EFFECT OF SALT REDUCTION ON AROMA ACTIVE COMPOUNDS FROM DRY FERMENTED SAUSAGES

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Abstract –The aim of this work was to study the effect of a small reduction of NaCl (16%) (RS) and substitution by KCl (RSK) on aroma active compounds in dry fermented sausages. Sensory analysis by consumer acceptance of the aroma and overall quality was performed. The aroma compounds were identified by GC-MS and GC-FID-Olfactometry. Small salt reduction affected the aroma and overall acceptability of dry fermented sausages, whilst substitution by KCl showed the same acceptability by consumers as control treatment (S) but not for the aroma quality. The aroma was affected due to the increase of aroma compounds derived from lipid autooxidation, Staphylococci esterase activity, and the decrease of amino acid degradation derived compounds. The aroma active compounds characteristic from these sausages were 2-hexenal, 1-octen-3-ol, butanoic acid and dimethyl trisulfide.

Key Words – Aroma, Volatile compounds, Sodium chloride, Salt reduction

I. INTRODUCTION

There are scientific evidences about the association of high salt intake with the incidence/prevalence of hypertension; therefore European Union (EU) proposed a salt reduction of 16 % in fourth years [1]. However, salt is an essential ingredient in the manufacture of dry fermented sausages (protein solubilization, water activity decrease, biochemical/enzymatic control) affecting sensory characteristics such as aroma [2, 3]. However, only Campagnol et al. [2] studied the effect of salt reduction on volatile compounds of dry fermented sausages reporting few analytical differences using 25 and 50 % KCl to replace NaCl. Nevertheless, the sensory analysis showed significant differences in aroma and taste between control and 50 % substitution. On the other hand, Ravyts et al. [4] did not report a great impact on the microbiota growth which can have an effect on volatile compound production. However, there are not studies available in literature about the effect of salt reduction on aroma active compounds. Therefore, the aim was to study the effect of small salt reduction (16%) on aroma active compounds present in dry fermented sausages.

II. MATERIALS AND METHODS

Three treatments of dry fermented sausages were manufactured with different salt contents: control treatment (S) with 2.7% NaCl, reduced salt treatment (RS) with 2.26% NaCl and reduced NaCl and replaced with KCl treatment (RSK) with 2.26 % NaCl and 0.43 % KCl as reported Corral et al. [5].

Sensory analysis was carried out with 85 untrained consumers as described Corral et al. [5]. The attributes evaluated were aroma and overall quality.

Headspace volatile compounds of each dry fermented sausages treatment were extracted by SPME using 85µm CAR/PDMS fiber as described Corral et al. [5].

Volatile compounds were separated and identified in a GC-MS (Agilent GC 7890-5975 MS, Hewlett OAckard, Palo Alto, CA) using DB-624 capillary colum (J&W Scientific, Agilent Technologies, USA) and GC-FID-Olfactometry (GC-FID-O) (Agilent 6890, USA) by the Detection Frequency method as reported Corral et al. [5].

Effect of reduction/replacement of NaCl on sensory parameters and aroma compounds was performed by a one factor analysis of variance (ANOVA) using the statistic software XLSTAT 2009.4.03 (Addinsoft, Barcelona, Spain). Fisher test was used to evaluate differences among treatments.

III. RESULTS AND DISCUSSION

Sensory analysis showed that salt reduction had an effect on the acceptability of dry fermented sausages (Figure 1). The sensory panel detected significant differences among treatments in aroma

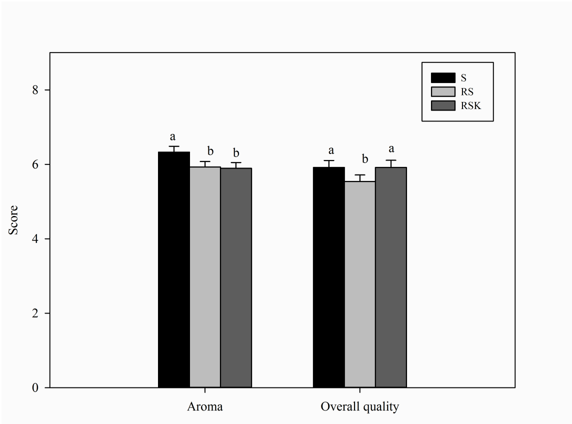

Figure 1. Sensory acceptability of dry fermented sausages with different salt content: S (control), RS (16% reduced salt) and RSK (16% KCl to replace NaCl).

acceptability that resulted in lower scores for reduced (RS) and replaced (RSK) treatments than control treatment (S). However, the consumers did not find significant differences in overall quality between S and RSK sausages. Therefore, a 16 % replacement by KCl can be carried although the aroma acceptability will be affected.

In order to elucidate how salt reduction/replacement affected sausage aroma; the aroma active compounds were analyzed. The volatile compounds were extracted by SPME with CAR/PDMS fiber and analyzed by GC-MS and GC-FID-O. Olfactometry analysis revealed 31 aroma active zones (Figure 2). All of them were identified by MS, LRI and odor description except five unknown compounds that were enumerated from 1 to 5 unknown. The aroma active compounds were described according to nine olfactory classes: acid-alcohol, earthy-undergrowth, empyreumatic, fruity-floral, green-vegetable, lactic-cheesy, plastic-chemical, sulphur-gas and not classified [6]. Dry fermented sausages aroma was defined by 13 green-vegetable notes, 5 sulphur-gas notes, 3 lactic-cheesy notes, 3 fruity-floral notes, 3 empyreumatic notes, 1 acid-alcohol note, 1 earthy-undergrowth note, 1 plastic-chemical note and 1 not classified note. According to the detection frequency (DF) method, the most potent odorants detected were acetic and butanoic acids, 2-hexenal, 3-methyl thiopropanal, dimethyl

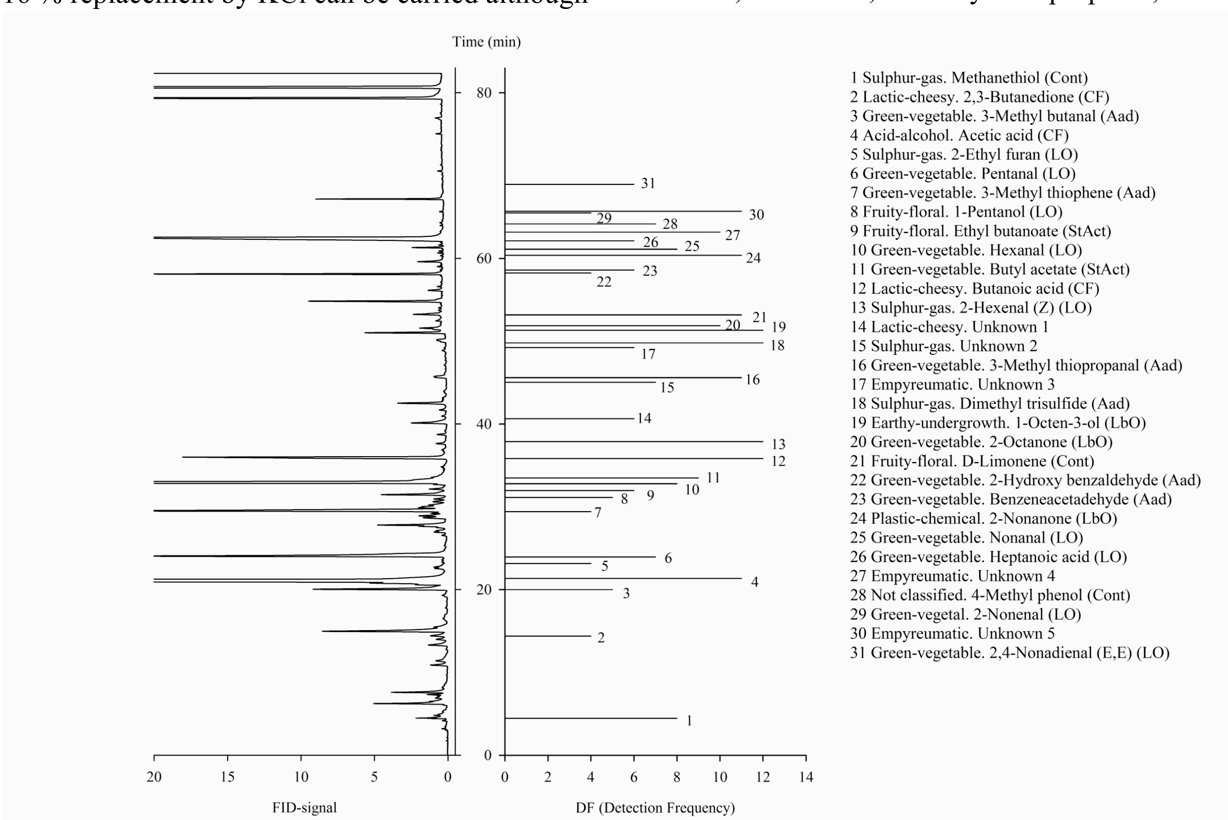

Figure 2. Aromagram of dry fermented sausages. Odors were described as olfactive classes (acid-alcohol, earthy-undergrowth, empyreumatic, flruity floral, green-vegetable lactic-cheesy, plastic-chemical, sulphur-gas and not classified. Compunds origin in parenthesis.

trisulfide, 1-octen-3-ol, D-limonene, 2-nonanone and unknown 4 and 5 described as empyreumatic odor.

The aroma active compounds detected by GC-O were quantified and classified by their possible origin: lipid autooxidation (LO), lipid beta-oxidation (LbO), carbohydrate fermentation (CF), amino acid degradation (Aad), Staphylococci esterase activity (StAct) and unknown or contaminant compounds (Cont) as indicated Ordoñez et al. [7] (Figure 3).

The compounds derived from carbohydrate fermentation were the most abundant compounds, representing 80-83 % of the total aroma compounds extracted, followed by those derived from lipid autooxidation (8-14%), amino acid degradation (4-8%), unknown or contaminant compounds (0.7-0.9%), lipid beta-oxidation (0.3-0.5%) and Staphylococci esterase activity compounds (0.1-0.3%).

Salt content produced significant differences on the aroma compounds derived from lipid autooxidation, amino acid degradation, Staphylococci esterase activity and unknown or contaminant compounds (Figure 3). The aroma compounds derived from lipid oxidation were significantly more abundant in replaced treatment (RSK) than reduced treatment (RS) and control treatment(S); whilst aroma compounds derived from amino acid degradation were less abundant in reduced treatments (RS and RSK) than S treatment.

Salt content also affected aroma compounds derived from Staphylococci esterase activity showing a higher HS abundance of esters in RS and RSK batches than S. The ester compounds are the products of the reaction between acids and alcohols such ethanol which were found in highest abundance in reduced and replaced treatments [5]. Therefore, this fact could explain the differences found among treatments. In relation to unknown or contaminant compounds they were more abundant in RS and RSK treatments than in S treatment. However, salt content did not produced significant differences on aroma compounds derived from carbohydrate fermentation or lipid beta-oxidation.

The obtained results showed that salt content affected the compounds derived from lipid autooxidation and several metabolic paths from bacterial metabolism (amino acid degradation and Staphylococci esterase activity). However, no significant differences were found on the growth of lactic acid bacteria and Staphylococci among treatments [5]. Therefore, the differences found in aroma compounds derived from amino acid degradation cannot be attributed to Staphylococci activity. Ravyst et al. [4] reported similar results whilst Olesen et al. [8] reported a great impact on the volatile profile with a 50 % NaCl reduction attributed to the activation of lactic acid bacteria growth and the ripening process. However, none of them studied aroma active compounds in detail and the salt reductions were of a 50 % or higher.

IV. CONCLUSION

Small salt reduction (16%) affected the aroma quality of slow fermented sausages producing a reduction in the overall quality acceptance; whilst the substitution by KCl did not improve the aroma.

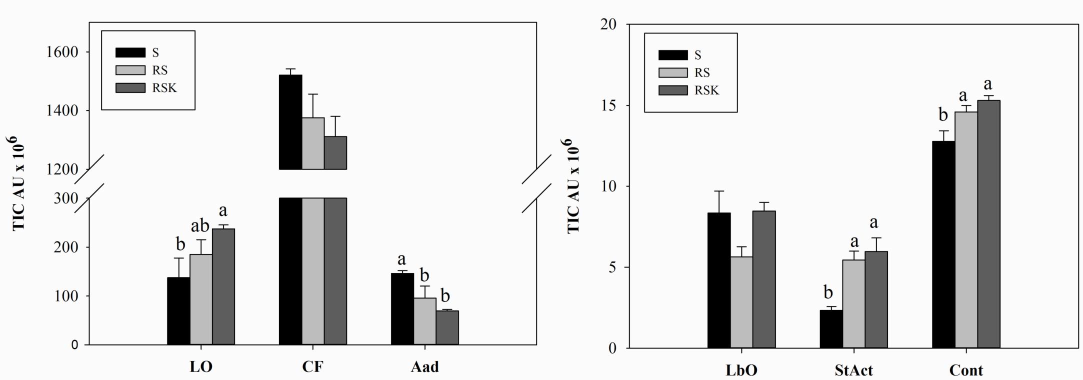

Figure 3. Total odorants abundance expressed as AU x 10 6 in the headspace of dry fermented sausages with different salt content: S (control), RS (16% reduced salt) and RSK (16% KCl to replace NaCl). Different letters in the same origin group indicate significant differences ($p<0.05$) among treatments.

This lowest aroma acceptability was due to the increase of compounds derived from lipid autooxidation and Staphylococci esterase activity reactions and the decrease of compounds derived from amino acid degradation reactions. The aroma active compounds characteristic from these sausages were 2-hexenal, 1-octen-3-ol, butanoic acid and dimethyl trisulfide. Therefore, further studies about other alternatives to KCl addition should be performed to improve the aroma perception.

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