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Effects of NaCl substitutes on the physicochemical properties of fermented dry sausage (#340)

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Introduction

Harbin dry sausage is one of the most popular and traditional fermented meat products in China because of its flavor, taste and texture. However, the long fermentation cycle of Harbin dry sausages results in a high level (3.6-4.0%) of NaCl in the final products. The excessive sodium intake in the human diet can lead to hypertension and increase the risk of cardiovascular disease (Paik, Wendel, & Freeman, 2005; Desmond, 2006). There are many strategies to reduce the NaCl content in fermented meat products, of which the direct reduction of the NaCl content and the use of salt substitutes (such as KCl, $MgCl_2$ and $CaCl_2$) to replace NaCl are the most commonly used methods (dos Santos et al., 2015; Lorenzo et al., 2015). Therefore, the aim of our study was to evaluate the effects of the sodium substitutes on the physicochemical properties of fermented dry sausages.

Methods

1. Preparation of fermented sausages

Three independent batches of Harbin dry sausages were prepared according to the method of Chen, Kong, Sun, Dong, and Liu (2015) with some modification. The sausages were prepared with lean pork (90%, w/w) and pork back fat (10%, w/w), and the following additives were added: 2.5% salt, 1.0% sugar, 0.3% monosodium glutamate, 0.01% sodium nitrite, 1.0% wine, 5.0% water and 0.8% mixed spices. *Lactobacillus curvatus*, *Pediococcus pentosaceus* R1 and *Staphylococcus xylosus* A1 were used as mixed starter culture (10^7 cfu/g) in the current study. For control samples, salt was 100% NaCl. For other two treatments, NaCl was partly substituted by 30% KCl (SS1) and by 20% KCl combined with 3.5% maltodextrin, 4% L-Lys, 1% L-Ala, 0.5% citric acid and 1% Ca-lactate (SS2).The sausages in each treatment were sampled at various fermentation times (0, 3, 6, and 9 d) to measure the physicochemical characteristics.

2. Moisture content, water activity (aw) and pH

The moisture content was determined according to AOAC procedures (AOAC, 1995). Aw was measured by an Aqualab water activity meter. The pH of the sausages was measured based on the method described by Berardo et al. (2016) with slight modification. Briefly, fermented sausages (10.0 g) were homogenized in a blender with 90.0 mL of distilled water. A standard pH meter was used to measure the pH of the mixture.

3. Shear force and thiobarbituric acid reactive substances (TBARS)

The shear forces of cooked sausages (15 min at 90 °C) were measured by a TA-XT2 plus Texture Analyser (Stable Micro Systems Ltd., England, U.K.) with a knife blade. The TBARS values of dry sausages were determined following the method of Wang and Xiong (2005), andexpressed as mg of malondialdehyde (MDA) per kg of sausage.

Results

1. Moisture content, aw and pH

The moisture content and aw declined in all sausages during fermentation, as presented in Fig. 1 (A) and (B). The initial moisture content was 62.58%, and it had declined to 29.87%, 32.12%, and 33.15% for the control, S1 and S2 treatments, respectively, at the end of fermentation ($P < 0.05$), which was due to the migration and evaporation of water in the sausages. Compared to the control treatment, there were higher moisture contents in the S1 and S2 treatments at 6 d and 9 d ($P < 0.05$), which was attributed to the lower Na^+ concentration, which inhibited the release of water (Aliño, Grau, Baigts, & Barat, 2009). The initial aw was 0.968, and by the end of fermentation, it had decreased to 0.797, 0.807, and 0.835 for the control, S1 and S2 treatments, respectively ($P < 0.05$). Reducing the amount of NaCl in the fermented sausages led to an increased moisture content and aw.

As shown in Fig. 1 (C), the initial pH of the sausages was approximately 6.35, and it gradually decreased to 4.96, 4.86 and 4.53, respectively, for the control, S1 and S2 treatments after a nine-day fermentation. The pH of the S1 and S2 treatments was significantly lower than that of the control treatment ($P < 0.05$), which was mainly attributed to the higher LAB population caused by lowering the NaCl addition level. Then, the pH of all sausages remained stable from 6 d to 9 d, mainly due to the environment being unsuitable for the growth of LAB and the formation of ammonia from protein hydrolysis.

2. Shear force and TBARS

As shown in Fig. 2(A), the shear force values of all the treatments gradually increased during fermentation ($P < 0.05$). Additionally, the shear force values of the S1 and S2 treatments after a nine-day fermentation were significantly lower than that in the control treatment ($P < 0.05$). As shown in Fig. 2(B), the initial TBARS value in all sausages was 0.05 mg MDA/kg meat, and it increased to 0.62, 0.65, and 0.56 mg MDA/kg meat for the control, S1 and S2 treatments, respectively, after a nine-day fermentation ($P < 0.05$). However, there were no significant differences in the TBARS values among the three treatments for the same fermentation time.

Conclusion

According to our results, substitution of 30% of the NaCl by KCl and flavor enhancers resulted in higher moisture content and aw, as well as led to lower pH and shear force. Therefore, treatment S2 can be employed as a low-sodium substitute in fermented sausages to achieve better quality with a 30% reduction in NaCl.

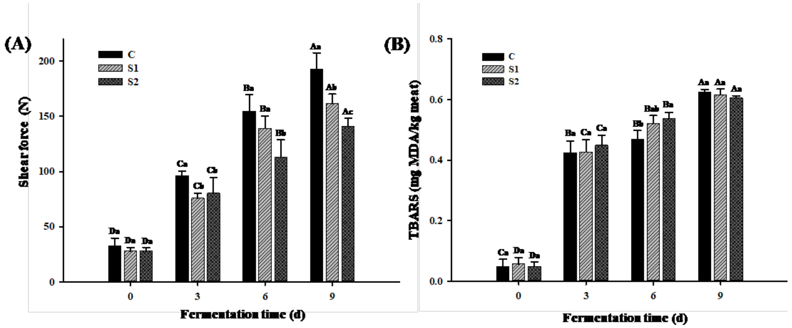

Figure 2. Shear force and TBARS of fermented sausages during fermentation

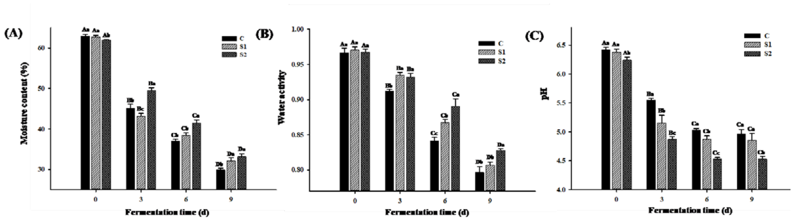

Figure 1. Moisture content, water activity and pH of fermented sausages during fermentation

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