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REDUÇÃO DE CLORETO DE SÓDIO EM CARNES MARINADAS BOVINA E DE FRANGO: QUALIDADE DA CARNE, COMPOSIÇÃO QUÍMICA E ASPECTOS MICROBIOLÓGICOS

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BIOGRAFIA

CAMILA BARBOSA CARVALHO nasceu em PARANAVAÍ no estado do PARANÁ. Possui graduação em NUTRIÇÃO pela UNIVERSIDADE FEDERAL DO PARANÁ. Tem experiência nas áreas de desenvolvimento de novos produtos, controle de qualidade, técnica dietética e alimentos especiais assim como em Boas Práticas de Fabricação e APPCC, atuando principalmente nos seguintes temas: Controle de qualidade para alimentos, desenvolvimento de novos produtos e alimentos especiais.

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"*Existem pessoas que passam pela nossa vida e deixam marcas eternas, pessoas que guardamos na lembrança e em nossos corações para sempre".*

APRESENTAÇÃO

Esta dissertação de mestrado está apresentada na forma de dois artigos científicos:

1 Camila Barbosa Carvalho, Grasiele Scaramal Madrona, Silvana da Silva Corradine, Péricles Martins Reche, Magali Soares dos Santos Pozza, Ivanor Nunes do Prado. SODIUM CHLORIDE REDUCTION IN MARINATED BOVINE AND CHICKEN MEAT: MEAT QUALITY, CHEMICAL COMPOSITION AND MICROBIOLOGICAL ASPECTS, International Journal of Food Science & Technology.

2 Camila Barbosa Carvalho, Grasiele Scaramal Madrona, Adriela Albino Rydlewski, Silvana da Silva Corradine, Ivanor Nunes do Prado . ANÁLISE SENSORIAL DE CARNES BOVINA E DE FRANGO COM TEMPERO COMPLETO HIPOSSÓDICO, Unopar Científica Biológica.

GENERAL ABSTRACT

Meat and meat products are important sources of protein, fat, amino acids, minerals, vitamins and other nutrients (Biesalski, 2005). In recent years, consumer demand for a food safer and better quality of meat and meat products with reduced levels of fat, sodium chloride, cholesterol , nitrite plus a composition improved in profile fatty acids, incorporating functional ingredients, grown worldwide (Scollan *et al*, 2006; Hocquette *et al*, 2012)

Sodium is considered an important marker of quality of food. The Ministry of Health recommends that the content of this nutrient in the diet does not exceed 2300 mg for adults. However, the population mean of sodium intake in Brazil exceeds 3200 mg. The consumption of pizza, processed meats, industrialized snacks, stuffed cookie and soda has been linked to high intakes of sodium and more than 70% of the population consumes quantities above the maximum tolerable intake for sodium.

In the category of manufactured products, meat and meat products represent the second largest contribution in sodium intake in the diet, approximately 20.8% of the daily sodium intake. The higher contribution of sodium comes from processed meat products (0.54g), with only 0.05g of sodium from fresh meat (Jiménez-Colmenero *et al.*, 2001).

The use of salt substitutes such as potassium chloride is limited primarily by its bitter taste. Therefore, various compounds bitter taste inhibitors have been proposed mainly to be added in the parameter flavor objects may be further study including the use of masking the bitter taste, for example, herbs and spices (Carraro *et al.* 2012). For these reasons, partial substitution of sodium chloride by potassium chloride and addition of aromatic herbs, and spices coloríficos marinated meat products becomes an output promising for the reduction of sodium and maintaining the palatability of these products.

This study aimed to develop marinated meats (beef and chicken) using low-sodium seasonings complete, replacing sodium chloride by potassium chloride in percentages of 25 and 50% with the addition of herbs and spices.

We used four types of meat to perform the analyzes, 2 types (bovine *Longissimus dorsi* and *Quadriceps femoris*) and 2 types of chicken (drumstick and breast fillet). Loin The - Longissimus dorsi was acquired in the cattle production sector in Cutting Experimental Farm Iguatemi (FEI) belonging to the State University of Maringá (UEM), Brazil. The duckling - Q*uadriceps femoris* was purchased from Maria Macia Agricultural Cooperative Mista, Campo Mourao-Pr, Brazil. The chicken were purchased from Poultry Slaughterhouse Canção, Maringa-Pr, Brazil, belonging to the same batch. The herbs and spices were purchased from a local market in Maringa-Pr, Brazil. The spices were used for marinated garlic (*Allium sativum*), annatto (*Bixa orellana*), turmeric (*Curcuma longa*), chilli (*Capsicum frutescens*), black pepper (*Piper nigrum*), oregano (*Oreganum vulgare*) and Marjoram (*Oreganum majorana*) . The reagents were analytical grade, belonging to the laboratory of Food Engineering - UEM, Brazil.

The marination of the meat was applied statically, using 2g spice to 100g of meat, dip the meat in seasoning, when ingredients penetrate gradually by diffusion, without the application of force for 24 hours kept at 4 º C and packed vacuo.

Meat moisture and ash were determined according to (ISO-R-1442, 1997) and (ISO-R-936, 1998). Crude protein were obtained according to (ISO-R-937, 1978) and total fat was determined according to (ISO-R-1443, 1973). As regards the mineral composition analysis, samples were digested by dry method (AOAC, 1990) and the contents of sodium and potassium were quantified on a AA240FS atomic absorption spectrophotometer (Varian, USA) in mg per kg of mineral product, using standard analytical solutions and curves. Microbiological analyzes were performed for thermo-tolerant coliform and Salmonella sp, determined using methodology determines by Silva et al (1997). The pH was measured 24 hours after thawing of the meat marinade for all samples. A portable Crisson 503 pH-meter equipped with a penetration probe electrode was used to measure pH of the samples, in triplicate. The cooking loss was calculated as the difference between the weight of the samples thawed and baked (% CL = [weight (thawed - cooked weight) / thawed] x 100). The mechanical properties of meat has been obtained by texture analysis using Stable Micro Systems Taxt Plus (Texture Technologies Corp., UK) with a load cell of 5.00 kg and a Warner-Bratzler (WB). The analysis was performed according to the methodology proposed by the Research Center of the USDA Meat Animal (Wheeler *et al*., 1997). The determination of color was measured after 24 hours storage of the product at 5 ° C marinated by colorimetry. For the analysis of the color, the samples were grilled until reaching an internal temperature of 70 ° C. Lipid oxidation was assessed in duplicate by the method of measuring the quantity of 2-thiobarbituric acid (TBA) (Raharjo *et al*. 1992), using 5 g of milled raw meat sample.

The sensory test in this study was approved by the Ethics Committee for Human Research at the State University of Maringá, CAAE File No. 0389-11 and performed with 100 untrained hypertensive and 40 admitted to a local hospital, using hedonic scale of 9 points.

Statistical analyzes were performed by analysis of variance (ANOVA) and Bonferroni averaging (Berthold *et al*., 2011) at a significance level of 5% by Statistics 7.0 (SAS, 2004).

To beef of all microbiological treatments fulfilled the recommendations given by Brazilian legislation for seasoned meats. Levels of moisture, ash, protein and fat did not differ between treatments. These levels according to normality for beef (Torres *et al.,* 1998). The replacement of sodium by potassium, herbs and spices in marinades reduced the level of sodium in 47.5% of samples from the *longissimus dorse* muscle and 45.1% in the *quadriceps femoris* muscle (Duckling) for the treatment F50. The color of meat with regard to brightness (L *), redness (a *) and yellowness (b *) were similar for all samples. The cooking losses were on average 30%, within the normal range for seasoned meats.

A significant difference was observed between treatments only with regard to texture the *quadriceps femoris*, probably due to the presence of the cut nerve. As to the results of sensory analysis for beef, the acceptability index remained above 70% for all samples and reached 80% for bovine duckling when the sodium content was replaced by 50%. The results are considered excellent and entirely acceptable with regard to sensory attributes, second Dutcosky (2011).

For the chicken all treatments reached the microbiological specifications of the Brazilian legislation for chicken marinade with *Salmonella* and maximum value of 10^4 for coliforms at 45 º C (Silva et al., 2005). For the physico-chemical properties of chicken meat marinated with sodium reduction was no statistical difference between the samples on moisture, ash, crude protein and total lipid. The samples showed a significant difference ($p < 0.05$) in levels of sodium and potassium between control and F50 for the two types of chicken cuts. There was a significant reduction in sodium between samples, reduction of 51.06% for chicken drumstick and 50.71% for chicken breast fillet compared to the control treatment and F50, a

percentage above 50 % reduction due to the addition of herbs and spices for seasoning, which corresponds to 17% of the total composition, and the added ingredients (*Allium sativum*, *Oreganum Majorana*, *Curcuma longa*, *Piper nigrum*) did not contain significant levels of sodium its composition (TACO, 2011). Significant difference in color was observed for the filet of chicken breast between treatments F25 and F50. This is probably due to the use of the spice turmeric-long causing a higher concentration of yellowish color. Although there was no significant difference ($p < 0.05$) among treatments for both types of meat in relation to weight loss after cooking the chicken drumsticks had higher rates on this factor, due to the high content fat compared to beef and chicken breast. Texture values remained stable between treatments. There was no significant difference between samples for pH and TBARS, and the analyzed parameters remained within the normal range and similar to the results found by Harder *et al*. (2010) for chicken with annatto a mean pH of 6.47 and Torres et al. (1998) with an average pH to 6.54 with spices chicken burger, similar to the values of this study. Rates of 1.84 mg malonaldehyde /kg^{-1} TBARS were also reported by the same authors, after 15 days of storage of the product. The results of sensory evaluation indicate that all samples tested had acceptability index above 70%. The chicken drumstick with a 50% reduction in sodium content was potentially accepted by consumers, reaching 80% of acceptability.

Replacement of 25 to 50% sodium chloride by potassium chloride in beef and chicken marinated products with herbs and spices, proved to be a highly effective strategy to achieve acceptable products, without altering its microbiological, sensorial, chemistry and physics.

RESUMO GERAL

Carne e produtos cárneos são importantes fontes de proteína, gordura, aminoácidos essenciais, minerais, nutrientes vitamínicos e outros (Biesalski, 2005). Nos últimos anos, a demanda dos consumidores por um alimento mais seguro e de maior qualidade da carne e de produtos à base de carne com níveis reduzidos de gordura, cloreto de sódio, colesterol e nitrito, acrescidos de uma composição melhorada no perfil de ácidos graxos, incorporando ingredientes funcionais, cresceu mundialmente (Scollan *et al*, 2006;.. Hocquette *et al*, 2012)

O sódio é considerado um importante marcador da qualidade da alimentação. O Ministério da Saúde recomenda que o teor desse nutriente na dieta não ultrapasse 2300 mg para indivíduos adultos. Porém, a média populacional de ingestão de sódio no Brasil ultrapassa 3200 mg. O consumo de pizza, carnes processadas, salgadinhos industrializados, biscoito recheado e refrigerante foi relacionado ao consumo elevado de sódio e mais que 70% da população consome quantidades superiores ao valor máximo de ingestão tolerável para o sódio.

Na categoria de produtos industrializados, carne e produtos cárneos representam a segunda maior contribuição no consumo de sódio na dieta, aproximadamente 20.8% do consumo de sódio diário. A maior contribuição de sódio provém de produtos cárneos industrializados (0.54g), sendo apenas 0.05g de sódio proveniente de carne fresca (Jiménez-Colmenero *et al.*, 2001).

O uso de sais substitutos como o cloreto de potássio é limitado principalmente pelo seu sabor amargo. Por isso, vários compostos inibidores do sabor amargo têm sido propostos para serem adicionados principalmente no parâmetro sabor poderão ser objeto de estudo futuro incluindo o uso de mascaradores do sabor amargo como, por exemplo, ervas e especiarias (Carraro *et al.*, 2012). Por estas razões, a substituição parcial do cloreto de sódio pelo cloreto de potássio e a adição de ervas aromáticas, colorífícos e especiarias aos produtos cárneos marinados torna-se uma saída promissora para a redução de sódio e a manutenção da palatabilidade destes produtos.

Assim, este estudo teve como objetivo desenvolver carnes marinadas (bovina e de frango) utilizando temperos completos hipossódicos, substituindo o cloreto de sódio por cloreto de potássio em percentuais de 25 e 50% com adição de ervas aromáticas e especiarias.

Foram utilizadas 4 tipos de carne para realização das análises, 2 tipos bovina(*Longissimus Dorsi* e Patinho) e 2 tipos de frango (sobrecoxa e filé de peito).O contrafilé - *Longíssimos dorsi* foi adquirido no Setor de Bovinocultura de Corte na Fazenda Experimental de Iguatemi (FEI) pertencente à Universidade Estadual de Maringá (UEM), Brasil. O patinho – *Quadríceps femoris* foi adquirido de Maria Macia Cooperativa Mista Agropecuária, Campo Mourão-Pr, Brasil. As carnes de frango foram adquiridas do Abatedouro de Frangos Canção, Maringá-Pr, Brasil, pertencentes ao mesmo lote. As ervas e especiarias foram compradas de um comércio local em Maringá-Pr, Brasil. As especiarias utilizadas para os marinados foram alho (*Allium sativum*), urucum (*Bixa orellana*), açafrão (*Curcuma longa*), pimenta calabresa (*Capsicum frutescens*), pimenta preta (*Piper nigrum*), orégano (*Oreganum vulgare*) e manjerona (*Oreganum majorana*). Os reagentes eram de qualidade analítica, pertencentes ao laboratório de Engenharia de Alimentos - UEM, Brasil.

A marinação das carnes foi aplicada de forma estática, utilizando 2g de tempero para 100g de carne, por imersão da carne no tempero, quando os ingredientes penetram gradativamente por difusão, sem aplicação de força, durante 24 horas mantidas a temperatura de 4ºC e embaladas a vácuo.

Umidade da carne e cinzas foram determinadas de acordo com (ISO-R-1442, 1997) e (ISO-R-936, 1998). Teores de proteína bruta foram obtidos de acordo com (ISO-R-937, 1978) e de gordura total foi determinada de acordo com (ISO-R-1443, 1973). No que se refere à análise da composição mineral, as amostras foram

digeridas pelo método seco (AOAC, 1990) e os teores de sódio e potássio foram quantificados em um espectrofotómetro de absorção atómica AA240FS (Varian, EUA), em mg por kg de mineral do produto, usando o padrão soluções analíticas e curvas. As análises microbiológicas foram realizadas para coliformes termo-tolerantes e *Salmonella sp*, determinados utilizando metodologia determina por Silva *et al*(1997). O pH foi medido 24 horas após o descongelamento da carne marinada para todas as amostras. Um aparelho portátil Crisson 503 pH-metro equipado com uma sonda de eléctrodo de penetração foi utilizado para medir o pH das amostras, em triplicata. A perda por cocção foi calculada pela diferença entre o peso descongelado e cozido das amostras (% CL = [peso (descongelado - peso cozido) / descongelado] x 100). As propriedades mecânicas das carnes foram obtidas pela análise de textura utilizando o Stable Micro Systems Taxt Plus (Texture Technologies Corp, UK) com uma célula de carga de 5,00 kg e uma probe Warner-Bratzler (WB). A análise foi realizada de acordo com a metodologia proposta pelo Centro de Pesquisas de carne Animal do USDA (Wheeler et al., 1997). A determinação da cor foi medida após 24 horas de armazenamento do produto marinado a 5 ° C por colorimetria. Para a análise da cor, as amostras foram grelhadas até atingirem uma temperatura interna de 70 º C. A oxidação lipídica foi avaliada em duplicata pelo método de aferição da quantidade do ácido 2-tiobarbitúrico (TBA) (Raharjo et al., 1992), utilizando-se 5 g de carne crua moída por amostra.

O teste sensorial neste estudo foi aprovado pelo Comitê de Ética em Pesquisa com Seres Humanos da Universidade Estadual de Maringá, Arquivo CAAE n º 0389-11 e realizado com 100 provadores não treinados e 40 hipertensos internados em um hospital local, utilizando escala hedônica estruturada de 9 pontos.

As análises estatísticas foram realizadas por análise de variância (ANOVA) e cálculo médio de Bonferroni (Bertoldo *et al*., 2011) ao nível de significância de 5% por 7,0 Estatística (SAS, 2004).

Para carne bovina de todos os tratamentos cumpriram as recomendações microbiológicas determinada pela legislação brasileira para carnes temperadas .Os níveis de umidade , cinzas, proteina e gordura não variou entre os tratamentos. Níveis estes de acordo com a normalidade para carne bovina (Torres *et al*., 1998). A substituição de sódio por potássio, ervas e especiarias nas s marinadas reduziram o nível de sódio das amostras em 47,5% no músculo Longissimus dorsi e 45,1% no Músculo quadríceps femoris (Patinho) para o tratamento F50. A cor da carne no que se refere à luminosidade (L *), vermelhidão (a *) e amarelecimento (b *) foram semelhantes para todas as amostras. As perdas por cocção foram em média de 30%, ou seja, dentro da normalidade para carnes temperadas.

Diferença significativa foi observada entre os tratamentos apenas no que diz respeito à textura do *Quadríceps femoris*, provavelmente devido a presença de nervos no corte. Quanto aos resultados da análise sensorial para carne bovina, o índice de aceitabilidade permaneceu acima de 70% para todas as amostras e chegou a 80% para o patinho bovino, quando o teor de sódio foi substituído em 50%. Os resultados podem ser considerados excelentes e inteiramente aceitáveis no que diz respeito aos atributos sensoriais, segundo Dutcosky (2011).

Para carne de frango todos os tratamentos atingiram as especificações microbiológicas da legislação brasileira para carne de frango marinada com ausência de *Salmonella* e com valor máximo de 10^4 para coliformes a 45 º C (Silva *et al*., 2005). Para as características físico-químicas da carne de frango marinada com redução de sódio não houve diferença estatística entre as amostras nos teores de umidade, cinzas, proteina e lipídio. As amostras apresentaram diferença significativa ($p < 0,05$) nos teores de sódio e potássio entre os tratamentos controle e F50 para os dois tipos de cortes de frango. Houve uma redução significativa na taxa de sódio entre amostras, ou seja, redução de 51,06% para a sobrecoxa de frango e 50,71% para o file de peito de frango quando comparados o tratamento controle e F50, uma porcentagem acima de 50% de redução se deve à adição de ervas e especiarias ao tempero, o que corresponde a 17% da sua composição total, sendo que os ingredientes adicionados (*Allium sativum, Oreganum Majorana, Curcuma longa, Piper nigrum*) não continham níveis significativos de sódio em sua composição (TACO, 2011). Diferença significativa de cor foi observada para o filé de peito de frango entre os tratamentos F25 e F50. Isto se deve provavelmente ao uso da especiaria curcuma-longa o que causou maior concentração de cor amarelada. Embora não tenha havido diferença significativa ($p < 0,05$) entre os tratamentos para os dois tipos de carne

no que diz respeito à perda de peso após a cocção, as sobrecoxas de frango apresentaram taxas mais elevadas sobre este fator, devido ao elevado teor de gordura quando comparadas com o da carne de peito de frango. Valores de textura mantiveram-se estáveis entre os tratamentos. Não houve diferença significativa entre as amostras para valores de pH e TBARS, sendo que os parâmetros analisados permaneceram dentro da faixa de normalidade e semelhante aos resultados encontrados por Harder *et al*. (2010) para frango cozido com urucum com uma média de pH 6,47 e por Torres *et al*. (1998) com uma média de pH 6,54 para hambúrguer de frango com condimentos, semelhante aos valores deste estudo. Taxas de TBARS de 1,84 mg malonaldeído/kg^{-1} também foram relatados pelos mesmos autores, após 15 dias de armazenamento do produto. Os resultados da análise sensorial indicam que todas as amostras testadas apresentam índice de aceitabilidade acima de 70%. A sobrecoxas de frango com redução de 50% em seu teor de sódio foram potencialmente aceitas pelos consumidores, atingindo 80% de aceitabilidade.

A substituição de 25 e 50% de cloreto de sódio por cloreto de potássio em carne bovina e de frango marinados com ervas e especiarias provou ser uma estratégia altamente eficaz para alcançar a aceitabilidade desses produtos, sem alterar a sua qualidade microbiológica, sensorial, química e física.

ARTICLE 1

SODIUM CHLORIDE REDUCTION IN MARINATED BOVINE AND CHICKEN MEAT: MEAT QUALITY, CHEMICAL COMPOSITION AND MICROBIOLOGICAL ASPECTS

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Summary. The substitution of 25 and 50% NaCl by KCl in marinated beef and chicken meat with the addition of aromatic herbs and spices was used by the meat´s microbiological, micronutrient, chemical composition and sensorial analyses. Meats showed a reduction in NaCl contents without any change in their physical and chemical characteristics while the products´ quality and microbiological safety were maintained. Further, 50% KCl caused no reduction in the products´ sensory quality and the overall acceptance for both types of meat was maintained, with 70% for bovine and chicken meat with a 50% reduction in their sodium content. Results show that 50% reduction in NaCl contents of marinated meat products with a combination of herbs and spices is possible. Future applications in other meat products and sausages are highly promising.

Keywords: Beef, sensory analysis, sodium, spices.

Introduction

Meat and meat products are important sources of protein, fat, essential amino acids, minerals, vitamin and other nutrients (Biesalski, 2005). In recent years, consumers´ demands for safer and higher quality meat and meat products with reduced levels of fat, cholesterol, sodium chloride (NaCl), nitrite, coupled to an improved composition of fatty acid profile and incorporated health-enhancing ingredients, are rapidly increasing worldwide (Scollan *et al.*, 2006; Hocquette *et al.*, 2012). Meat enrichment with bioactive compounds and the effects of meat-based substances on human health have been studied extensively (Zhang *et al.*, 2010). The consumers´ acceptance of functional foods varies widely and depends on their social, economical, geographical, political, cultural and ethnic backgrounds (Jiménez-Colmenero *et al.*, 2001).

Different studies have shown that human health risks, such as hypertension, may be related to high NaCl intake (Elliott *et al.*, 2007), which effects on coronary heart diseases (Cook *et al.*, 2007), stroke occurrences (Xie *et al.*, 1992) and non-cardiovascular diseases (Tarek & Graham, 1996). In fact, approximately 12.8% of mortality in world population may be traced to a non-optimal blood pressure (Lawes *et al.*, 2006). He and MacGregor (2003) estimated that if global NaCl intake were reduced from approximately 10 g day^{-1}, around one quarter of mortality rates caused by coronary heart diseases and one third deaths caused by stroke would be prevented. Furthermore, the suggestion of reducing NaCl intake from approximately 10 g day^{-1} to 5 g day^{-1} has a significant effect on blood pressure reduction. Moreover, a decrease to 3 g day^{-1} will have relevant additional effects (He & MacGregor, 2003). Actually the long term target for NaCl intake worldwide should be 3 g day^{-1} instead 6 g day^{-1} (He & MacGregor, 2003).

NaCl is extant in several foods, although its greatest contribution occurs in industrially processed ones (He & MacGregor, 2003). An efficient and cost-effective way to decrease heart conditions and stroke occurrences is the reduction of NaCl in food. Consequently, the food industry is trying to reduce NaCl in food by replacing sodium with other substances. However, NaCl replacement in food is complex, especially in meat products, and the understanding of NaCl mechanism in meat is highly relevant for its reduction. In

the case of sodium reduction, several ingredients such as potassium, ammonium, calcium, magnesium (Cardozo *et al.*, 2004) and lithium, in the form of chloride salts, and anions, such as phosphate and glutamate, should be decreased. Potassium chloride (KCl) is a common alternative as a possible sodium replacer (Beck *et al.*, 2012). Sensory analyses have shown that 20% of NaCl may be replaced by KCl in foods (Cardozo *et al.*, 2004). Since the use of KCl provides a negative taste to the product (Beck *et al.*, 2012), other natural ingredients, including herbs and spices, have been studied as potential sodium reduction and replacement in meat and meat products (Carraro *et al.*, 2012). Compounds from herbs and spices contain many phytochemicals which are potential sources of natural antioxidants which include phenolic diterpenes, flavonoids, tannins and phenolic acids (Dawidowicz *et al.*, 2006). These compounds have antioxidant, anti-inflammatory and anticancer activities. In food systems, they improve flavor, retard lipid oxidation-induced food deteriorations, inhibit the growth of microorganisms and decrease risks of certain diseases (Tanabe *et al.*, 2002). Among the spices, the clove is reported to have the strongest antioxidant capacity, followed by rose petals, cinnamon, nutmeg and others (Zhang *et al.*, 2010). In addition, spices have antimicrobial capacities, mainly due to their phenolic compounds. The possible mechanisms for the phenolic compounds´ antimicrobial effect include alterations in microbial cell permeability (Bajpai *et al.*, 2008); interference with the membrane function, including electron transport, nutrient uptake, protein and nucleic acid synthesis and enzyme activity (Bajpai *et al.*, 2008); interaction with membrane proteins causing deformation in structure and functionality (Rico-Munoz *et al.*, 1987); transformation of alkyls into phenol nucleus (Dorman & Deans, 2008). Allicin is known as the main ingredient of garlic, with antimicrobial activities against gram-positive and gram-negative bacteria. Allicin is enzymatically produced from its precursor aliin via the intermediate product of allylsulfenic acid (Ellmore & Feldberg, 1994). Many studies demonstrated that garlic extract was effective in reducing the growth of many pathogens (Zhang *et al.*, 2010). Aqueous garlic extract in refrigerated poultry meat inhibited the growth of microbial contaminants, including facultative aerobic, mesophile and fecal coliforms (Oliveira *et al.*, 2005). The addition of 1% and 3% of garlic juice may decrease peroxide rates, TBARS, residual nitrite and total microbiological counts when compared to rates of control in emulsified sausage during cold storage (Park & Kim, 2009).

Oregano is a traditional Mediterranean spice and its essential oil, obtained by steam distillation, contains more than 30 compounds. Among the compounds, carvacrol and thymol constitute its major antioxidant capacity (Vekiari *et al.*, 1993). The addition of 3% oregano essential oil on pork and beef lowered oxidation levels after 12 days of refrigerated storage (Fasseas *et al.*, 2008). Oregano oil could extend the shelf-life of fresh chicken breast meat by reducing the growth of microorganisms during refrigerated storage. However, 1% oregano oil could introduce very strong unfavorable flavor to food products and thus low sensory quality ranking (Chouliara *et al.*, 2007). On the other hand, oregano essential oil (0.05%, 0.5% and 1%) could delay the growth of microorganisms and decrease the final counts of spoilage microorganisms under modified atmosphere conditions (Skandamis & Nychas, 2002).

Obviously, NaCl cannot be substituted by a single substance. Rather, possible substitutes should be combined in such a way that taste and quality of the meat are largely preserved. Actually the partial substitution of NaCl by KCl and the addition of aromatic herbs and spices in meat products are becoming a promising strategy for the reduction of sodium and for the maintenance of the products´ palatability. Current assay was performed to develop marinated meats (beef and chicken) with complete low-sodium seasonings by replacing NaCl 25 and 50% by KCl with the addition of herbs and spices.

Materials and methods

Sample collection

Nine bovine *Longissimus dorsi* (LD) muscles were obtained from a local abattoir 24 h after slaughtering; they were vacuum-packed and kept at 4^{o}C. Samples came from Aberdeen Angus vs. Nellore bulls, 20 months old, raised on the same farm and fed *ad libitum* on a concentrated diet and corn silage. Nine bovine knuckles (*Quadriceps femoris)* were obtained from Frigorífico Maria Macia in Campo Mourão PR Brazil. Chicken meat was obtained from Frigorífico Frangos Canção in Maringá PR Brazil. Samples from each muscle were analyzed in triplicate. Steaks with 2 cm thickness were cut with a knife from each sample and

randomly allocated for each analysis; they were vacuum-packed and kept frozen at –18^{o}C until analysis within 2 months. Prior to each analysis, the samples were thawed at 4^{o}C for 24 h, removed from the vacuum package, placed individually in polystyrene trays (15.5 × 21.5 × 2.5 cm) and randomly allocated to each treatment.

Spices and herbs were purchased from the local market in Maringa PR Brazil. Spices for the marinades comprised garlic (*Allium sativum*), annatto (*Bixa orellana)*, turmeric (*Curcuma longa*), chilli (*Capsicum frutescens*), ground pepper (*Piper Nigrum*), oregano (*Oreganum vulgare*) and marjoram (*Oreganum majorana*). The reagents were of recognized analytical grade.

Samples

Six samples were prepared to determine the effect of substituting 25% and 50% of sodium chloride (NaCl) by potassium chloride (KCl) using herbs and spices, with three formulations for beef and three for chicken, as shown in Table 1.

Beef samples: control - CON (20 g.kg^{-1} NaCl + 2 g.kg^{-1} *Allium sativum* + 0.2 g.kg^{-1} *Oreganum Vulgare* + 1 g.kg^{-1} Urucum (*Bixa orellana)* + 0.2 g.kg^{-1} *Capsicum frutescens*); sample with 25% substitution - F25 (15 g.kg^{-1} NaCl + 5 g.kg^{-1} KCL + 2 g.kg^{-1} *Allium sativum*+ 0.2 g.kg^{-1} *Oreganum Vulgare* + 1 g.kg^{-1} Urucum *(Bixa orellana)* + 0.2 g.kg^{-1} *Capsicum frutescens*); sample with 50% substitution – F50 (10 g.kg^{-1} NaCl + 10 g.kg^{-1} KCl + 2 g.kg^{-1} *Allium sativum*+ 0.2 g.kg^{-1} *Oreganum Vulgare* + 1 g.kg^{-1} Urucum (*Bixa orellana)* + 0.2 g.kg^{-1} *Capsicum frutescens*).

Chicken meat samples: control - CON (20 g.kg^{-1} NaCl+ 2 g.kg^{-1} *Allium sativum*+ 0.2 g.kg^{-1} *Oreganum Majorana* + 1 g.kg^{-1} *Curcuma Longa* + 0.2 g.kg^{-1} *Piper Nigrum*); sample with 25% substitution - F25 (15 g.kg^{-1} NaCl + 5 g.kg^{-1} KCl + 2 g.kg^{-1} *Allium sativum*+ 0.2 g.kg^{-1} *Oreganum Majorana* + 1 g.kg^{-1} *Curcuma Longa* + 0.2 g.kg^{-1} *Piper Nigrum*); sample with 50% substitution – F50 (10 g.kg^{-1} NaCl + 10 g.kg^{-1} KCL + 2 g.kg^{-1} *Allium sativum*+ 0.2 g.kg^{-1} *Oreganum Majorana* + 1 g.kg^{-1} *Curcuma Longa* + 0.2 g.kg^{-1} *Piper Nigrum*). Herbs and spices comprised 17% of the spices formulation employed for the two types of marinated meat.

Marinating process

The meat marinating was statically performed with 2 g of seasoning for 100 g of meat. Meat was immersed in the condiment, leaving the gradually penetration of ingredients by diffusion without the application of force, for 24 hours, at 4º C, and then vacuum-packed.

Chemical analysis

Laboratory analyses of beef were carried out two months after sampling. Meat samples were thawed at 4+1°C, grounded, homogenized and analyzed in triplicate. Meat moisture and ash contents were determined according to ISO-R-1442 (1997) and ISO-R-936 (1998). Crude protein contents were obtained following ISO-R-937 (1978) and total fat was determined according to ISO-R-1443 (1973).

With regard to the analysis of mineral composition, the samples were digested by the dry method AOAC (1998) and sodium and potassium were quantified in an atomic absorption spectrophotometer AA240FS (Varian, USA) as mg of mineral per kg of product, using standard solutions and analytical curves.

Microbiological analyses

The three samples were used in batch prior to sensory analysis; food safety and product contamination after processing were evaluated for thermo-tolerant coliforms; *Salmonella sp.* was determined as proposed by Silva *et al.* (1997).

pH and water-holding capacity

Further, pH was measured 24 h after thawing marinated meat for all samples. A portable CRISSON 503 pH-meter equipped with a penetrating electrode probe was used to measure the pH of samples, in triplicate.

So that losses by cooking could be determined, the samples were thawed overnight at 4ºC + 1ºC and thermally processed by dry conventional cooking in an electric Grill 2 Multi Britain 127V. Samples were individually weighed on an electronic semi-analytical scale and identified. They were then grilled up to an internal temperature of 70ºC, checked by digital thermometer spit Incoterm with a temperature between -50 ºC and 300º C, and a stem with 145mm x 4mm diameter. They were then cooled at room temperature and reweighed. Cooking loss was calculated by the difference between thawed and cooked weight (% CL = [(thawed weight – cooked weight)/thawed weight] x 100).

Texture determination

The mechanical properties of meats were obtained by texture analyzer Stable Micro Systems TAXT Plus (Texture Technologies Corp., UK) with a 5.00 kg load cell and a Shear force (SF). Analysis was performed according to methodology proposed by the Meat Animal Research Center of the USDA (Wheeler *et al.*, 1997).

Each sample, weighing approximately 100g, was wrapped in foil and grilled on electric grill Multi Grill 2 Britannia 127V, up to 70ºC, measured by thermometer-type skewer food INCOTERM, temperature range between -50ºC and 300ºC and stem with 145mm X 4mm diameter.

Speed reached 5.0 mm / sec and peak force was expressed in kgf. In both cases, six samples of 1 cm^2 (square cross-section), with fibers parallel to the longitudinal axis of the sample, were measured. Analysis was realized in quintuplicate.

Meat color

Color determination was measured after 24-hour storage of the marinated product at 5°C by colorimeter. For color analysis, samples were put on grids until they reached an internal temperature of 70ºC.

Color was evaluated by a portable colorimeter Minolta ® CR10, with integrating sphere and 3º viewing angle, or rather, D3 lighting and illuminant D65. System was CIE (1986) a*b*L* and measured coordinates were: L* = black (0) to white (100); a* = green (–) to red (+); b* = blue (–) to yellow(+). Other parameters obtained were color saturation rate (C*) and tone angle (H*). Rates comprised the average of three independent measurements collected at random from sites across the meat.

Lipid oxidation (TBARS)

Lipid oxidation was assessed in duplicate by the 2-thiobarbituric acid (TBA) by Raharjo *et al.* (1992) method, using 5 g of minced raw meat (sampled from the whole minced steak previously trimmed of its adjacent fat and connective tissue). Thiobarbituric Acid Reacting Substances (TBARS) rates were calculated from a standard curve and expressed as mg malonaldehyde (MDA) per kg of meat. Three marinated samples for each of the 6 treatments were used.

Sensory analysis

Consumer population comprised 100 untrained subjects, 55% females and 45% males, featuring 26% less than 30 years old; 31% between 31 and 44 years old; 21% between 45 and 59 years old; 22% over 60 years. Before the start of each session, consumers were asked to fill in a paper with their personal data (gender, age, occupation) and then they were given information about the test. During the entire assay period, consumers were surveyed to make sure that the test was carried out properly. Each consumer was presented with three samples, one per treatment for each kind of meat, served and tasted at random (Macfie *et al.*, 1989). Consumers were asked to eat a piece of bread and drink some mineral water at the beginning of the sensory evaluation and between samples in an attempt to taste each sample within the same palate conditions. Consumers evaluated overall, tenderness and flavor acceptability, with an 9-point structured hedonic scale from 1 (dislike very much) to 9 (like very much), where the neutral central point (neither like

nor dislike) had been deleted in an attempt to force the consumer to make a decision either way (Font i Furnols *et al.*, 2009).

Frozen samples were thawed for 24 h in a chiller (0-4ºC) on the day before each session. Meat slices were kept at room temperature (20ºC) for approximately 1 h before cooking so that an internal muscle temperature at 13-15 ºC could be acquired. Cooking was performed at 200ºC on a pre-heated, double-grill hotplate (SAMMIC P8D-2) until the internal muscle temperature reached 70ºC monitored by an internal thermocouple JENWAY 2000. Samples were kept warm at 50ºC, or rather, less than 10 min after being cooked, until served at random to avoid first-over and carry-over effects (Macfie *et al.*, 1989).

The sensory testing in this study was approved by the Ethics Committee in Research with Human Beings of the Universidade Estadual de Maringá, CAAE File No. 0389-11. All panelists signed a free and informed consent form prior to their participation in the sensory analysis.

Acceptability rate for the product was calculated by the following Dick *et al.* (2011) equation:

IA (%) = A x 100/B

where:

A = average score of the product

B = highest score of the product

Statistics analysis

Statistical analysis was carried out by analysis of variance (ANOVA) and average calculus by Bonferroni (Bertoldo *et al.*, 2011) at 5% significance level by Statistics 7.0 (SAS, 2004).

Results and discussion

Beef meat

In current study, beef meat from all treatments met the microbiological recommendations by Brazilian Law for seasoned meats, without salmonella and with maximum coliform rate of 10^4, at 45ºC (Silva *et al.*, 2005). Thus sodium decrease did not alter the microbiological quality of marinated beef (Table 2). In a study realized by Bidlas and Lambert (2008), the authors observed that KCl may be a direct substitute for common salt with regard to antimicrobial control. A partial or complete replacement of NaCl by KCl is consequently possible without any changes in the microbiological quality of meat.

The moisture, ash, protein and fat levels of meat did not change among the treatments (Table 3). Levels of these four factors were accordingly for beef meat (Torres *et al.*, 1998). The replacement of sodium by potassium in the marinated meat reduced ($p<0.05$) sodium level in the samples and increased potassium level. Sodium level was reduced by 47.5% on *Longissimus* muscle and 45.1% on *Quadriceps femoris* muscle for the F50 treatment meat. On contrary, potassium level increased with the replacement of sodium by potassium in marinated meat. Carraro *et al.* (2012) observed a reduction of sodium level (31%) with a 50% sodium replacement by potassium in sausage to which herbs and spices were added.

Meat color with regard to lightness (L*), redness (a*) and yellowness (b*) was similar for all samples, except for the reduction in L* rates for the *Longissimus* with 50% substitution of sodium by potassium. Average L* was 45, or rather, within the normal range of cooked beef (Page *et al.*, 2001).

Cooking of samples did not affect water losses, approximately 30%, for the two cuts. In fact, specialized literature shows water loss between 25 and 30% of beef (Torres *et al.*, 1998; Andrade *et al.*, 2010; Tobin *et al.*, 2012).

Table 4 shows color, losses by cooking, pH, shear force and TBARS rates for beef. A significant difference was observed between treatments only with regard to the texture of *Quadriceps femoris*, probably due to the veal nerves, very similar to what occurred with regard to the color of *Longissimus*. Although

different, the above parameters were within normal range, values below 6.0 $Kgf.cm^{2-1}$ in shear force for beef and between 92% in brightness between 42 to 42.9 for beef, according to study by Page *et al.* (2001).

In the case of sensory acceptance, Table 5 shows no difference ($p<0.05$) for all attributes between *Quadriceps femoris* and *Longissimus* samples. The above indicates that the tasters did not notice any difference between the control formulation and the samples with reduced sodium. The addition of herbs and spices may have masked the bitter aftertaste left by less NaCl and more KCl in the food (Albarracín *et al.*, 2011).

The acceptability index remained above 70% and reached 80% for *Quadriceps femoris* when 50% sodium content was substituted. Results may be considered excellent and fully acceptable with regard to second sensory attributes (Dutcosky, 2011). According to Armenteros *et al.* (2009), the substitution of NaCl by KC in cured and dry loin, at proportions 35 and 50%, failed to affect the flavor, texture, taste and color. However, in the context of a 70% substitution, no change occurred for all attributes, except for color. Similarly, Katsiari *et al.* (1998) verified that there was no difference in sensory attributes (appearance, texture, flavor and overall appearance) in Kefalograviera cheese with 50% substitution of NaCl by KCl. Study on beef hamburgers by Tobin *et al.* (2012) produced the same good acceptability with 50% reduction in sodium content when compared to commercial products available in Ireland and the UK.

Chicken meat

Current study shows that all treatments met the microbiological specifications of Brazilian law for beef and marinated chicken, with the absence of *Salmonella* and with maximum value of 10^4 for coliforms at 45ºC (Silva *et al.*, 2005). The above shows that sodium decrease did not affect the microbiological quality of chicken meat marinade (Table 6).

Table 7 shows the physicochemical characteristics of chicken meat marinated with reduced sodium. There was no statistical difference among the samples in moisture, ash, protein and lipid in all treatments.

Research on chicken burgers and condiments by Torres *et al.* (1998) indicated 70% and 2.78% respectively for average moisture and ash, close to rates in current study.

Samples showed statistical differences ($p<0.05$) in sodium and potassium levels between control and F50 for the two chicken cuts. There was a significant reduction in sodium rates between samples, or rather, 51.06% reduction for chicken drumstick and 50.71% for chicken breast fillet between control and F50, while potassium levels increased proportionally between samples, confirming the substitution. This boils down to a percentage above 50% reduction due to the addition of herbs and spices for seasoning, which corresponds to 17% of total composition, since the added ingredients (*Allium sativum*, *Oreganum majorana*, *Curcuma Longa*, *Piper Nigrum*) did not contain significant sodium levels in their composition (TACO, 2011).

Color, loss by cooking, pH, shear force and TBARS rates for chicken meat are shown in Table 8. Significant difference in color was observed for chicken breast fillet between treatments F25 and F50. This was probably due to the use of *curcuma-longa* which caused higher concentration of the yellowish color when compared to that of the curcuminas.

In a study with cuts of cooked chicken with annatto, Harder *et al.* (2010) found 68-69 L rates for baked chicken drumsticks and 70 to 74 for cooked chicken breast, very close to rates in current paper. Although there was no significant difference ($p<0.05$) among treatments for the two types of meat with regard to weight loss after cooking, chicken drumsticks showed higher rates on this factor, perhaps due to high fat contents when compared to those in chicken breast fillet.

Texture rates remained stable between treatments, or rather, between 2.55 and 3.91 Kgf, approaching the results in a study by Devant *et al.* (2007) with chicken carcasses subjected to varying temperatures, in which CFs between 2.92 and 3.50 Kgf were obtained, and in a study by Faria *et al.* (2008) with 2.63 Kgf for chicken meat.

No significant difference between samples of chicken drumsticks occurred for the parameters analyzed which remained within normal range and similar to results by (Stelzer *et al.*, 2009) for chicken meat to produce fresh sausage with a 6.47 pH average, and to assay by Torres *et al.* (1998) with a 6.54 pH average

for chicken hamburger with condiments, similar to current study. TBARS rates of 1.84 mg malonaldheyde/kg^{-1} were also reported by the same authors after 15 days of product storage.

Results in Table 9 indicate that all tested samples showed an over 70% acceptability index. Chicken drumsticks with 50% sodium reduction or with the substitution of 50% NaCl for KCl were potentially acceptable to consumers, reaching an 80% acceptability score above 7.0. In an overall evaluation, these rates were considered optimal by Dutcosky (2011). The above results represented all the attributes analyzed by consumers who, as a rule, gave satisfactory grades.

Conclusion

The substitution of 25 to 50% sodium chloride by potassium chloride in beef and chicken marinated products with herbs and spices proved to be a highly effective strategy for achieving the acceptability of these products without altering their microbiological, sensorial and physical chemical quality. A reduction of 50% of sodium in the products maintains all the characteristics of a standard commercial marinated product.

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Table 1 Seasoning formulations with the substitution of 25 and 50% NaCl by KCl by the addition of herbs and spices

Ingredient (%)	Bovine Meat			Chicken Meat		
	CON[1]	**F25[2]**	**F50[3]**	**CON[1]**	**F25[2]**	**F50[3]**
Bovine meat	97.79	97.79	97.79	-	-	-
Chicken meat	-	-	-	97.79	97.79	97.79
NaCl	2.0	1.5	1.0	2.0	1.5	1.0
KCl	-	0.5	1.0	-	0.5	1.0
Allium sativum	0.2	0.2	0.2	0.2	0.2	0.2
Oreganum vulgare	0.02	0.02	0.02	-	-	-
Bixa orellana	0.1	0.1	0.1	-	-	-
Capsicum frutescens	0.02	0.02	0.02	-	-	-
Curcuma longa	-	-	-	0.1	0.1	0.1
Piper nigrum	-	-	-	0.02	0.02	0.02
Oreganum majorana	-	-	-	0.02	0.02	0.02

Bovine meat: [1]CON (20 $g.kg^{-1}$ NaCl + 2 $g.kg^{-1}$ *Allium sativum* + 0.2 $g.kg^{-1}$ *Oreganum vulgare* + 1$g.kg^{-1}$ *Bixa orellana* + 0.2 $g.kg^{-1}$ *Capsicum frutescens*); [2]F25 (15 $g.kg^{-1}$ NaCl + 5 $g.kg^{-1}$ KCl + 2 $g.kg^{-1}$ *Allium sativum* + 0.2 $g.kg^{-1}$ *Oreganum vulgare* + 1 $g.kg^{-1}$ *Bixa orellana* + 0.2 $g.kg^{-1}$ *Capsicum frutescens*); [3]F50 (10 $g.kg^{-1}$ NaCl + 10 $g.kg^{-1}$ KCl + 2 $g.kg^{-1}$ *Allium sativum* + 0.2 $g.kg^{-1}$ *Oreganum vulgare* + 1$g.kg^{-1}$ *Bixa orellana* + 0.2 $g.kg^{-1}$ *Capsicum frutescens*).

Chicken meat: [1]CON (20$g.kg^{-1}$ NaCl+ 2$g.kg^{-1}$ *Allium sativum*+ 0.2$g.kg^{-1}$ *Oreganum Majorana* + 1$g.kg^{-1}$ *Curcuma Longa* + 0.2$g.kg^{-1}$ *Piper Nigrum*), [2]F25-(15$g.kg^{-1}$ NaCl + 5$g.kg^{-1}$ KCl + 2$g.kg^{-1}$ *Allium sativum*+ 0.2$g.kg^{-1}$ *Oreganum Majorana* + 1$g.kg^{-1}$ *Curcuma Longa* + 0.2$g.kg^{-1}$ *Piper Nigrum*),[3]F50- (10$g.kg^{-1}$ NaCl + 10$g.kg^{-1}$ KCl + 2$g.kg^{-1}$ *Allium sativum*+ 0.2$g.kg^{-1}$ *Oreganum Majorana* + 1$g.kg^{-1}$ *Curcuma Longa* + 0.2$g.kg^{-1}$ *Piper Nigrum*).

Table 2 Microbiological results for beef marinated with sodium reduction

	Quadriceps femoris			***Longissimus* Muscle**		
	CON[1]	**F25[2]**	**F50[3]**	**CON[1]**	**F25[2]**	**F50[3]**
Coliforms (UFC. mL^{-1})	$<10^1$	$1.0x10^1$	$0.5x10^1$	$<10^1$	$<10^1$	$<10^1$
Salmonella sp (UFC.mL^{-1})	Absent	Absent	Absent	Absent	Absent	Absent

[1]CON (20 $g.kg^{-1}$ NaCl + 2 $g.kg^{-1}$ *Allium sativum* + 0.2 $g.kg^{-1}$ *Oreganum vulgare* + 1$g.kg^{-1}$ *Bixa orellana* + 0.2 $g.kg^{-1}$ *Capsicum frutescens*); [2]F25 (15 $g.kg^{-1}$ NaCl + 5 $g.kg^{-1}$ KCl + 2 $g.kg^{-1}$ *Allium sativum* + 0.2 $g.kg^{-1}$ *Oreganum vulgare* + 1 $g.kg^{-1}$ *Bixa orellana* + 0.2 $g.kg^{-1}$ *Capsicum frutescens*); [3]F50 (10 $g.kg^{-1}$ NaCl + 10 $g.kg^{-1}$ KCl + 2 $g.kg^{-1}$ *Allium sativum* + 0.2 $g.kg^{-1}$ *Oreganum vulgare* + 1$g.kg^{-1}$ *Bixa orellana* + 0.2 $g.kg^{-1}$ *Capsicum frutescens*).

Table 3 Chemical analysis for marinated beef

Item	*Quadriceps femoris*			*Longissumus Muscle*		
	CON[1]	**F25[2]**	**F50[3]**	**CON[1]**	**F25[2]**	**F50[3]**
Moisture (%)	$74.47^{a} \pm 0.53$	$75.26^{a} \pm 0.09$	$74.50^{a} \pm 0.07$	$72.02^{A} \pm 0.37$	$71.43^{A} \pm 0.82$	$71.68^{A} \pm 0.28$
Ashes (%)	$1.99^{a} \pm 0.27$	$2.38^{a} \pm 0.31$	$2.46^{a} \pm 0.43$	$2.26^{A} \pm 0.12$	$2.66^{A} \pm 0.15$	$2.17^{A} \pm 0.27$
Crude protein (%)	$19.33^{a} \pm 0.41$	$19.53^{a} \pm 0.11$	$20.27^{a} \pm 0.21$	$21.63^{A} \pm 0.33$	$21.03^{A} \pm 0.80$	$21.91^{A} \pm 0.26$
Total fat (%)	$3.78^{a} \pm 0.23$	$4.12^{a} \pm 0.15$	$3.41^{a} \pm 0.63$	$1.76^{A} \pm 0.21$	$1.72^{A} \pm 0.28$	$1.69^{A} \pm 0.28$
Sodium ($mg.100g^{-1}$)	$662.13^{a} \pm 1.85$	$528.18^{b} \pm 4.90$	$363.20^{c} \pm 3.13$	$765.10^{A} \pm 9.63$	$678.20^{B} \pm 11.55$	$401.62^{C} \pm 0.47$
Potassium ($mg.100g^{-1}$)	$368.60^{a} \pm 19.14$	$474.29^{b} \pm 29.28$	$707.74^{c} \pm 7.47$	$421.79^{A} \pm 16.72$	$594.03^{B} \pm 10.99$	$744.47^{C} \pm 27.22$

[1]CON (20 $g.kg^{-1}$ de NaCl + 2 $g.kg^{-1}$ de *Allium sativum* + 0.2 $g.kg^{-1}$ de *Oreganum vulgare* + 1$g.kg^{-1}$ de *Bixa orellana* + 0.2 $g.kg^{-1}$ de *Capsicum frutescens*); [2]F25 (15 $g.kg^{-1}$ de NaCl + 5 $g.kg^{-1}$ de KCl + 2 $g.kg^{-1}$ de *Allium sativum* + 0.2 $g.kg^{-1}$ de *Oreganum vulgare* + 1 $g.kg^{-1}$ de *Bixa orellana* + 0.2 $g.kg^{-1}$ de *Capsicum frutescens*); [3]F50 (10 $g.kg^{-1}$ de NaCl + 10 $g.kg^{-1}$ de KCl + 2 $g.kg^{-1}$ de *Allium sativum* + 0.2 $g.kg^{-1}$ de *Oreganum vulgare* + 1$g.kg^{-1}$ de *Bixa orellana* + 0.2 $g.kg^{-1}$ de *Capsicum frutescens*). Means followed by different letters on the same line for each meat are different ($p< 0.05$).

Table 4 Color (L*, a* e b*), loss by cooking (LC), pH, shear force (WBSF) and TBARS (mg malonaldeído/kg of meat) for marinated beef

Item	*Quadriceps femoris*			*Longissimus muscle*		
	CON[1]	**F25[2]**	**F50[3]**	**CON[1]**	**F25[2]**	**F50[3]**
L*	$42.82^{a} \pm 6.43$	$45.00^{a} \pm 4.69$	$46.84^{a} \pm 4.68$	$48.30^{A} \pm 1.48$	$49.29^{A} \pm 1.36$	$42.32^{B} \pm 2.47$
a*	$7.92^{a} \pm 1.28$	$7.55^{a} \pm 0.67$	$7.02^{a} \pm 2.39$	$8.24^{A} \pm 0.65$	$7.36^{A} \pm 0.27$	$8.42^{A} \pm 1.66$
b*	$16.54^{a} \pm 1.55$	$13.65^{a} \pm 1.86$	$17.32^{a} \pm 2.18$	$16.53^{A} \pm 0.48$	$17.05^{A} \pm 0.71$	$17.58^{A} \pm 0.55$
LC (%)	$34.23^{a} \pm 1.88$	$31.19^{a} \pm 6.08$	$32.80^{a} \pm 0.24$	$27.11^{A} \pm 2.78$	$34.34^{A} \pm 1.66$	$20.82^{A} \pm 3.95$
pH	$5.50^{a} \pm 0.02$	$5.54^{a} \pm 0.13$	$5.66^{a} \pm 0.15$	$5.07^{A} \pm 0.10$	$5.14^{A} \pm 0.07$	$5.68^{A} \pm 0.25$
WBSF (Kgf)	$2.86^{a} \pm 0.17$	$2.77^{a} \pm 0.55$	$3.79^{b} \pm 0.51$	$4.44^{A} \pm 0.24$	$4.55^{A} \pm 0.35$	$4.53^{A} \pm 0.23$
TBARS	$0.054^{a} \pm 0$	$0.048^{a} \pm 0.02$	$0.044^{a} \pm 0$	$0.042^{A} \pm 0.07$	$0.053^{A} \pm 0.03$	$0.046^{A} \pm 0.08$

[1]CON (20 g.kg^{-1} de NaCl + 2 g.kg^{-1} de *Allium sativum* + 0.2 g.kg^{-1} de *Oreganum vulgare* + 1g.kg^{-1} de *Bixa orellana* + 0.2 g.kg^{-1} de *Capsicum frutescens*); [2]F25 (15 g.kg^{-1} de NaCl + 5 g.kg^{-1} de KCl + 2 g.kg^{-1} de *Allium sativum* + 0.2 g.kg^{-1} de *Oreganum vulgare* + 1 g.kg^{-1} de *Bixa orellana* + 0.2 g.kg^{-1} de *Capsicum frutescens*); [3]F50 (10 g.kg^{-1} de NaCl + 10 g.kg^{-1} de KCl + 2 g.kg^{-1} de *Allium sativum* + 0.2 g.kg^{-1} de *Oreganum vulgare* + 1g.kg^{-1} de *Bixa orellana* + 0.2 g.kg^{-1} de *Capsicum frutescens*). Means followed by different letters on the same line for each meat are different ($p<0.05$).

Table 5 Sensory analysis for marinated beef with sodium reduction

	Quadriceps femoris			*Longissimus muscle*		
	CON[1]	**F25[2]**	**F50[3]**	**CON[1]**	**F25[2]**	**F50[3]**
Smell	$6.86^{a} \pm 1.62$	$6.96^{a} \pm 1.61$	$6.94^{a} \pm 1.31$	$6.28^{A} \pm 1.82$	$6.54^{A} \pm 1.66$	$5.78^{A} \pm 1.79$
Taste	$7.16^{a} \pm 1.34$	$7.24^{a} \pm 1.43$	$7.28^{a} \pm 1.40$	$6.02^{A} \pm 1.59$	$6.14^{A} \pm 1.71$	$5.46^{A} \pm 2.05$
Color	$6.72^{a} \pm 1.34$	$6.86^{a} \pm 1.47$	$6.96^{a} \pm 1.14$	$6.46^{A} \pm 1.56$	$6.54^{A} \pm 1.68$	$5.86^{A} \pm 1.76$
Texture	$7.50^{a} \pm 1.38$	$7.46^{a} \pm 1.38$	$7.18^{a} \pm 1.61$	$5.26^{A} \pm 1.95$	$5.66^{A} \pm 2.02$	$5.06^{A} \pm 2.11$
Overall Acceptance	$7.38^{a} \pm 1.08$	$7.38^{a} \pm 1.14$	$7.18^{a} \pm 1.17$	$5.76^{A} \pm 1.62$	$6.18^{A} \pm 1.62$	$5.72^{A} \pm 1.86$
I.A.[4]	82%	82%	80%	72%/	77%/	71%

[1]CON (20 $g.kg^{-1}$ NaCl + 2 $g.kg^{-1}$ *Allium sativum* + 0.2 $g.kg^{-1}$ *Oreganum vulgare* + 1$g.kg^{-1}$ *Bixa orellana* + 0.2 $g.kg^{-1}$ *Capsicum frutescens*); [2]F25 (15 $g.kg^{-1}$ NaCl + 5 $g.kg^{-1}$ KCl + 2 $g.kg^{-1}$ *Allium sativum* + 0.2 $g.kg^{-1}$ *Oreganum vulgare* + 1 $g.kg^{-1}$ *Bixa orellana* + 0.2 $g.kg^{-1}$ *Capsicum frutescens*); [3]F50 (10 $g.kg^{-1}$ NaCl + 10 $g.kg^{-1}$ KCl + 2 $g.kg^{-1}$ *Allium sativum* + 0.2 $g.kg^{-1}$ *Oreganum vulgare* + 1$g.kg^{-1}$ *Bixa orellana* + 0.2 $g.kg^{-1}$ *Capsicum frutescens*). Means followed by different letters on the same line for each meat are different ($p<0.05$). [4]I.A. = index of product´s acceptability

Table 6 Microbiological results for chicken meat marinated with sodium reduction

	Drumstick			Chicken breast fillet		
	CON[1]	**F25[2]**	**F50[3]**	**CON[1]**	**F25[2]**	**F50[3]**
Coliforms (UFC mL^{-1})	$2.5x10^1$	$3.5x10^1$	$12.5x10^1$	$6.5x10^1$	$1.5x10^1$	$2.0x10^1$
Salmonella sp (UFC.mL^{-1})	Absent	Absent	Absent	Absent	Absent	Absent

[1]CON (20 g.kg^{-1} NaCl + 2 g.kg^{-1} *Allium sativum* + 0.2 g.kg^{-1} *Oreganum vulgare* + 1g.kg^{-1} *Bixa orellana* + 0.2 g.kg^{-1} *Capsicum frutescens*); [2]F25 (15 g.kg^{-1} NaCl + 5 g.kg^{-1} KCl + 2 g.kg^{-1} *Allium sativum* + 0.2 g.kg^{-1} *Oreganum vulgare* + 1 g.kg^{-1} *Bixa orellana* + 0.2 g.kg^{-1} *Capsicum frutescens*); [3]F50 (10 g.kg^{-1} NaCl + 10 g.kg^{-1} KCl + 2 g.kg^{-1} *Allium sativum* + 0.2 g.kg^{-1} *Oreganum vulgare* + 1g.kg^{-1} *Bixa orellana* + 0.2 g.kg^{-1} *Capsicum frutescens*).

Table 7 Chemical analysis for marinated chicken

Item	Drumstick			Chicken breast fillet		
	CON[1]	**F25[2]**	**F50[3]**	**CON[1]**	**F25[2]**	**F50[3]**
Moisture (%)	$73.83^{a} \pm 2.96$	$72.76^{a} \pm 0.55$	$72.56^{a} \pm 0.27$	$72.74^{A} \pm 0.07$	$72.80^{A} \pm 0$	$72.84^{A} \pm 0$
Ash (%)	$2.37^{a} \pm 0.30$	$2.28^{a} \pm 0.14$	$2.65^{a} \pm 0.18$	$2.64^{A} \pm 0.12$	$2.48^{A} \pm 0.12$	$2.63^{A} \pm 0.14$
Crude protein (%)	$17.71^{a} \pm 0.33$	$17.42^{a} \pm 0.07$	$17.47^{a} \pm 0.29$	$21.54^{A} \pm 0.71$	$22.03^{A} \pm 0.42$	$21.59^{A} \pm 0.72$
Total fat (%)	$7.16^{a} \pm 0.19$	$7.55^{a} \pm 0.07$	$7.28^{a} \pm 0.04$	$3.03^{A} \pm 0.28$	$2.66^{B} \pm 0.28$	$2.91^{AC} \pm 0.28$
Sodium ($mg.100g^{-1}$)	$951.70^{a} \pm 1.39$	$634.26^{b} \pm 4.78$	$465.74^{c} \pm 1.03$	$823.29^{A} \pm 4.42$	$643.16^{B} \pm 1.47$	$405.79^{C} \pm 4.63$
Potassium ($mg.100g^{-1}$)	$359.75^{a} \pm 28.07$	$569.64^{b} \pm 27.77$	$676.61^{c} \pm 2.17$	$439.56^{A} \pm 29.52$	$646.18^{B} \pm 22.14$	$789.14^{C} \pm 11.51$

[1]CON ($20g.kg^{-1}$ NaCl+ $2g.kg^{-1}$ *Allium sativum*+ $0.2g.kg^{-1}$ *Oreganum Majorana* + $1g.kg^{-1}$ *Curcuma Longa* + $0.2g.kg^{-1}$ *Piper Nigrum*), [2]F25-($15g.kg^{-1}$ NaCl + $5g.kg^{-1}$ KCl + $2g.kg^{-1}$ *Allium sativum*+ $0.2g.kg^{-1}$ *Oreganum Majorana* + $1g.kg^{-1}$ *Curcuma Longa* + $0.2g.kg^{-1}$ *Piper Nigrum*),[3]F50- ($10g.kg^{-1}$ NaCl + $10g.kg^{-1}$ KCl + $2g.kg^{-1}$ *Allium sativum*+ $0.2g.kg^{-1}$ *Oreganum Majorana* + $1g.kg^{-1}$ *Curcuma Longa* + $0.2g.kg^{-1}$ *Piper Nigrum*). Means followed by different letters on the same line for each meat are different ($p<0.05$).

Table 8 Color (L*, a* e b*), loss by cooking (LC), pH, shear force (WBSF) and TBARS (mg malonaldeído.kg^{-1} of meat) for chicken marinated with sodium reduction

	Drumstick			Chicken breast fillet		
	CON[1]	**F25[2]**	**F50[3]**	**CON[1]**	**F25[2]**	**F50[3]**
L*	59.14^{a} ± 3.62	61.27^{a} ± 2.19	62.13^{a} ± 0.80	63.30^{A} ± 6.58	74.32^{AB} ± 4.15	76.16^{B} ± 1.84
a*	3.41^{a} ± 1.63	4.79^{a} ± 2.06	4.19^{a} ± 1.50	1.58^{A} ± 4.82	1.83^{A} ± 0.23	1.96^{A} ± 0.84
b*	27.02^{a} ± 3.04	25.66^{a} ± 4.92	25.25^{a} ± 2.20	36.07^{A} ± 4.18	37.54^{A} ± 2.88	39.26^{A} ± 2.72
LC (%)	26.21^{a} ± 8.23	24.58^{a} ± 0.87	21.44^{a} ± 3.33	19.67^{A} ± 8.17	17.09^{A} ± 2.07	17.45^{A} ± 2.70
pH	6.14^{a} ± 0.07	6.83^{a} ± 0.23	6.31^{a} ± 0.28	6.10^{A} ± 0.22	5.68^{A} ± 0.12	5.46^{A} ± 0.38
WBSF (Kgf)	2.67^{a} ± 0.92	3.91^{a} ± 2.17	2.84^{a} ± 0.37	3.23^{A} ± 0.14	2.55^{A} ± 0.69	3.83^{A} ± 1.77
TBARS	1.82^{a} ± 0.038	1.81^{a} ± 0.02	1.84^{a} ± 0.01	0.046^{A} ± 0.10	0.052^{A} ± 0.03	0.043^{A} ± 0.01

[1]CON (20g.kg^{-1} NaCl+ 2g.kg^{-1} de *Allium sativum*+ 0.2g.kg^{-1} *Oreganum Majorana* + 1g.kg^{-1} *Curcuma Longa* + 0.2g.kg^{-1} *Piper Nigrum*), [2]F25-(15g.kg^{-1} NaCl + 5g.kg^{-1} KCl + 2g.kg^{-1} *Allium sativum*+ 0.2g.kg^{-1} *Oreganum Majorana* + 1g.kg^{-1} *Curcuma Longa* + 0.2g.kg^{-1} *Piper Nigrum*),[3]F50- (10g.kg^{-1} NaCl + 10g.kg^{-1} KCl + 2g.kg^{-1} *Allium sativum*+ 0.2g.kg^{-1} *Oreganum Majorana* + 1g.kg^{-1} *Curcuma Longa* + 0.2g.kg^{-1} *Piper Nigrum*). Means followed by different letters on the same line for each meat are different ($p<0.05$).

Table 9 Sensory analysis for marinated chicken with sodium reduction

	Drumstick			Chicken breast fillet		
	CON[1]	**F25[2]**	**F50[3]**	**CON[1]**	**F25[2]**	**F50[3]**
Smell	$6.80^{a} \pm 1.69$	$6.62^{a} \pm 1.74$	$7.00^{a} \pm 1.56$	$6.57^{A} \pm 1.66$	$6.65^{A} \pm 1.52$	$6.80^{A} \pm 1.36$
Taste	$7.12^{a} \pm 1.69$	$6.92^{a} \pm 1.55$	$7.05^{a} \pm 1.55$	$6.97^{A} \pm 1.34$	$7.22^{A} \pm 1.51$	$6.80^{A} \pm 1.43$
Color	$6.62^{a} \pm 1.59$	$6.44^{a} \pm 1.67$	$7.56^{a} \pm 1.28$	$6.70^{A} \pm 1.59$	$6.74^{A} \pm 1.63$	$6.70^{A} \pm 1.41$
Texture	$7.17^{a} \pm 1.81$	$7.15^{a} \pm 1.68$	$7.20^{a} \pm 1.50$	$7.32^{A} \pm 1.14$	$7.32^{A} \pm 1.40$	$6.65^{A} \pm 1.67$
Overall Acceptance	$7.05^{a} \pm 1.66$	$6.97^{a} \pm 1.62$	$7.25^{a} \pm 1.25$	$7.20^{A} \pm 1.28$	$7.20^{A} \pm 1.41$	$7.00^{A} \pm 1.41$
I.A.[4]	78%	77%	80%	80%	80%	78%

[1]CON (20g.kg^{-1} de NaCl+ 2g.kg^{-1} de *Allium sativum*+ 0.2g.kg^{-1} de *Oreganum Majorana* + 1g.kg^{-1} de *Curcuma Longa* + 0.2g.kg^{-1} de *Piper Nigrum*), [2]F25-(15g.kg^{-1} de NaCl + 5g.kg^{-1} de KCl + 2g.kg^{-1} de *Allium sativum*+ 0.2g.kg^{-1} de *Oreganum Majorana* + 1g.kg^{-1} de *Curcuma Longa* + 0.2g.kg^{-1} de *Piper Nigrum*),[3]F50- (10g.kg^{-1} de NaCl + 10g.kg^{-1} de KCl + 2g.kg^{-1} de *Allium sativum*+ 0.2g.kg^{-1} de *Oreganum Majorana* + 1g.kg^{-1} de *Curcuma Longa* + 0.2g.kg^{-1} de *Piper Nigrum*). Means followed by different letters on the same line for each meat are different ($p<0.05$). [4]I.A. = index of product´s acceptability

ARTICLE 2

ANÁLISE SENSORIAL DE CARNES BOVINA E DE FRANGO COM TEMPERO COMPLETO HIPOSSÓDICO

SENSORY ANALYSIS OF BEEF AND CHICKEN COMPLETE WITH SEASONING LOW SODIUM

Resumo

A redução do sódio em alimentos processados no Brasil é na atualidade um dos grandes desafios da indústria alimentícia, que busca juntamente com o Ministério da Saúde minimizar o impacto da ingestão de sódio na saúde da população em geral e ou em grupos específicos. Na categoria de produtos industrializados, carne e produtos cárneos representam a segunda maior contribuição no consumo de sódio na dieta. Este estudo teve como objetivo analisar sensorialmente carnes bovinas e de frango marinadas em tempero completo hipossódico utilizando sal comum, sal com reduzido teor de sódio e especiarias. Foram analisados sensorialmente, utilizando julgadores não-treinados e hipertensos, os atributos cor, aroma, sabor, textura e avaliação global de quatro amostras temperadas de carne bovina e quatro amostras temperadas de carne de frango com redução de 25 e 50% em seu teor de sódio comparado ao tempero padrão. Os resultados do índice de aceitabilidade das amostras ficaram acima de 85% e para os demais atributos analisados apenas em relação a duas amostras houve diferença significativa no atributo cor. Em conclusão, foi possível substituir em 25 e 50% o cloreto de sódio dos temperos pelo cloreto de potássio, reduzindo desta forma os teores de sódio, sem prejuízo à palatabilidade dos produtos analisados.

Palavras-chaves: Dieta Hipossódica. Carne. Indústria alimentícia. Especiarias.

Abstract

The decrease in sodium in processed foods in Brazil is now day one of the great challenges of the food industry, seeking together with the Ministry of Health to minimize the impact of sodium intake on the health of the population in general or in specific groups. In the category of industrial products, meat and meat products represent the second largest contribution to dietary sodium intake. This study aimed to analyze sensory beef and chicken marinated in spices using full-sodium salt, salt with low sodium and spices. It was sensorially analyzed using non-trained judges and hypertensive, the attributes color, aroma, flavor, texture and overall assessment of four samples of poultry meat seasoned and four samples of beef seasoned with a reduction of 25% and 50% in its content sodium compared to the seasoning standard. The index score of acceptability of the samples were above 85% and for the other variables analyzed only for two samples was no significant difference in the color attribute. We can then conclude that it was possible to replace 25 and 50% of the sodium chloride by potassium chloride seasonings, thereby reducing their levels of sodium, without prejudice in relation to palatability of the products analyzed.

Keywords: Diet, Sodium-Restricted. Meat. Food industry. Spices.

1 Introdução

A hipertensão arterial sistêmica (HAS) é um importante desafio para a saúde pública mundial devido à sua alta frequência e risco concomitante para as doenças cardiovasculares e renais. Atualmente, mais de 25% da população mundial é hipertensa e há estimativas de que este percentual pode chegar a 29% até 2025[1]. Uma das possíveis causas para o aumento da incidência de HAS é o consumo de alimentos industrializados, enlatados, em conserva, defumados e temperos prontos consumidos em maior proporção,

no qual, se ingere uma grande quantidade de sódio, muitas vezes superior ao necessário para o organismo humano[2].

O Ministério da Saúde pelo termo de compromisso número 004 de 2011 firmado em sete de abril de 2011 estabelece um acordo com a ABIA (Associação Brasileira das Indústrias de Alimentação) com a finalidade de definir metas nacionais para a redução do teor de sódio em alimentos processados no Brasil e coloca como uma das obrigações da indústria de alimentos avaliar a inclusão de novas categorias de alimentos com base em evidências científicas relevantes que justificam o impacto da ingestão de sódio na população em geral e ou em grupos específicos[3].

Na categoria de produtos industrializados, carne e produtos cárneos representam a segunda maior contribuição no consumo de sódio na dieta, com aproximadamente 20,8% do consumo de sódio diário. A maior contribuição de sódio provém de produtos cárneos industrializados (0,54g/100g), sendo apenas 0,05g/100g de sódio proveniente de carne fresca[4].

Substituir o sal comum (cloreto de sódio) pelo sal de ervas é uma das maneiras mais promissoras para se controlar a HAS. Basta utilizar ervas aromáticas e especiarias, para alcançar o sabor desejado. São vários os temperos que podem ser acrescentados para dar sabor ao alimento e, assim, proporcionar prazer aos portadores de HAS ao se alimentarem, pois a diminuição de sal no preparo do alimento reduz a satisfação devido à perda do sabor[5].

De acordo com a portaria nº 54/MS/SNVS, de 4 de Julho de 1995, o sal com teor reduzido de sódio (Na) recebe a definição de:

Sal hipossódico ou *light*, o produto elaborado a partir da mistura de cloreto de sódio com outros sais, de modo que a mistura final mantenha poder salgante semelhante ao do sal de mesa fornecendo, no máximo, 50 % do teor de sódio contido na mesma quantidade de cloreto de sódio[6].

A portaria nº 27, de 13 de Janeiro de 1998 do SVS/MS - Ministério da Saúde e Secretaria de Vigilância Sanitária determina a redução de 25% de sódio ou 120 mg por 100g do produto sólido para o produto ser considerado light em relação a composição de sódio[7].

O uso de sais substitutos com o intuito de obter esta redução como o cloreto de potássio é limitado principalmente pelo seu sabor amargo. Por isso, vários compostos inibidores do sabor amargo têm sido propostos para serem adicionados principalmente no parâmetro sabor incluindo o uso de mascaradores do sabor amargo como, por exemplo, extrato de levedura ou uma mistura de ervas naturais ou especiarias[4].

As especiarias podem ser definidas como substâncias de origem vegetal, indígenas ou exóticas, aromáticas ou de sabor forte, utilizadas para realçar o sabor dos alimentos ou adicionar os princípios estimulantes nelas contidos. Portanto, o termo especiaria aplica-se a produtos naturais de origem vegetal ou a sua mistura, estabilizados, inteiros, fragmentados ou em pó, sem adição de matérias de outras naturezas[8].

A substituição parcial do cloreto de sódio pelo cloreto de potássio e a adição de especiarias como ervas aromáticas e colorífícos aos produtos cárneos marinados vem a ser uma saída promissora para a redução de

sódio e a manutenção da palatabilidade destes produtos. No entanto, deve ser consumido com orientação de médicos ou nutricionistas principalmente por portadores de insuficiência renal que tem dificuldade na metabolização do potássio e outros minerais.

O objetivo deste trabalho foi desenvolver e analisar sensorialmente carnes bovinas e de frango marinadas em tempero completo hipossódico substituindo o cloreto de sódio por cloreto de potássio em percentuais de 25 e 50% com adição de ervas aromáticas e coloríficos.

2 Material e Métodos

A análise sensorial dos produtos cárneos hipossódicos foi conduzida realizando teste afetivo com um grupo de 40 pacientes hipertensos internados em um hospital na cidade de Maringá, estado do Paraná, sul do Brasil (homens e mulheres), com faixa etária entre 30 e 60 anos, tendo como parâmetro de exclusão a presença da patologia de insuficiência renal crônica, verificada no prontuário médico.

Foram elaborados dois tipos de temperos hipossódicos, para carne de frango (filé de peito e sobre coxa desossada) e carne bovina (Contrafilé - *Longissimus dorsi* e Patinho – *Quadriceps femoris*) Para as carnes de frango foram utilizadas as especiarias alho (*Allium sativum*), cúrcuma (*Curcuma longa*), manjerona (*Origanum majorana*) e pimenta moída branca (*Piper nigrum*) e para carne bovina foram utilizados alho (*Allium sativum*), colorau *(Urucum),* orégano (*Origanum vulgare*) e pimenta calabresa (*Capsicum frutescens*)[9]. Para a elaboração dos temperos foram adicionados 50% de sal *light* e 50% de sal comum e 100% de sal *light* para as duas composições, formulando-se então dois tipos de tempero para cada tipo de carne, produzindo quatro amostras para carne bovina e quatro amostras para carne de aves.

Os temperos para carnes bovinas foram denominados como TB50, contendo 50% de sal comum e 50% de sal hipossódico (75% de cloreto de sódio e 25% de cloreto de potássio) e TB100, contendo 100% de sal hipossódico (50% de cloreto de sódio e 50% de cloreto de potássio). Os temperos para frango foram denominados TF50 contendo 50% de sal comum e 50% de sal hipossódico (75% de cloreto de sódio e 25% de cloreto de potássio) e TF100, contendo 100% de sal hipossódico (50% de cloreto de sódio e 50% cloreto de potássio). Utilizou-se produto hipossódico sal *light* com informação nutricional para porção de 1g de 267mg de potássio, 191mg de sódio e 25mcg de iodo e o sal comum com informação nutricional para porção de 1g de 390 mg de sódio e 25 mcg de iodo.

As amostras de carnes foram temperadas e preparadas grelhadas (contrafilé, patinho, filé de peito de frango) e assadas (sobre coxa desossada de frango) em forno convencional à 200 °C por 1 hora, atingindo 70 °C em seu interior, servidas imediatamente após o preparo à temperatura mínima de 60ºC em porções de 20g e cubos de dimensão 2X2cm, acondicionadas em bandejas individuais, térmicas e vedadas. Todas as amostras de carnes bovinas e de frango foram avaliadas pelos provadores em dois dias alternados, utilizando 20 provadores para cada dia, separando as amostras de carne bovina e carne de frango.

Por utilizar voluntários para a análise sensorial, o presente trabalho foi analisado previamente pelo Comitê de Ética e pesquisa da Universidade Estadual de Maringá - UEM e aprovado de acordo com o CAAE número 0389-11.

Os produtos foram avaliados em relação aos atributos cor, sabor, textura, aroma e impressão global. Para realização dessa avaliação foram aplicados testes de aceitação, utilizando-se escala hedônica estruturada de 9 pontos (9=gostei muitíssimo; 1=desgostei muitíssimo)[10].

Os resultados da análise sensorial foram analisados estatisticamente, utilizando programa Excel 2003, pela análise de variância com fator duplo sem repetição (ANOVA) e teste de Tukey para avaliar se houve diferença significativa entre os produtos com nível de significância à 5% ($p< 0,05$).

O índice de aceitação das amostras foi calculado pela seguinte expressão matemática: [11]

$$IA\ \% = X*100/N$$

Onde: X = média de cada amostra

N = nota máxima, de cada amostra, dada pelos provadores.

3 Resultados e Discussão

Na Tabela 1 estão apresentados os valores de cor, sabor, textura, aroma e avaliação global obtidos na avaliação sensorial de carnes de boi (contrafilé e patinho) com os dois temperos.

Tabela 1: Valores de cor, sabor, textura, aroma e avaliação global para carnes de boi

Amostra/ Atributo	Cor	Sabor	Textura	Aroma	Avaliação Global
TB50P	8,2±1,64	7,95±1,10	7,75±1,04	7,8±1,43	8,05±0,89
TB50C	7,8±1,56	7,8±1,33	7,95 ±1,31	7,65±2,4	8,0±1,37
TB100P	8,1±1,25	7,65±1,60	7,55±1,63	7,8±1,54	7,75±1,56
TB100C	8,1±1,46	7,8±1,01	7,65±1,82	7,7±1,69	7,95±1,31

a,b Médias da mesma coluna com letras iguais não diferem (Tukey, 5%).
TB50 - Tempero para carne de boi com 50% sal light e 50% de sal comum
TB100- Tempero para carne de boi com 100% de sal light
P- Patinho
C- Contrafilé

Os resultados não apresentaram diferença ($p< 0,05$) entre os dois tipos de carnes bovinas temperadas com temperos hipossódicos e mostram notas acima de 7 para todos os atributos e índice de aceitabilidade acima de 86%, o que pode ser considerado aceitável sensorialmente[12].

De acordo com Armenteros[13], a substituição de NaCl por KCl, em lombo curado e seco, nas proporções de 35 e 50% também não ocasionaram alterações no aroma, textura, paladar e cor porém com 70% de substituição houve alteração em todos os atributos, exceto para cor, assim como Katsiari[14] verificou que em queijo Kefalograviera com substituição de 50% do NaCl por KCl não houve diferença nos atributos

sensoriais (aparência, textura, flavor e aparência geral). Rech[15] avaliou em teste de aceitabilidade e preferência um salame de calibre pequeno com substituição de 50% de NaCl por KCl e não observou diferença em relação ao controle.

Na Tabela 2 estão apresentados os valores de cor, sabor, textura, aroma e avaliação global obtidos na avaliação sensorial de carnes de frango (sobre coxa e filé de peito de frango) com os dois tipos de temperos.

Tabela 2: Valores de cor, sabor, textura, aroma e avaliação global para carnes de frango

Amostra/ atributo	Cor	Sabor	Textura	Aroma	Avaliação Global
TF100S	8,65ª±0,24	8,55ª±0,58	8,25ª±1,04	8,5ª±0,68	8,55ª±0,36
TF100F	8,15ª±1,61	8,50ª±0,58	8,35ª±0,66	8,4ª±0,57	8,45ª ±0,57
TF50S	8,04ªb±1,73	8,05ª±4,05	7,8ª±3,01	8,05ª±2,68	8,15ª ±1,61
TF50F	7,7b±3,8	8,35ª±2,03	8,2ª±2,06	7,95ª±1,73	8,25ª ±0,58

a,b Médias da mesma coluna com letras iguais não diferem significativamente a p<0,05 (Teste Tukey).
TF50 - Tempero para frango com 50% sal light e 50% de sal comum
TF100- Tempero para frango com 100% de sal light
S- Sobre coxa
F- Filé de Peito de Frango

Os tratamentos não tiveram efeito (P>0,05) sobre o sabor, textura, aroma e a avaliação global das carnes de frango (sobre coxa e filé de peito de frango).

As amostras da sobre coxa e de filé de peito de frango que foram temperadas com TF50 - Tempero para frango com 50% sal *light* e 50% de sal comum, apresentaram diferença estatística (P>0,05) apenas no quesito cor. Isto pode ter ocorrido devido a forma de cocção diferente para os dois tipos de carne, a sobre coxa foi assada em forno convencional e o filé de peito de frango foi grelhado propiciando diferença na aparência do produto final.

Os índices de aceitação das amostras estão expressos na Tabela 3 abaixo:

Tabela 3: Índice de aceitação das amostras de patinho, contra filé (longíssimos dorsi), sobre coxa e filé de peito de frango com temperos hipossódicos.

Amostra	**Índice de aceitação(%)**
TB50 Patinho	89,44
TB50 Contra filé	88,88
TB100 Patinho	86,11
TB100 Contra filé	88,33
TF100 Sobre coxa	95,00
TF100 Filé de frango	93,88
TF50 Sobre coxa	90,55
TF50 Filé de filé de peito de frango	91,66

TB50 - Tempero para carne de boi com 50% sal light e 50% de sal comum
TB100- Tempero para carne de boi com 100% de sal light
TF50 - Tempero para frango com 50% sal light e 50% de sal comum
TF100- Tempero para frango com 100% de sal light

Os resultados acima mostram que todas as amostras testadas apresentaram índice de aceitabilidade acima de 70%. A amostra com maior aceitabilidade foi a sobre coxa de frango com tempero utilizando 100% de sal *light*, ou seja, com substituição de 50% do cloreto de sódio pelo cloreto de potássio, apresentando potencial aceitação pelo consumidor mesmo com uma maior substituição do cloreto de sódio em sua formulação.

Esses resultados são o reflexo de todos os atributos analisados pelos provadores, os quais obtiveram notas satisfatórias de maneira geral. Entre os fatores mais comuns relacionados à aceitabilidade de algum alimento está a frequência de consumo do mesmo[12].

Estudos realizados pela Organização das Nações Unidas para Agricultura e Alimentos e FAO (2005) mostraram que o consumo de carne de frango cresceu, tanto no mundo quanto no Brasil[16]. De 1996 até 2005, o consumo nacional "*per capita*" subiu de 22 para 33 kg/habitante/ano[11]e em 2010, o consumo anual "*per capita*" de carne de frango foi 44% superior ao registrado em 2001.[17]

4 Conclusão

Conclui-se que é viável a substituição de 25 e 50% de NaCl por KCl adicionando especiarias aromáticas, que conferem sabor aos alimentos e mascaram o residual amargo deixado pelo cloreto de potássio.

A substituição do tempero padrão pelo sal *light* com ervas é uma alternativa promissora, pois as carnes temperadas com esse sal apresentaram características sensoriais aceitáveis pelos pacientes. Dessa forma, além do sal *light* com ervas ter um teor reduzido de NaCl, ele também manteve as características sensoriais das carnes, sendo portanto uma nova alternativa para viabilizar a adesão a dietoterapia de pacientes que necessitam consumir quantidades de sódio reduzidas.

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