EFFECTS OF Na-LACTATE REPLACEMENT BY K-LACTATE ON PHYSICO-CHEMICAL PROPERTIES OF LOW SODIUM SAUSAGE CONTAINING HIGH LEVELS OF DEBONED POULTRY MEAT

Carla I. Carraro[1*], Thales L.C. de Oliveira[1], Natália M. M. Alencar[1], Maria T. E. L. Galvão[1], Débora B. Moura[2], Adriano G. Cruz[1], Andrea C. S. Barreto[3], Marcelo A. Morgano[4] and Marise A. R. Pollonio[1]

[1]Department of Food Technology. Food Engineering Faculty. State University of Campinas, FEA/UNICAMP, Campinas, São Paulo, Brazil; [2]Brasilfoods BRF – São Paulo, São Paulo, Brazil; [3]University of São Judas Tadeu, São Paulo, São Paulo, Brazil. [4]Food Technology Institute, ITAL, Campinas, São Paulo, Brazil

Abstract – Reducing sodium intake is among the most pressing challenges due to its proven role in the development of hypertension, one of the most important risk factors for cardiovascular disease. The objective of this research was to study the effects of Na-lactate replacement by K-lactate on physico-chemical properties of sausages containing 50% reduction in sodium chloride by its partial substitution with potassium chloride and high levels of mechanically deboned poultry meat. The Na-lactate by K-lactate substitution at 30g/kg had changed significantly ($p \leq 0.05$) moisture, pH values, emulsion stability and sodium and potassium content. Nevertheless, water activity, TBARS values were not significantly affected. The Na-lactate by K-lactate replacements can represent a feasible alternative to reduce sodium in low-cost sausages formulations.

Keywords - Emulsion-type sausages, Potassium chloride, Sodium chloride

I. INTRODUCTION

Currently, the high sodium intake (Na^+, mainly derived from NaCl) has been received attention from public health organs due its association with hypertension and cardiovascular diseases witch, result in excessive spend to governs in all countries. In human daily diet, the Na^+ amount arising from processed meats is significant and it has their consumption criticized [1]. However, because the technological properties of sodium chloride in meat products (flavoring agent, hurdle for microbial control, miofibrillar protein extraction agent) salt reduction in emulsified meat products a complex challenge. NaCl substitutions have been studied showing moderated success with chloride salts such as KCl, $MgCl_2$, $CaCl_2$ application and microbiological stability, physico-chemical and sensory changes were reported by these researchers [2]. Sodium lactate and diacetate are commonly associated to sodium chloride as additives to assure safety and quality along shelf life in commercial formulations increasing total sodium content in final products [3].

In popular meat emulsion products, salt replacement/reduction becomes a great challenge mostly in low-cost formulations containing Mechanically Deboned Poultry Meat (MDPM), a by-product obtained from slaughter and deboning processing of poultry meat carcasses. MDPM is a common raw material applied in comminuted meat products due to its fine consistency, low-cost, and functional properties [4]. Despite the evident economical benefits of MDPM use, manufacturers still have to address their negative effects on final meat product such as characteristic color depreciation, poorer textural effects, increased lipid oxidation susceptibility and higher microbial load [5]. In Brazil, according to MAPA (2000), MDPM is generally legally used in emulsion-type meat products (sausages and bologna) in concentrations up to 600g/kg.

To improve quality and extend shelf-life of emulsion-type sausages, mainly in this low-cost formulations (MDPM added), the traditional meat processing industry has been used alternatively GRAS additives, such as Na and K-lactate. They can contribute to stability of emulsified meat products acting as antimicrobial agents, acidity

regulator (pH), flavor enhancer agent, color stability and antioxidant [6, 7]. Regarding the sodium reduction in meat products, the Na-lactate are used in concentrations of 20-40g/kg in emulsion-type sausages in Brazil, significantly increasing Na^+ levels in final product. A feasible alternative to increment sodium reduction ensuring quality and safety can be to replace Na-lactate by K-lactate. However the impacts on physico-chemical properties of this substitution still are not precisely studied, especially if combined with a NaCl by KCl substitution in low-cost sausages formulations, consisting in a relevant meat science research gap.

This study aimed evaluate the effects of Na-lactate by K-lactate substitution on quality attributes of emulsion-type sausages containing mechanically deboned poultry meat (MDPM) with low-sodium content (50% replacement by potassium chloride-KCl) to search a further significant sodium reduction in the final meat product.

II. MATERIALS AND METHODS

The emulsion-type sausages were prepared following conventional processing and formulation as depicted in Table 1. The different evaluated treatments were formulated varying the NaCl contents by KCl (Merse, Brazil) substitution (50%) and with addition of Na-lactate and K-lactate at 30g/kg. The lactates were kindly provided by PURAC (commercially called NaL PurasalS® and KL (PurasalP®, Brazil). The physico-chemical analysis were carried out after 2 weeks (14 days) of refrigerated storage including moisture content [8]; water activity (a_w); pH measurements, sodium and potassium contents (AOAC [8]). Emulsion stability was evaluated following the method described by Parks & Carpenter [9]. The effects of NaCl reduction and lactates addition on sausages lipid oxidation was determined by thiobarbituric acid reactive substances (TBARS index) according to Bruna *et al* [10]. The TBARS values were expressed after absorbance reading at 532nm as mg of malondialdehyde (MDA) per kg sample.

The data obtained were subjected to analysis of variance (ANOVA), and the comparison between means was determined by Tukey-test adopting a 95% confidence level. These statistical analyses of data were carried out using statistical software R version 2.10.1 [11].

III. RESULTS AND DISCUSSION

The physical and chemical results of the different emulsion-type sausages treatments evaluated are showed in Table 2. The Na-lactate decreased moisture content of the samples (F2 and F5) ($p<0.05$) when compared to control and K-lactate formulation. The moisture value in control (F1) and formulation F4 (both without lactates) presented higher values ($p<0.05$) when compared with the other others treatments. However, it was not observed significant effect on Aw values for all formulations. Na/K-lactates are sodium and potassium salts from lactic-acid neutralization with high water-affinity, being able to reduce available moisture content of meat products assuring their humidity and quality during shelf life period.

About pH values, the values ranged from 6,47 – 6,66 and F2, F5 and F6 (with lactates salts) showed measurements significantly higher than the other treatments. The lactates are an excellent buffering agent which maintains the pH stability of the sausage during storage. The NaCl by KCl replacement and lactates addition affected ($p<0.05$) the sausages sodium and potassium contents and an effective and significant sodium reduction and potassium increment for the emulsion-type sausages formulated was observed when K-lactate was associated to KCl as salt substitute.

Regarding to emulsion stability, it was observed that the control treatment (F1) showed a higher emulsion-stability compared to the other treatments and it was different from F3, F4, F5 and F6. However, it was not detected significant differences among the treatments F2, F3, F4, F5 and F6 ($p<0.05$). These results seem to be related to a larger amount of MDPM present in formulations and ionic strength provided by combination of KCl and lactates salts. Significant differences were not observed in the TBARS indexes among all treatments evaluated indicating that the sodium reduction and using K-lactate doesn´t compromise the lipid oxidation stability.

Table 1 Formulations and different evaluated treatments of low-cost emulsion-type sausages containing variable levels of NaCl, KCl, Na-lactate and K-lactate.

Raw Material / Ingredients (g/kg)	Treatments / Formulations					
	F1	F2	F3	F4	F5	F6
Bovine meat	275.40	275.40	275.40	275.40	275.40	275.40
MDPM[a]	413.10	413.10	413.10	413.10	413.10	413.10
Pork backfat	100.00	100.00	100.00	100.00	100.00	100.00
Water/Ice	142.25	112.25	112.25	142.25	112.25	112.25
Salt (Sodium Chloride) - NaCl	20.00	20.00	20.00	10.00	10.00	10.00
Potassium Chloride - KCl[b]	-	-	-	10.00	10.00	10.00
Sodium Lactate - NaL	-	30.00	-	-	30.00	-
Potassium Lactate - KL	-	-	30.00	-	-	30.00
Sodium Nitrite - $NaNO_2$	0.15	0.15	0.15	0.15	0.15	0.15
Tripolyphosphates	2.50	2.50	2.50	2.50	2.50	2.50
Erythorbate	0.40	0.40	0.40	0.40	0.40	0.40
Cassava Starch	20.00	20.00	20.00	20.00	20.00	20.00
Isolated Soybean Protein - ISP	20.00	20.00	20.00	20.00	20.00	20.00
Spices / Seasonings						
White pepper	0.50	0.50	0.50	0.50	0.50	0.50
Garlic powder	2.20	2.20	2.20	2.20	2.20	2.20
Onion powder	2.20	2.20	2.20	2.20	2.20	2.20
Coriander	0.10	0.10	0.10	0.10	0.10	0.10
Cardamom	0.10	0.10	0.10	0.10	0.10	0.10
Marjoram	0.60	0.60	0.60	0.60	0.60	0.60
Jamaica pepper	0.50	0.50	0.50	0.50	0.50	0.50
Total	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00

F1-(20g/kg NaCl); F2- 20g/kg NaCl+30g/kg Na-lactate; F3-20g/kg NaCl+30g/kg K-lactate; F4-10g/kg NaCl+10 g/kg KCl; F5-10g/kg NaCl+10 g/kg KCl+30g/kg Na-lactate; F6-10g/kg NaCl+10 g/kg KCl+30g/kg Na-lactate.
[a]Mechanically Deboned Poultry Meat – MDPM -[b]Ionic Strength Correction – 38.26g KCl per batches of 3000g.

Table 2 Effects of different treatments evaluated on physico-chemical properties of emulsion-type sausages containing MDPM and formulated with low-sodium content after storage at 14 days at 7ºC.

Properties	Treatments / Formulations					
	F1	F2	F3	F4	F5	F6
Moisture content[1]	62.79±0.10^{bc}	62.03±0.14^{e}	63.05±0.02^{bc}	64.28±0.15^{a}	62.34±0.51^{de}	63.57±0.06^{b}
(a_w)	0.9856±0.01^{a}	0.9796±0.01^{a}	0.9819±0.01^{a}	0.9962±0.80^{a}	0.9850±0.00^{a}	0.9882±0.00^{a}
pH	6.47±0.05^{c}	6.64±0.01^{a}	6.51±0.04^{c}	6.55±0.04^{bc}	6.66±0.01^{a}	6.63±0.02^{ab}
Emulsion Stability (%)	96.52±1.71^{a}	93.53±2.00^{ab}	90.27±1.15^{b}	91.44±0.58^{b}	92.82±0.50^{b}	90.44±2.04^{b}
Sodium[2]	830,81±46.56^{c}	1400,62±56.40^{a}	813,32±44.65^{c}	466,73±16.23^{d}	1041,81±17.00^{b}	447,45±19.21^{d}
Potassium[2]	5,11±1.87^{d}	5,06±1.53^{d}	1468,12±11.16^{b}	503,23±9.54^{c}	500,58±14.99^{c}	1934,82±25.64^{a}
TBARS[3]	0.1351±0.00^{a}	0.1259±0.02^{a}	0.1220±0.01^{a}	0.1367±0.01^{a}	0.1482±0.03^{a}	0.1272±0.01^{a}

[1]Moisture g/100g; [2]sodium/potassium mg/100g; [3]Thiobarbituric Acid Reactive Substances –as mg malondialdehyde/kg sample.
F1-(20g/kg NaCl); F2- 20g/kg NaCl+30g/kg Na-lactate; F3-20g/kg NaCl+30g/kg K-lactate; F4-10g/kg NaCl+10 g/kg KCl; F5-10g/kg NaCl+10 g/kg KCl+30g/kg Na-lactate; F6-10g/kg NaCl+10 g/kg KCl+30g/kg Na-lactate.
Mean values ± Standard deviation. Values followed by the different small letter within the same line are significantly different ($p \leq 0.05$) by Tukey's test.

IV. CONCLUSIONS

The Na-lactate by K-lactate replacements in low-cost (mechanically deboned poultry meat added) emulsion-type sausages formulated with reduced NaCl levels (by KCl addition) promoted a significant sodium content decreasing in final product with slightly changes in physico-chemical attributes.

REFERENCES

1. World Health Organization (2011a). Review and updating of current WHO recommendations on salt/sodium and potassium consumption. Call for Public
2. Horita, C. N., Morgano, M. A., Celeghini, R. M. S., & Pollonio, M. A. R. (2011). Physico-chemical and sensory properties of reduced-fat mortadella prepared with blends of calcium, magnesium and potassium chloride as partial substitutes for sodium chloride. Meat Science: 89, 426–433.
3. Maks, N., Zhu, L., Juneja, V. K., & Ravishankar, S. (2010). Sodium lactate, sodium diacetate and pediocin: Effects and interactions on the thermal inactivation of Listeria monocytogenes on bologna. Food Microbiology: 27, 64–69.
4. Mielnik, M. B., Aaby, K., Rolfsen, K., Ellenkjaer, M. R., & Nilsson, A. (2002). Quality of comminuted sausages formulated from mechanically deboned poultry meat. Meat Science: 61, 73–84.
5. Pereira, A. G. T., Ramos, E. M., Teixeira, J. T., Cardoso, G. P., Ramos, A. L. S., Fontes, P. R. (2011). Effects of the addition of mechanically deboned poultry meat and collagen fibers on quality characteristics of frankfurter-type sausages. Meat Science: 89, 519–525.
6. Fulladosa, E., Sala, X., Gou, P., Garriga, M., & Arnau, J. (2012). K-lactate and high pressure effects on the safety and quality of restructured hams. Meat Science: 91, 56-61.
7. Sallam, K. I., & Samejima, K. (2004). Microbiological and chemical quality of ground beef treated with sodium lactate and sodium chloride during refrigerated storage. Lebensmittel-Wissenschaft & Technologie-LWT: 37, 865−871.
8. AOAC (2005). Official methods of analysis of AOAC International (17th ed.). Maryland, USA: Association of Official Analytical Chemistry.
9. Parks, L. L., & Carpenter, J. A. (1987). Functionality of six non meat proteins in meat emulsion systems. Journal of Food Science, 52, 271-274.
10. Bruna, J. M., Ordóñez, J. A., Fernández, M., Herranz, B., de la Hoz, L. (2001). Microbial and physico-chemical change during the ripening of dry fermented sausages superficially inoculated with or having added and intracellular cell-free extract of Penicillinum auratiogriseum. Meat Science, 59, 87-96.
11. R Development Core Team. R, (2004). A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Viena. www. r-project. org.