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

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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 changed significantly (*p*≤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 sodium in low-cost sausage formulations.

Keywords - Emulsion-type sausages, low-sodium, mechanically deboned poultry meat.

I. INTRODUCTION

Currently, the high sodium intake (Na^+, mainly derived from NaCl) has received attention from public health organizations due to its association with hypertension and cardiovascular diseases, which result in excessive government health care expenditure in all countries. In the human daily diet, the amount of Na^+ from processed meats is significant and as a result their consumption is criticized [1]. However, because of the technological properties of sodium chloride in meat products (flavoring agent, hurdle for microbial control, myofibrillar protein extraction agent), salt reduction in emulsified meat products is a complex challenge. NaCl substitutions have been studied and moderated success has been shown with chloride salts such as KCl, $MgCl_2$, and $CaCl_2$ although microbiological stability, physico-chemical and sensory changes were reported by these researchers [2]. Sodium lactate and diacetate are commonly used in association with sodium chloride to assure safety and quality along with shelf life in commercial formulations, thus increasing the 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 the 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 its negative effects on final meat product such as characteristic color depreciation, poor textural effects, increased lipid oxidation susceptibility and high 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 these low-cost formulations (MDPM added), the traditional meat processing industry has used alternatively GRAS additives, such as Na and K-lactate. They can contribute to stability of emulsified meat products by acting as antimicrobial agents, acidity regulators (pH), flavor enhancer agents, color stabilizers and antioxidants [6,7]. Regarding the sodium reduction in meat products, Na-lactate is used in concentrations of 20-40g/kg in emulsion-type sausages in Brazil, significantly increasing

Na^+ levels in the final product. A feasible alternative to incremental 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 substitution of NaCl by KCl in low-cost sausages formulations.

This study aimed to 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 investigate a further significant sodium reduction in the final meat product.

II. MATERIALS AND METHODS

The emulsion-type sausages were prepared following conventional processing and the formulation is shown in Table 1. The different treatments were formulated by 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 analyses 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 a Tukey-test using 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) ($p \leq 0.05$) when compared to control and K-lactate formulation. The moisture value in control (F1) and formulation F4 (both without lactates) presented higher values ($p \leq 0.05$) 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.

The pH 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 excellent buffering agents which maintain the pH stability of the sausage during storage. The NaCl by KCl replacement and lactates addition affected ($p \leq 0.05$) the sausages sodium and potassium contents and an effective and significant sodium reduction and potassium increment for the emulsion-type sausages formulated was achieved when K-lactate was associated with KCl as salt substitute.

The control treatment (F1) showed a higher emulsion-stability compared to the other treatments and it was different from F3, F4, F5 and F6. There were no significant differences in emulsion stability among the other treatments F2, F3, F4, F5 and F6 ($p>0.05$). These results seemed to be related to a large amount of MDPM present in the formulations and the ionic strength provided by the 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 did not compromise lipid 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 forequarter – fore shank	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 – Control formulation; F2 – Sodium lactate added; F3 – Potassium lactate added; F4 - NaCl + KCl (50% NaCl replacements); F5 - NaCl + KCl (50% NaCl replacements) added of Sodium Lactate; F6 - NaCl + KCl (50% NaCl replacements) added of Potassium 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 4-7°C.

Properties	Treatments / Formulations					
	F1	F2	F3	F4	F5	F6
Moisture content	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	3101.77±106.56[c]	4394.03±76.40[a]	3284.53±44.65[b]	2025.97±16.23[d]	3034.17±17.00[c]	2080.83±19.21[d]
Potassium	2269.73±116.87[d]	801.13±17.53[e]	726.77±7.16[e]	2658.67±19.54[c]	2904.27±14.99[b]	4040.97±65.64[a]
TBARS[a]	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]

[a]Thiobarbituric Acid Reactive Substances – TBARS as mg malondialdehyde/kg sample. Standard curve TEP - (y=0.8233x + 0.0243 R^2=0.9974). Moisture g/100g; sodium/potassium mg/100g . 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.

V. 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 decrease in the sodium content of the final product with only slightly changes in physico-chemical attributes.

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