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DIFFERENT STABILIZATION MECHANISMS OF SAUSAGE MEAT BATTERS DEPENDING ON THE FAT SOURCES: PORK FAT VS. AGAR-BASED EMULSION GEL

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I. INTRODUCTION

Meat products are excellent sources of macro- and micronutrients. However, excessive consumption of saturated fatty acids (SFAs) can increase the risk of chronic diseases [1]. Therefore, plant oils have been considered as substitutes for animal fats [2]. Emulsion gels has been investigated as one possible strategy for addressing the lack of plasticity of plant oils. Pork fat and plant oils are characterized by various properties, including fatty acid (FA) composition, droplet distribution, emulsion size, physical structure, and polarity [3]. Nevertheless, research focusing on the different emulsion stabilization mechanisms in meat batter and the resulting qualities of the final products and their relationships with the fat source is still lacking. Thus, the main objective of this study was to develop a plant oil-based emulsion gel as a replacement for pork fat and to evaluate its emulsification behavior compared to pork fat when added to sausage batter.

II. MATERIALS AND METHODS

The agar (AG), Konjac glucomannan (GM), gum Arabic (GA), and corn oil contents in the emulsion gel were 1.91%, 2.13%, 0.96%, and 20% (w/w), respectively. The meat batters were classified according to the fat replacement ratio: conventional sausages produced with pork fat (PF100), sausages in which 50% of the pork fat was replaced with emulsion gel (PF50+EG50), and sausages in which 100% of pork fat was replaced with emulsion gel (EG100). The emulsion stability of the meat batter was evaluated using a turbidity test, and confocal laser scanning microscope images were acquired. Proteins adsorbed onto the oil-water interface of the meat batter were extracted using a previously reported method [4] and subjected to sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE). Molecular and FA composition analyses of sausages were performed according to the methods of Gómez-Guillén et al [5] and Lee et al [4]. Experiments were conducted in three batches with triplicate samples (n = 9 per treatment), and data were analyzed using SAS software (version 9.3, SAS Institute Inc., Cary, NC, USA).

III. RESULTS AND DISCUSSION

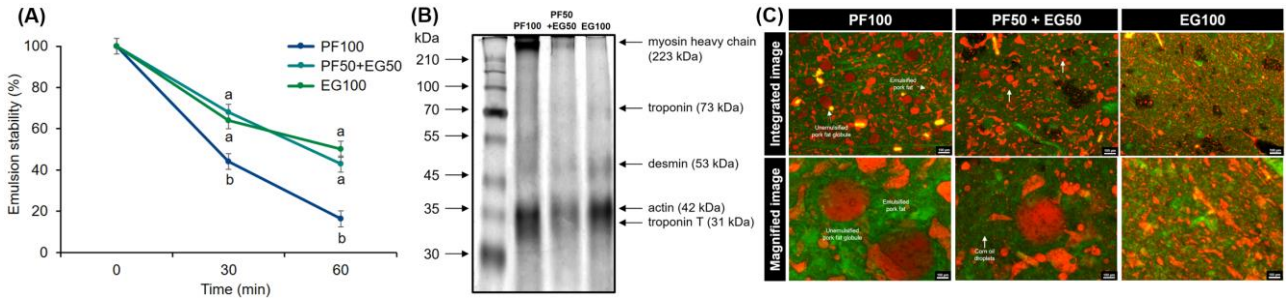


Figure 1. Emulsion stability (%, A) of the meat batter, SDS-PAGE electrophoretogram (B) of the adsorbed proteins onto the oil-water interface in the pork meat batter and confocal laser microscopy images (C) of the pork meat batters

PF100, which utilized only pork fat as the fat source, exhibited the lowest emulsion stability at 30 and 60 min ($P<0.05$, Figure1A). By contrast, EG100 and PF50+EG50, which incorporated the emulsion gel, showed higher emulsion stability with no significant differences between the two treatments ($P<0.05$). In the electrophoretogram (Figure 1B), myosin heavy chain band was present only in the PF100 and PF50+EG50, and the band intensity was lower in PF50+EG50 than in PF100. When two or more double bonds are present in the carbon chain of an oil, electron transfer is partially hindered, leading to increased polarity [6]. Therefore, corn oil may exhibit stronger polarity than pork fat. Han et al. [7] reported that with an increasing degree of unsaturation in the oil, the α-helix content of salt-soluble meat proteins decreases while β-sheet content increases, reducing adsorption efficiency.

Therefore, the adsorption efficiency could be lower in EG100 and PF50+EG50 than in PF100. Nevertheless, most regions containing fat globules in the PF50+EG50 and EG100 (Figure 1C). Therefore, despite the lower interfacial myofibrillar protein adsorption in PF50+EG50 and EG100 than in PF100, the polysaccharide-induced thickening effects appear to result in the higher emulsion stability of PF50+EG50 and EG100 than that of PF100.

As shown in Figure 2A, for all treatments, hydrophobic interactions showed the highest contribution, followed by disulfide bonds. However, PF50+EG50 and EG100 showed significantly lower contributions of hydrophobic interactions and higher contributions of disulfide and hydrogen bonds compared to PF100 ($P<0.05$). As shown in Figure2B, the atherogenic and thrombogenic indices were lowest in EG100, at 0.53 and 1.07, respectively ($P<0.05$).

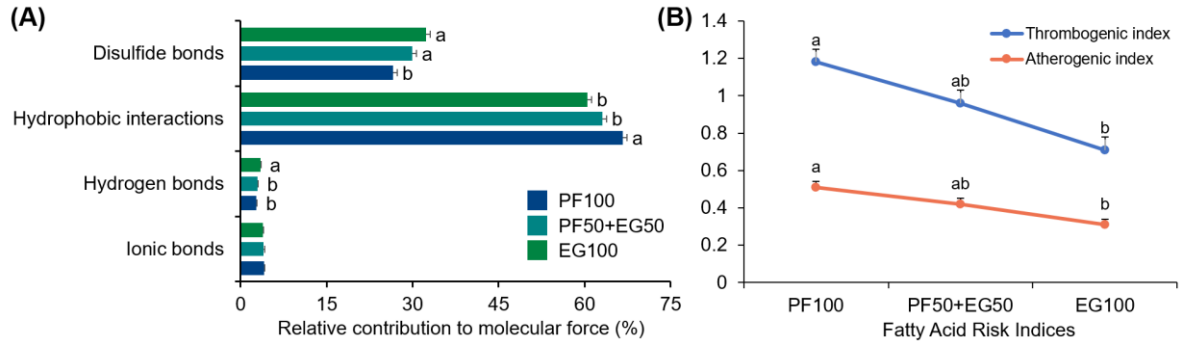


Figure 2. Relative contributions (%, A) of disulfide bonds, hydrophobic interactions, hydrogen bonds, and ionic bonds during heat-induced gelation and thrombogenic and atherogenic Indices (B) based on the fatty acid composition of pork sausages

IV. CONCLUSION

This study aimed to investigate the differences in the stabilization mechanisms of meat batters and the resulting sausage qualities based on the fat source. EG100 exhibited higher emulsion stability, however, PF100 showed greater interfacial myofibrillar protein adsorption. The molecular force results showed that as the proportion of the emulsion gel increased in the sausage, the contribution of hydrophobic interactions decreased, and the contribution of disulfide bonds increased. These results indicated that different fat sources have different stabilization mechanisms in meat batters, resulting in different gelation behaviors during heating. In conclusion, substitution of pork fat with a plant oil-based emulsion gel could improve the emulsion and FA composition of sausages without degrading the sausage gel quality.

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