The Annals of the University Dunarea de Jos of Galati
Fascicle VI – Food Technology (2017), 41(2), 42-50

SHORT COMMUNICATION

A STUDY UPON SALT REDUCTION IN EMULSIFIED MEAT PRODUCTS

CRISTIAN TUDOSE*, GHEORGHE ZGHEREA, GABRIELA IORDĂCHESCU, CORINA NEAGU, DOINA GEORGETA ANDRONOIU, FLORICEL CERCEL, PETRU ALEXE

Dunarea de Jos University, 111 Domneasca Street, 800201Galati, Romania
*Corresponding author: cristian.tudose@ugal.ro

Received on 10th November 2016
Revised on 6th September 2017

Taking into account the new tendencies of a healthy nutrition, the issue of meat products and their effect on the overall health condition remains on the top list of the solutions to be found. Some of the most approached ideas consist in reducing the animal fat content from meat products and replacing them with vegetable oils. Moreover, many studies propose the substitution of NaCl with other chloride salts. In a wide study we aimed at combining the two proposed solutions and at observing their effect on quality characteristics of the product. In this short communication, the second part of the study is presented, where the effects of partial NaCl replacement with KCl on proximate composition, textural characteristic, microbiological analyses and sensory characteristics were studied. The new reformulated salami type product was well accepted by the panelists, with no bitter taste sensed. KCl determined a significant increase in firmness values while decreasing the oxidative process of lipids.

Keywords: potassium chloride, lipid peroxidation, sensory analyses, firmness

Introduction

Meat is still considered as an essential component in a healthy balanced diet, being an excellent source of high-quality proteins, minerals, oligoelements and vitamins (Estruch *et al*., 2006). However, meat products contain high levels of saturated fat and salt, which, if eaten in excess, increase the risk of obesity, diabetes and cancer. The intake of NaCl from the diet plays an important role in a healthy diet. The World Health Organization recommends a daily intake of NaCl lower than 5 g, equivalent to 2 g of Na per day for an adult (WHO, 2012). According to Desmond (2006), food products associated with high slat content are by far ready-to-eat products such as cereals and cereal products, meat products, soups and sauces, snacks and milk products. According to Zugravu *et al*. (2011), in Romania, the average salt content in meat products is 2.2g/100g. The high sodium intake contributes directly to high blood pressure, hypertension, being a major risk factor in cardiovascular disease (Appel *et al*., 1997). Moreover, it was also associated with low bone density (Martini

et al., 2000). In this respect, decreasing the sodium content is acknowledged as a must for food specialists but also as a major challenge, as it influences the sensory and functional properties, as well as the microbiological safety of food products (Pereira *et al*., 2010). As salt substitute, potassium chloride is the mostly used. However, its use is limited by the bitter taste and the loss of saltiness. On the other hand, sodium chloride is known to have a prooxidant effect in meat products, while potassium chloride decreases the rate of the phenomenon (Min & Ahn, 2005), which may fairly influence flavor.

The present research is a part of a more complex study regarding the reduction of animal fat and sodium content in meat emulsified products. In the first part, the pork back fat was replaced with an emulsion obtained from olive and palm oils. The obtained results were published in Tudose *et al.* (2014a), Tudose *et al.* (2014b) and Tudose *et al.* (2017). The aim of the second part was to evaluate the possibility of reducing the NaCl content in a new obtained salami type product (with olive and palm oil), by replacing a part of it with KCl and to investigate the effect of salt substitution on physico-chemical and sensory characteristics of the product.

Materials and methods

Beef and pork cuts were finely chopped (8 mm particle size) and mixed with an olive-palm oil pre-emulsion at a ratio of 70:30 as described in Tudose et al. (2014b) such as to obtain a salami type meat product. In order to study the effect of salt substitution on quality characteristics of the emulsified meat, two samples were obtained - a control sample where NaCl mix was added at a ratio of 1.8g/100g and the sample where 50% of the NaCl content was replaced with KCl. In order to enhance the sensory characteristics of the products, ground pepper (0.15kg/100kg composition), garlic (0.25 kg/100kg composition), and nutmeg (0.03kg/100kg composition) were used. Meat pastes thus obtained were filled in synthetic casings of 50mm in diameter (Cutisin SPR50) and thermally treated by pasteurization and smoking in a Vemag Micromat C7-100 smoking cell. The obtained product can be seen in Figure 1. Samples thus obtained were stored at a temperature of 6-8°C and relative humidity of 75-80% for a period of 22 days, being analysed over the entire storage time.

Figure 1. Section view of the salami type product obtained by substitution of pork back fat with olive and palm oils

The obtained samples were tested in terms of proximate composition. Thus, moisture, ash content, total proteins, and fat content were determined according to AOAC methods on analyses (2002). Quality characteristics of the obtained products were analyzed by determining the lipid oxidation after the method described in Shahidi *et al*. (2002). In short, the method is based on the formation of the coloured complex between the oxidation products of the fat and the 2-tiobarbituric acid, and the measurement of the coloration intensity at maximum 530 nm. Microbiological analyses were conducted in order to determine the Aerobic Mesophilic Bacteria (BAM) and the Enterobacteriaceae number (ENT). All determinations were carried out in triplicate for each sample.

CIELAB color characteristics were determined with a Miniscan XE Plus Hunter Lab colorimeter.

The instrumental analysis of the samples texture was carried out with a Brookfield CT3 Texture Analyser. The testing method was adapted after Bourne (2002) based on the Textural Profile Analysis method (TPA). To be tested, the meat products were chopped into 20 mm small cubes and subjected to double compression, without any pause between the two cycles. The compression took place on a distance of 10 mm by means of an acrylic cylinder, 40 mm in diameter, the penetration speed being 1 mm/s, the cell load 10 kg and the sensitivity threshold 2 g. The textural parameters thus determined were firmness (the force for a given value of deformation, N), cohesiveness (the ratio between the area corresponding to the second compression cycle, non-dimensional ratio), springiness (the deformation retrieved between the two compression cycles, mm), gumminess (the force necessary to disintegrate the sample in order to be swallowed– the composition between firmness and cohesion, N) and masticability (the energy necessary to chew the sample in order to be swallowed– the composition between cohesion, firmness and elasticity, mJ).

The sensory analysis was performed by assessing the intensity of 11 sensory characteristics on the basis of a 15-point score scale as following: 0 if the characteristic is absent or cannot be perceived and 15 for the highest intensity of the characteristic. The sensory features taken into account were: color, uniformity, moisture, presence of foreign smell, taste, aroma, consistency, moisture release, masticability, mouthcoating, and aftertaste. The tasting was performed by a group of 13 trained panelists (8 women and 5 men) aged between 20 and 24. The tests were carried out in the first, the 8th, the 15th, and the 22nd day since manufacture.

The statistical analyses of the experimental results were performed using Microsoft Office Excel® predefined tools. The analyses were performed in triplicate and the results were reported as mean values. The results of the sensory analysis were statistically processed using ANOVA single factor which allowed the analysis of variance, respectively the analysis of variance of a variable in relation with the influencing factor.

Results and discussion

The tests were analyzed over the entire storage period, on the first day after obtaining the sample, on the 8th day, on the 15th day and on the 22nd day.

The results obtained reflect the characteristics of a semi-smoked meat product with heterogeneous structure of the summer salami type. The values of the two samples are notably close, except for moisture.

Table 1. Proximate composition of studied salami samples during storage period as a function of partial salt replacement with KCl.

Sample	Period of analysis	Moisture (%)	Proteins (%)	Fat (%)	Ash (%)
Control sample	1st day	59.99±0.97[a]	14.89±1.25	21.06±1.12	3.29±0.02
	8th day	54.24±1.16	17.01±1.07	24.55±1.65	3.67±0.02
	15th day	50.23±1.02	18.56±1.10	25.41±1.51	3.98±0.05
	22nd day	47.19±1.26	19.14±1.15	26.95±3.38	4.16±0.03
Experimental sample	1st day	61.39±1.14	15.84±1.09	20.24±1.85	3.65±0.08
	8th day	57.17±1.11	17.08±1.02	22.03±1.27	3.97±0.06
	15th day	51.85±1.19	18.95±0.99	24.39±1.78	4.34±0.01
	22nd day	44.20±1.05	22.13±0.95	28.45±3.94	5.05±0.03

Values represent means of three replicates ± Standard Deviation

It may be seen in Table 1 that the experimental sample had slightly higher moisture content, and replacing NaCl by KCl triggered a lower weight loss in comparison to the control sample during the first eight days of storage. This difference may be caused by the faster penetration of the salt mixture containing KCl which seems more efficient in removing the water from the sample (Armenteros *et al*., 2012).

When considering the TBA values of the studied samples, it can be seen that the experimental sample presented lower values in comparison to the control sample (Figure 2). The phenomenon is explained by the increased effectiveness of the KCl in decreasing rancidity in processed meat in comparison to NaCl (Min & Ahn, 2005).

Regarding microbiological analyses, we found that partial substitution of NaCl with KCl did not affect products innocuity. Immediately after production (day 1), the values of mesophilic aerobic bacteria (BAM) and enterobacteriaceae (ENT) were < 10 for both analyzed products. During storage time, no significant differences between products types were observed for BAM. At the end of the storage period, the total number of mesophilic aerobic bacteria was 6.74×10^2/g product in the control sample and 8.27×10^2/g product in the experimental sample (data not reported). The ENT number was < 10 over the entire storage period for both types of products. These results are in agreement with the Commission R (EC) No 1441/2007.

The effect of partial salt replacement with KCl on color characteristics of the tested salami samples is presented in Table 2. Results showed that the use of KCl determined a slight decrease of all color parameters with no significant differences ($p>0.05$). In fact, all color parameters decreased during storage period, especially between the 8th and the 15th day ($p<0.05$).

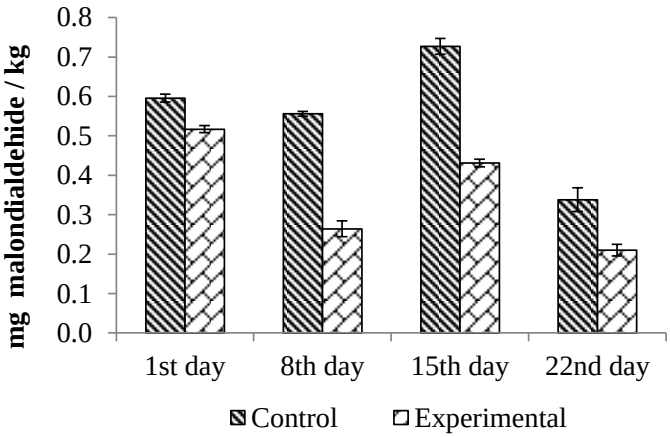

Figure 2. The effect of NaCl substitution with KCl on lipid peroxidation in salami type meat product as a function of partial salt replacement with KCl

The analysis of the obtained results, by means of the textural analyses, revealed that during the entire storage period the experimental sample (with NaCl:KCl 50/50) recorded significantly higher firmness values (4.62 ÷ 9.56N) as compared to the control sample (3.65 ÷ 8.18 N) ($p<0.05$), as it can be seen in Table 3. This behaviour is due to the ionic strength and the functional properties of the proteins. The reduced NaCl amount determines the decreasing of myofibrillar proteins solubility, as a consequence of a reduced ionic strength (Horita *et al*., 2014). In this context, the water holding capacity is reduced and the firmness increases. Similar results have been reported by Jimenez Colomero *et al*. (2005) and by Horita *et al*. (2014) for similar meat products. The other texture parameters were rather correlated with moisture decrease during storage period.

When studying the effect of partial salt replacement with KCl on sensory characteristics of salami samples, we found no significant differences between samples ($p>0.05$). Similar observations were also made by Guardia *et al.* (2006). However, taste, aroma and consistency were slightly better appreciated for the experimental sample where 50% of the NaCl was replaced with KCl. Moreover, panellists did not sense any bitter taste due to KCl, nor a decrease in saltiness compared to the control sample. Nevertheless, the olive oil aroma was mostly perceived as a foreign smell uncharacteristic to meat products, as it can be seen in Figure 3.

Table 2. CIELAB color parameters of studied salami samples during storage period as a function of partial salt replacement with KCl

Determination period	L		a*		b*	
/ Sample	Control	Experimental	Control	Experimental	Control	Experimental
1st day	60.00±0.90	58.45±1.01	10.17±1.14	9.67±0.98	11.14±1.13	11.02±0.97
8th day	58.56±0.12	56.58±0.80	9.13±0.81.	8.77±0.36	11.45±1.02	10.86±0.83
15th day	49.12±0.02	41.44±1.49	9.62±0.74	8.80±1.01	10.80±0.77	10.15±0.41
22nd day	40.46±0.79	37.89±0.33	9.15±0.69	8.25±0.77	9.78±0.25	9.14±0.36

Values represent means of three replicates ± Standard Deviation

Table 3. Textural characteristics of studied salami samples during storage period as a function of partial salt replacement with KCl

Sample	Period of analysis	Firmness (N)	Cohesiveness	Springiness (mm)	Gumminess (N)	Chewiness (mJ)
Control sample	1st day	3.65±0.41	0.58±0.47	3.23±0.27	2.40±0.17	1.56±0.09
	8th day	7.09±0.70	0.53±0.52	3.32±0.33	3.70±0.25	2.46±0.18
	15th day	6.03±0.55	0.68±0.58	2.38±0.56	4.19±0.28	3.34±0.22
	22nd day	8.18±0.69	0.67±0.61	1.52±0.49	6.39±0.59	6.88±0.32
Experimental sample	1st day	4.62±0.27	0.63±0.60	3.57±0.51	2.95±0.20	2.10±0.17
	8th day	8.77±0.74	0.82±0.68	4.76±0.26	7.19±0.67	6.88±0.24
	15th day	9.63±0.93	0.79±0.71	2.53±0.37	7.63±0.75	6.74±0.30
	22nd day	9.56±0.96	0.80±0.79	1.75±0.63	6.52±0.44	5.78±0.15

Values represent means of three replicates ± Standard Deviation

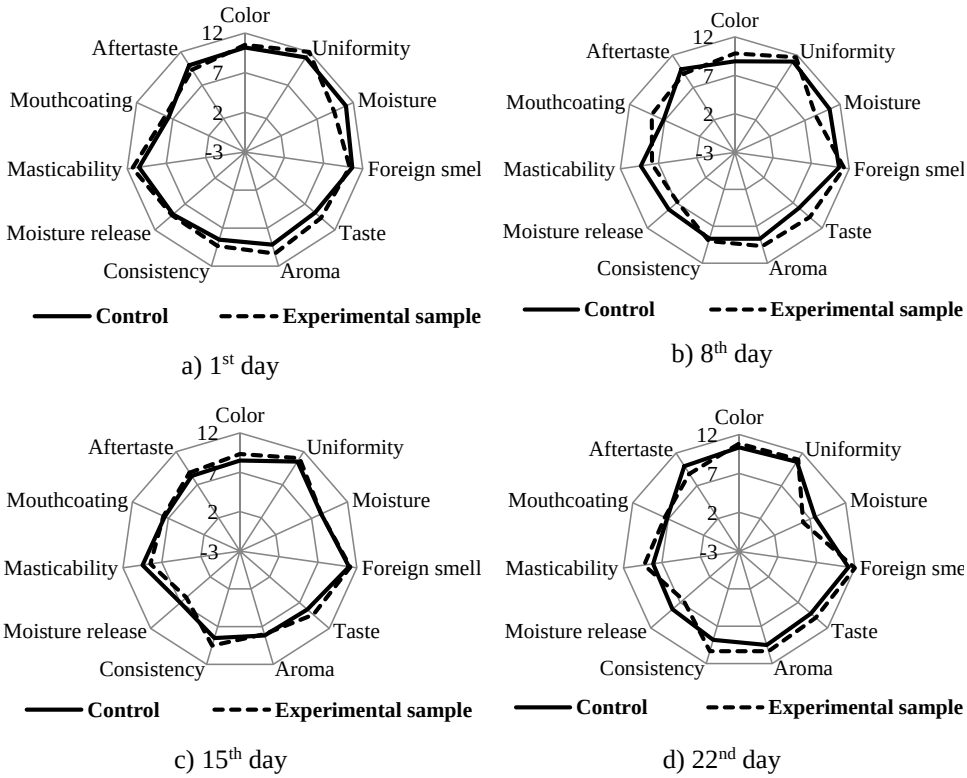

Figure 3. Sensory characteristics of studied salami samples during storage period as a function of partial salt replacement with KCl

Conclusions

The present study intended to propose a dietetic meat product by replacing animal fat with vegetable oils and by decreasing the NaCl content. The measurement performed revealed a rather good sensory acceptance of the newly formulated product. No bitter taste was observed, most probably alleviated by the specific taste of olive oil. However, KCl determined an increase of firmness due to the effect on the ionic strength which reduced myofibrilar proteins solubility. The use of KCl also improved the product`s quality by reducing lipid peroxidation.

Acknowledgement

The work has been funded by the Sectorial Operational Programme Human Resources Development 2007-2013 of the Romanian Ministry of European Funds through the Financial Agreement POSDRU/159/1.5/S/132397.

This work benefited from the technical support of the RE-SPIA (695/09.04.2010. SMIS code 11377) project financed by REGIO (Regional Operational Programme 2007-2013).

References

Appel, L., Moore, T., Obarzanek, E. 1997. A clinical trial of the effects of dietary patterns on blood pressure. *The New England Journal of Medicine*, **16**(336), 1117–1124.

Armenteros, M., Aristoy, M.C., Barat, J.M., Toldrá, F. 2012. Biochemical and sensory changes in dry-cured ham salted with partial replacements of NaCl by other chloride salts. *Meat Science*, **90**(2), 361-367.

Armenteros, M., Aristoy, M.C., Barat. J.M., Toldra, F. 2012. Biochemical andsensory changes in dry-cured ham salted with partial replacements of NaCl by other chloride salts. *Meat Science*, **90**, 361-367.

Association of Official Analytical Chemists - AOAC. (2002). Official Methods of Analysis (17 Ed.). Gaithersburg, Maryland: Association of Official Analytical Chemists.

Bourne, M.C. 2002. *Food texture and viscosity: Concept and measurement*. NewYork: Academic Press.

Desmond, E. 2006. Reducing salt: A challenge for the meat industry. *Meat Science*, **74**, 188–196.

Estruch. R., Martinez-Gonzalez. M.A., Corella, D., Salas-Salvado, J., Ruiz-Gutierrez, V., Covas, MI. 2006. Effects of a Mediterranean style diet on cardiovascular risk factors: a randomized trial. *Ann Intern Medical*, **145** (1), I11.

Guardia, M.D., Guerrero, L., Gelabert, J., Gou, P., Arnau, J. 2006. Consumer attitude towards sodium reduction in meat products and acceptability of fermented sausages with reduced sodium content. *Meat Science*, **73**, 484–490.

Horita, C.N., Messias, V.C., Morgano, M.A., Hayakawa F.M., Pollonio, M.A.R. 2014. Textural. microstructural and sensory properties of reduced sodium frankfurter sausages containing mechanically deboned poultry meat and blends of chloride salts. *Food Research International*, **66**, 29-35.

Jimenez Colmenero, F., Ayo, M.J., Carballo, J. 2005. Physicochemical properties of low sodium frankfurter with added walnut: effect of transglutaminase combined with caseinate. KCl and dietary fibre as salt replacers. *Meat Science*, **69**, 781–788.

Martini, L.A., Cuppari, L., Colugnati, F.A., Sigulem, D.M., Szejnfeld, V.L., Schor, N., Heilberg, I.P. 2000. High sodium chloride intake is associated with low bone density in calcium stone-forming patients. *Clinical nephrology*, **54**(2), 85-93.

Min, B., Ahn, D.U. 2005. Mechanism of lipid peroxidation in meat and meat products - A review. *Food Science and Biotechnology*, **14**(1), 152-163.

Pereira. H.C., de Souza. V.R., Azevedo. N.C., Rodrigues. M.D., Nunes. C.A., Pinheiro. A.C.M. 2015. Optimization of Low Sodium Salts Mix for Shoestring Potatoes. *Journal of Food Science*, **80**(6), S1399-S1403.

Shahidi. F., Wanasundara. U.N. 2002. Methods for measuring oxidative rancidity in fats and oils. *Food lipids: chemistry, nutrition and biotechnology*, 387-403.

Tudose, C., Iordachescu, G., Stan, F., Cercel, F., & Alexe, P. 2014a. Influence of animal fat replacement with vegetable oils on the sensorial perception of meat emulsified products. *The Annals of the University of Dunarea de Jos of Galati. Fascicle VI. Food Technology*, **38**(2), 94.

Tudose, C., Neagu, C., Borda, D., Alexe, P. 2017. The impact of water activity on storage stability of a newly reformulated salami. *Revista de Chimie*, **68**(4), 763-767.

Tudose, C., Patrascu, L., Alexe, P. 2014b. Rheological characteristics of beef filling mixture with vegetable oils. *Studia Universitatis Babes-Bolyai, Chemia*, **59**(2).

WHO (World Health Organization) 2012. Guideline. Sodium intake for adults and children. Geneva.

Zugravu, C.A., Parvu, M., Tarcea, M., Patrascu, D., & Stoian-Pantea, A. 2011. Reformulation of Romanian Meat Products and Cheeses: is this a Necessity for a Lower Salt Intake?. *Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Agriculture*, **68**(2).