supstitucijom kalijum hloridom i amonijum hloridom

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A p s t r a k t: Cilj rada bio je da se ispita uticaj smanjenja sadržaja natrijum hlorida u svinjskom paprikašu, delimičnom supstitucijom natrijum hlorida kalijum hloridom i amonijum hloridom u svrhu postizanja optimalne slanosti. U ogledu je formirano pet grupa. U kontrolnoj grupi uzoraka dodat je samo natrijum hlorid. U grupi 1, trećina natrijum hlorida zamenjena je kalijum hloridom, dok je u grupi 2, polovina natrijum hlorida zamenjena kalijum hloridom. U grupi 3, natrijum hlorid je upola smanjen, a četvrtina amonijum hlorida je dodata, u odnosu na količinu soli u kontrolnoj grupi, dok je u četvrtoj grupi natrijum hlorid smanjen za 62,5%, a amonijum hlorid dodat u istoj količini kao natrijum hlorid. Senzorska ocena bila je izvedena od strane deset obučenih ocenjivača korišćenjem numeričkih skala. Ocene za prihvatljivost boje i konzistenciju bile su bez statistički značajnih razlika (P≥0.05). Slanost je bila najizraženija u uzorcima prve grupe usled najveće količine dodate soli. Amonijum hlorid dodat u uzorcima treće grupe pojačao je slanost proizvoda, iako je sadržaj natrijum hlorida upola smanjen u odnosu na kontrolnu grupu. Prihvatljivost ukusa bila je u direktnoj korelaciji sa slanošću i bila je bolje ocenjena u uzorcima iz druge i četvrte grupe. Statistički značajne razlike utvrđene su između uzoraka druge i treće grupe (P≤0.01), između uzoraka kontrolne i druge grupe (P≤0.05) i između uzoraka treće i četvrte grupe (P≤0.05).

Ključne reči: *svinjski paprika, redukcija natrijum hlorida, kalijum hlorid, amonijum hlorid.*

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