*Estudos Tecnológicos* - Vol. 5, n° 3:431-439 (set/dez. 2009) ISSN 1808-7310
doi: 10.4013/ete.2009.53.13

# Development of smoked chicken product with low-sodium content

## *Desenvolvimento de um produto defumado de frango com baixo teor de sódio*

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## Abstract

Sodium intake exceeds the nutritional recommendations in many industrialized countries. Excessive intake of sodium has been linked to hypertension and consequently to increased risk of stroke and premature death from cardiovascular diseases. The main source of sodium in the diet is sodium chloride, which affects the flavor, texture and shelf life of meat products. Product development and studies concerning the reduction of salt content for public who intend to reduce sodium consumption were the goal of this study. The required salt content was achieved in accordance to national legislation (30% of sodium reduction). Five treatments were done: control (NaCl), NaCl + KCl, NaCl + KCl (flavored), NaCl + KCl + Condiments, NaCl + KCl (flavored) + Condiments. Sensorial evaluation showed that the reduction of NaCl and replacement with KCl did not affect taste and acceptability. Furthermore, consumers showed a behavioral intention to consume low salt meat products, which is indicated to produce in industrial field.

***Key words:*** *salt reduction, sodium reduction, reduced salt meat product, smoked product.*

## Resumo

A ingestão de sódio excede as recomendações nutricionais em muitos países industrializados. A excessiva ingestão de sódio tem sido associada à hipertensão arterial e, consequentemente, ao aumento do risco de acidente vascular cerebral e morte prematura devido a doenças cardiovasculares. A principal fonte de sódio na dieta é o cloreto de sódio, que afeta o sabor, a textura e vida de prateleira dos produtos cárneos. O desenvolvimento de produtos e estudos relativos à redução do teor de sal para o público que pretende reduzir consumo de sódio foram os objetivos do presente estudo. O conteúdo exigido de sal foi alcançado em conformidade com a legislação nacional (30% de redução de sódio). Foram feitos cinco tratamentos: controle (NaCl), NaCl + KCl, NaCl + KCl (aromatizado), NaCl + KCl + condimentos, e NaCl + KCl (aromatizado) + Condimentos. A avaliação sensorial mostrou que a redução de substituição com NaCl e KCl não afetou o sabor e a aceitabilidade. Além disso, os consumidores mostraram um comportamento de intenção de consumir produtos cárneos com baixo teor de sal, o que foi indicado para produção em escala industrial.

**Palavras-chave***: redução de sal, redução de sódio, produto de carne com redução de sal, produto defumado.*

## 1. Introduction

Researchers have suggested that sodium intake exceeds the nutritional recommendations in several industrialized countries and the presence of salt sensitivity is associated with an increased incidence of death or cardiovascular complications, representing an accelerated atherosclerotic process in the vascular wall. In

addition, salt sensitive hypertension is accompanied by more pronounced endothelial dysfunction. These results provide evidence of the harmful effects of high sodium chloride (NaCl) intake in the adult population, and in this way, public health and regulatory authorities have recommended a reduced dietary intake of sodium chloride (Muntzel and Drüeke, 1992; He and Macgregor, 2002; Ruusunen *et al*., 2003a, 2003b; Colmenero *et al*., 2005; Ruusunen *et al*., 2005; Desmond, 2006; Guàrdia *et al*., 2006; Haddy, 2006; Larrousse *et al*., 2006; García-García and Totosaus, 2008; Nakandakare *et al*., 2008; Swain *et al*., 2008).

Sodium chloride is one of the most frequently used ingredients in meat processing which affects flavor, texture and shelf life (due to its ability to lower water activity) of meat products, but its contents on processed meat products should be reduced. To control the dietary intake of sodium from these products is difficult because of the different levels of sodium found in the same type of product. One easy way for reducing the average sodium intake is to reduce the NaCl content particularly of those products in which NaCl content is higher than the average (Ruusunen *et al*., 2005; Ruusunen and Puolanne, 2005; Desmond, 2006; Guàrdia *et al*., 2006; García-García and Totosaus, 2008).

A 25% reduction in NaCl is probably the most that can be achieved without detrimentally affecting product characteristics (i.e., flavor, texture, and shelf-life). There are several approaches for reducing the sodium content in processed meats: (i) lowering the level of sodium chloride (NaCl) added; (ii) replacing all or part of the NaCl with other chloride salts (KCl, $CaCl_2$, and $MgCl_2$); (iii) replacing part of the NaCl with non-chloride salts, such as phosphates, or with new processing techniques or process modifications; and (iv) combinations of any of the above approaches (Crehan *et al*., 2000; Ruusunen and Puolanne, 2005; Desmond, 2006; Guàrdia *et al*., 2006; Torres, 2006; García-García and Totosaus, 2008).

In general, consumers seem to be concerned about the harmful effects that a high level of sodium in their diet could have, and there is a tendency to reduce the amount of sodium chloride (NaCl) in food. For this reason, reduction of sodium in meat products could be of great interest from a health point of view. However, the replacement of sodium chloride by potassium chloride can lead to bitterness, which can be a disadvantage because consumers are not accustomed to differences on sensory characteristics (Crehan *et al*., 2000; Paulino, 2005; Ruusunen and Puolanne, 2005; Guàrdia *et al*., 2006). The goal is to reduce the salt content, while looking for alternatives to reduce the bitterness and enhance the product flavour.

The aims of this study were: (i) to develop a low-sodium smoked chicken product; (ii) to investigate the effect of different formulation on the sensorial characteristics (sensory saltiness, flavor intensity, firmness and juiciness) and (iii) compare to traditional smoked chicken product.

## 2. Materials and methods

### 2.1 Smoked chicken product preparation

The smoked chicken product was developed in a meat factory located in Arroio do Meio, RS, Brazil. The Brazilian's Legislation (Brasil, 1998, 2002) requires that the product ready-for-eat, to receive the attribute "reduced" in relation to sodium content, must submit a reduction of at least 25% sodium and the difference greater than 120mg/100g of solid or 120 mg/100ml of liquids.

Based on the percentage of sodium found in the original formulation (total of 1.18% sodium) and the Brazilian's Legislation requirement (reduction of at least 25% sodium), we decided to reduce in 30% of the sodium content. The variation in the sodium content was achieved by varying 50% of commercial sodium chlorine (NaCl) content and replacing with 50% of potassium chloride (KCl).

According to Table 1, five treatments were tested to achieve the best formulation with acceptable sensory attributes. All weights corresponds the quantity of NaCl and/or KCl necessary to 5,000 g of raw chicken meat. A commercial flavored potassium chloride (Batches 2 and 4) and condiments (Batches 3 and 4) were used to minimize possible bitterness.

*Table 1: Treatments tested.*

| Ingredients | Control | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| NaCl | 99.78g | 49.89g | 49.89g | 51.26g | 51.26g |
| KCl | - | 49.89g | - | 51.26g | - |
| Flavoured KCl | - | - | 49.89g | - | 51.26g |
| Condiments | - | - | - | 2.94g | 2.94g |

Chicken meat was first ground through a plate (5 mm). Dry ingredients and flaked ice was mixed and divided in five portions (5 treatments). Then NaCl, KCl, flavored KCl and condiments were mixed and stored at refrigeration temperature for 12 hours. After, 500 g of meat was separated (Figure 1), rolled with chicken skin, tied and submitted to cold smoking process during 30 minutes. After smoked product was packaged into polystyrene expanded trays covered with stretching and sticking PVC plastic film; and stored for 5 days until sensory analysis.

*Grounded meat*

*Preparing to roll*

*Rolling with chicken skin*

*Tie process*

*Tied product*

*Smoking process*

*Smoked product*

*Packed product*

*Figure 1: Smoked chicken product process.*

## 2.2 Sensorial Analysis

Appearance, color, flavor, texture, saltiness, bitterness intensity and acceptability of treated and untreated (control) product were evaluated by a staff of 30 non-trained panelists (naturally chicken meat consumers) was carried out using an unstructured line scale of 9 cm (1 = low intensity and 9 = high intensity) to register their evaluations.

Samples were presented to the panelists with three-digit codes and in random order, and water was provided for rinsing of the mouth between samples. The test was accomplished in a sensory panel room (ICTA/UFRGS) according to methodology Dutcosky (2007). At the final, it was questioned if each panelist has intent to purchase the product.

### 2.3 Acceptability index

The acceptability index (AI) was employed to determine how much a person likes the food product. It has been calculated considering the average measure and maximum measure achieved for examined product according to the follow equation: AI (%) = (mean value/higher response) x 100. The product reaching a percentage > 70% will be considered accepted by panelists (Teixeira *et al*., 1987; Dutcosky, 2007).

### 2.4 Statistical analysis

The results were analyzed using SPSS statistical package (version 13). ANOVA and Tukey's test were used to identify significant effects at a 95% significance level ($p < 0.05$).

## 3. Results and Discussion

Meat industry and consumers have become more aware of the relationship between sodium and hypertension and, therefore, in many countries, the demand for a variety of low salt meat products has increased. Food processors are developing numerous low-salt products to meet the demands of consumers. Developing low-salt meat products is, however, not straightforward (Ruusunen and Puolanne, 2005).

Potassium chloride (KCl) is probably the most common cost-effective salt substitute used in low- or reduced salt/sodium foods, and is the only salt with generally recognized as safe (GRAS) status as a replacement of NaCl. However at blends over 50:50 sodium chloride/potassium chloride in solution, a significant increase in bitterness and loss of saltiness is observed. Masking agents are commonly used in these products, i.e., the use of flavor enhancers which do not have a salty taste, but enhance the saltiness of products when used in combination with salt (Collins, 1997; Colmenero *et al*., 2005; Paulino, 2005; Desmond, 2006; Guàrdia *et al*., 2006;).

Analysis of variance of the sensorial evaluation scores (Figure 2) results showed no significant differences ($p>0.05$) for all attributes among samples except to texture between product 2 (50% NaCl + 50% Flavored KCl) and product 4 (50% NaCl + 50% Flavored KCl + Condiments), which significant differences ($p<0.05$) were found. Tukey's test showed that for texture, product 2 (7.07) differed statistically from product 4 (6.13) and had superiors scores, probably due the increase of NaCl and KCl content (Table 1).

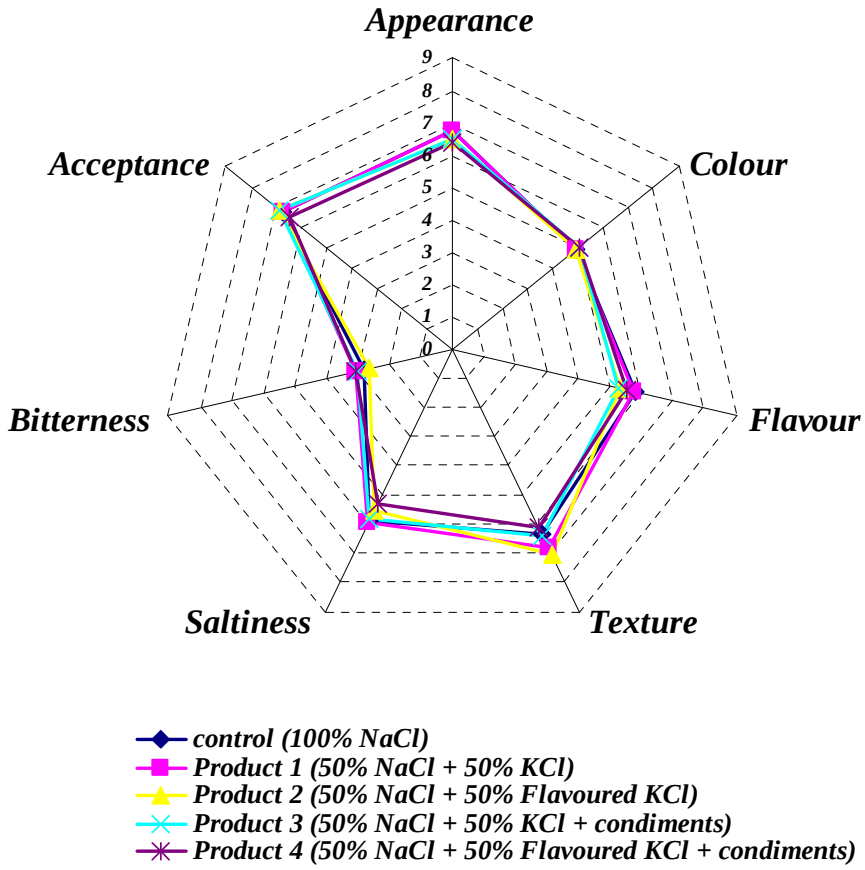


*Figure 2: Sensorial evaluation.*

Sodium chloride plays such an important role in meat products. A particular problem with low-salt meat products is that not only the perceived saltiness, but also the intensity of the characteristic flavour decreases, when salt is reduced. In this study, the exchange 50% of sodium chloride (NaCl) by 50% of potassium chloride (KCl) didn't show saltiness significant difference ($p>0.05$) between all products. In most cases, when low-salt meat products are developed, the benchmark for the low-salt meat product is the normal-salt product. Consequently, the same quality characteristics must apply to low-salt meat products as to the correspondent normal-salt meat products.

Ruusunen and Puolanne (2005) comment that meat product manufacturers have marketed low-salt alternatives, or have progressively reduced salt content over the years, where technological and microbiological considerations have made this possible.

Some authors consider a significant increase in bitterness and loss of saltiness when 50:50 sodium chloride/potassium chloride are used in low- or reduced salt/sodium foods (Colmenero *et al*., 2005; Paulino, 2005; Ruusunen and Puolanne, 2005; Desmond, 2006; Guàrdia *et al*., 2006; García-García and Totosaus, 2008).

In this study, panelists did not detect a significant difference ($p>0.05$) on bitterness between the products, which is extremely positive. However, it is valid comment that they were not trained, and little

information exists on consumer ideas and feelings towards reduced salt meat content, but in all evaluation the scores average obtained for all products were low (< 3.07). Moreover, probably that they had no familiarity with the type of product tasted (a differentiated product) and with occasional consumption. It is also pertinent to remember that this product is smoked and may have contributed to improve its taste, possibly masking the natural bitterness of potassium chloride.

However, preference can also be used to indicate choice or purchase decisions (Guàrdia *et al*., 2006). In the present study, preference was only based on sensory characteristics of the products tested. When we asked panelists the intention to purchase and/or consume the product, the panelists answered: 22.92% buy the control (100% NaCl) and product 2 (50% NaCl + 50% Flavored KCl), 20.83 % buy the product 3 (50% NaCl + 50% KCl + condiments), 18.75% buy the product 1 (50% NaCl + 50% KCl) and 14.58% buy the product 4 (50% NaCl + 50% Flavored KCl + Condiments). All products had an intention to purchase and the percentage was equilibrated and in accordance to the results of acceptance (scores > 6.5) and acceptability index (Table 2). The lower percentage of intention to purchase the product 4 suggested that the increase of condiment (and not to KCl employed) was rejected; however, this product has a high index of acceptability.

*Table 2: Intention to purchase and acceptability index.*

| **Products** | **Intention to Consume and/or buy (%)** | **Acceptability index (%)** |
|---|---|---|
| *Control (100% NaCl)* | 22.92 | 80.03 |
| *Product 1 (50% NaCl + 50% KCl)* | 18.75 | 81.20 |
| *Product 2 (50% NaCl + 50% Flavoured KCl)* | 22.92 | 75.34 |
| *Product 3 (50% NaCl + 50% KCl + condiments)* | 20.83 | 82.20 |
| *Product 4 (50% NaCl + 50% Flavoured KCl + condiments)* | 14.58 | 81.82 |

It is interesting to note that from the total of 30 panelists, none said they did not buy any of the samples, three did not answer the question, one said they would buy all samples and thirteen showed more than an intention to purchase.

According to Table 2, all products had a excellent acceptability (>70%), which means that all samples made with potassium chloride were accepted by panelists and thus could be produced commercially. Moreover, one of the biggest barriers to salt replacement is cost as salt is one of the cheapest food ingredients available. Also, consumers have grown accustomed to salt through processed foods so in some cases it has being difficult to remove. Although there are alternatives to salt in term of functionality some consumers and retailers could not be comfortable with these new ingredients on the label (Desmond, 2006).

## 4. Conclusions

The food industry needs to produce reduced salt products that are similar, in terms of texture and flavor, to regular products the consumer is familiar with.

According to these results it seems that consumers not only showed a behavioral intention to consume low salt meat products but they also liked them in a similar way to the regular ones. It would seem

possible to reduce half of the sodium chloride content in smoked chicken product obtaining a product with acceptable to the consumers.

A reduction by 50% of the NaCl can be done by substitution with KCl without modifying either acceptability or preference (acceptance index > 75%), and serve the target market of people who needs to reduce the intake of sodium in their diet.

Any alteration in salt content of meat products requires ingredient reformulation or manipulation. Some companies have produced products that are successful in replacing or substituting sodium in processed products others have been less so. Government agencies need to continue educating consumers in terms of salt and health, as 15–20% of salt intake is coming from discretionary sources.

For future experiments we also recommend that physical and chemical analysis could be accomplished with sensorial analysis (with more panelists, i.e., more than 50), as well as the cost-effectiveness analysis. Further research is needed to study the microbiological stability and safety of the smoked chicken product with low-sodium content.

## Acknowledgements

The authors express their sincere appreciation to Mr. Sr. Cristiano Weizenmann and to Control Quality Team (Factory 2 from Companhia Minuano de Alimentos) for the practical execution of this work.

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Submissão: 20/07/2009

Aceite: 23/11/2009