Effect of NaCl substitutes on lipid and protein oxidation of harbin dry sausage (#336)

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Introduction

Harbin dry sausage is one of the most popular and traditional fermented meat products in China due to its flavor and texture. However, the long fermentation cycle (approximately 12-15 d) of Harbin dry sausages causes a higher level (3.6-4.0%) of NaCl in the final products. Partially replacing NaCl with KCl and flavor enhancers such as lysine, alanine, citric acid, Ca-lactate and maltodextrin is a good choice for producing low-sodium meat products. However, the NaCl substitutes can affect lipid and protein oxidation during processing of the product, which influences the development of texture, color and flavor. Therefore, the purpose of this study was to evaluate the influence of NaCl substitutes on lipid and protein oxidation during fermentation.

Methods

1. Preparation of Harbin dry sausages

Three independent batches of Harbin dry sausages were prepared according to a procedure described by Chen, Kong, Sun, Dong, and Liu (2015). Three treatments were prepared as follows: control (100% NaCl), SS1 (70% NaCl and 30% KCl), and SS2 (70% NaCl, 20% KCl, 4% lysine, 1% alanine, 0.5% citric acid, 1% Ca-lactate and 3.5% maltodextrin).

2. Thiobarbituric acid reactive substances (TBARS)

The extent of lipid oxidation was evaluated by the TBARS assay. The TBARS of dry sausages were determined following the method of Wang and Xiong (2005). The TBARS value was expressed as mg of malondialdehyde (MDA) per kg of sausage.

3. Myofibrillarproteins (MP)

The MP was extracted from dry sausages as described by Liu and Xiong (1996).

4. Carbonyl content,sulfhydryl content andsurface hydrophobicity

The protein carbonyl content was determined according to the method of Chen et al. (2016). The content of carbonyl is expressed as nmol carbonyl/mg protein based on an absorption coefficient of 22,000 M^{-1} cm^{-1}. Sulfhydryl contents were detected according to the method described by Ellman (1959). Sulfhydryl content is expressed as nmol Sulfhydryl/mg protein based on an absorption coefficient of 13,600 M^{-1} cm^{-1}. The surface hydrophobicity was measured using bromophenol blue (BPB) as described by Chelh, Gatellier, and Santé-Lhoutellier (2006). The amount of bound BPB was used to determine surface hydrophobicity.

Results

1. Thiobarbituric acid reactive substances

TBARS is an important index to assess the extent of lipid oxidation during fermentation, which is mainly used to measure secondary products of lipid oxidation. As shown in Fig. 1, TBARS values with a slow increase at the former fermentation (0-3 d) and with a sharp increase at the latter fermentation (6-12 d) were found. During fermentation, TBARS values in the control treatment were higher than those in the SS1 and SS2 treatments ($P < 0.05$). That may be attributed to the promotive effect of NaCl on lipid oxidation. Meanwhile, TBARS values of the SS2 treatment were significantly lower than those of the SS1 treatment in the later fermentation stage ($P < 0.05$) due to their differences in KCl and amino acid salt contents.

2. Carbonyl content, total sulfhydryl content and surface hydrophobicity

The formation of carbonyl compounds is considered to be the main indicator of protein oxidation in meat and meat products. As shown in Figure. 2(A), regardless of treatments, the carbonyl contents increased significantly during fermentation ($P < 0.05$). In the later stage of fermentation, the carbonyl contents in the SS1 and SS2 treatments were significantly lower than those in the control treatment ($P < 0.05$). This was attributed to the enhanced ionic strength in meat that is caused by adding NaCl and KCl, which affects the degree of MP assembly and loosens the structure, which would favor the diffusion of radicals and other pro-oxidative factors.

Sulfhydryl group loss is also a marker of protein oxidation in meat and meat products. The oxidation products of sulfhydryl groups mainly include intra- or interprotein disulfide bonds and mixed-disulfides. The reduction of total sulfhydryl contents of MP in dry sausage during fermentation ($P < 0.05$) is presented in Figure. 2(B). The SS2 and SS1 treatments showed significant differences from the control treatment at the end of fermentation ($P < 0.05$). *This result was consistent with the carbonyl content results.*

As a suitable indicator to investigate protein denaturation, surface hydrophobicity was used to detect changes in the structure on the surface of MP in dry sausages. It is generally accepted that oxidation reactions would lead to changes in the secondary and tertiary structures of proteins. *As shown in Figure. 2(C), the surface hydrophobicity of MP increased during sausage fermentation, and* the highest hydrophobicity was found in the control treatment ($P < 0.05$). *This result further proved the promotive effect of NaCl on protein*

Notes

oxidation.

Conclusion

These results showed that Harbin dry sausages containing different NaCl significantly reduced the degree of lipid and protein oxidation during fermentation. The NaCl substitutes may influence the formation of volatile compounds that originated from these two pathways.

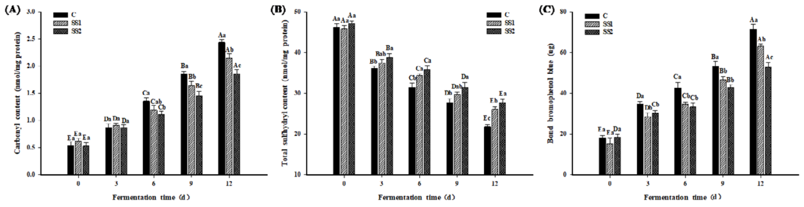

Figure 2. Carbonyl content, total sulfhydryl content and surface hydrophobicity of MP in Harbin dry

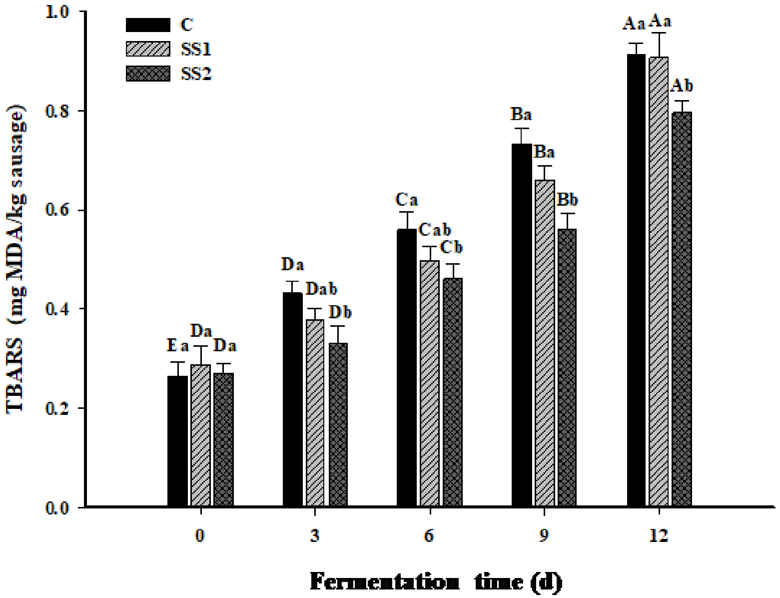

Figure 1. TBARS of Harbin dry sausages during fermentation: control and with NaCl substitutes

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