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IMPACTS OF THE MAILLARD REACTION ON THE COLOR, FLAVOR, AND AGEs IN MEAT AND PLANT-BASED MEAT

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I. INTRODUCTION

In meat and meat products, the Maillard reaction is a critical chemical reaction occurred during cooking and processing, and generates numerous chemicals which affect sensory properties such as color and flavor [1,2]. On the other hand, this reaction also generates potentially deleterious substances known as advanced glycation end products (AGEs) and relates to various chronic diseases [3]. The plant-based (PB) meat is a one of the meat alternatives made from legumes such as soybeans. Since there are little concerns for environment and animal welfare, they have attracted attention from consumers in recent years. The Maillard reaction can be occurred in PB meat products during extrusion and formulation of ingredients [4]. However, the effects of the Maillard reaction on PB-meat remains unclear. Therefore, the objective of this study was to compare the color, AGEs of meat and PB meat products. In addition, we also investigate that the volatile compounds released from PB-meat after heat treatment.

II. MATERIALS AND METHODS

Minced meat (beef and pork) and PB-meat (soybean and pea) samples were purchased from local market. These samples were heated at 0, 180, 230°C for 90 sec on both sides, and then measured their brightness (L*), redness (a*), and yellowness (b*). After color measurement, each sample were homogenized with PBS and measured absorbance at 294 nm (indicator of AGEs at early stage) and 420 nm (indicator of AGEs at final stage). Also, the intensities of fluorescent AGEs [5] including crossline (ex: 379 nm, em: 463 nm), pentosidine (ex: 355 nm, em: 385 nm), and pyrropyridine (ex: 370 nm, em: 455nm) were evaluated. The statistical analysis was performed using the two-way ANOVA followed by Tukey HSD test.

To evaluate the volatile compounds from PB meat, the volatiles in raw/heated (230°C) sample were obtained by the solid-phase micro extraction (SPME) method, and then subjected to GC/MS analysis. The principal component analysis (PCA) was used to distinguish the samples based on the peak intensity of their volatile components.

III. RESULTS AND DISCUSSION

The color of minced PB meat, which is recommended to be heated before consumption, showed an increase in yellowness (b*) with heat temperature. However, it was indicated that browning was less likely to occur than in minced meat. Interestingly, the intensities of fluorescent Maillard reaction products (e.g., pentosidine, crossline, and pyrropyridine) in unheated plant-based meat were approximately 2-10 times higher than in minced meat (Figure 1). In addition, such trend was also observed in plant-based products, including sausage, ham, and steamed chicken.

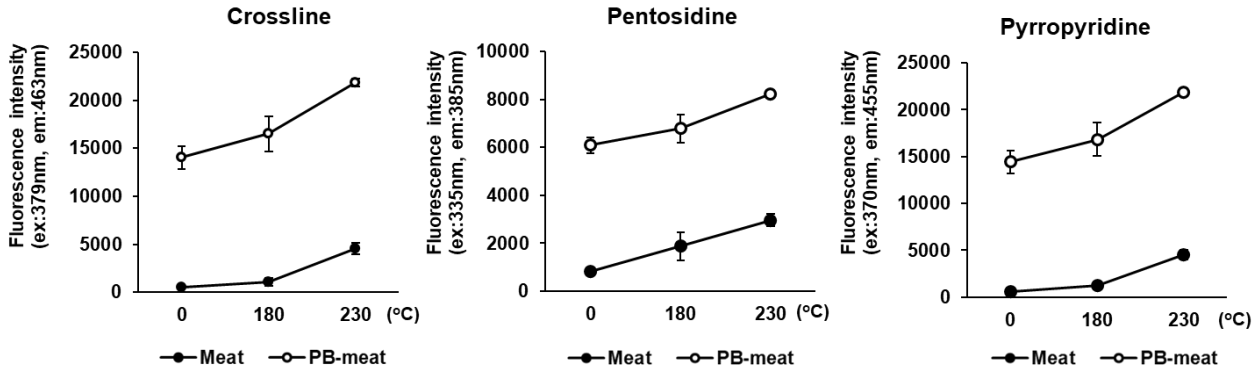


Figure 1. Changes in fluorescence AGEs of meat /plant based-meat with heat temperature

In the PCA analysis, the profile of volatile compounds was discriminated by heat treatment (Figure 2A). This result suggests that the volatile compounds of PB meat alter through the Maillard reaction. Fifty-seven volatile compounds were shared among all identified compounds. However, 24 and 25 volatile compounds were only identified in unheated and heated PB meat, respectively (Figure 2B). Propyl acetate, α-thujene, benzyl alcohol, diethyl phthalate contributed to the profile of unheated PB meat. In the heated PB meat, 2-methyl-butanal, 3-methyl-butanal, (*E*)-2-octenal, 6-methyl-1-heptanol were identified as unique volatile compounds.

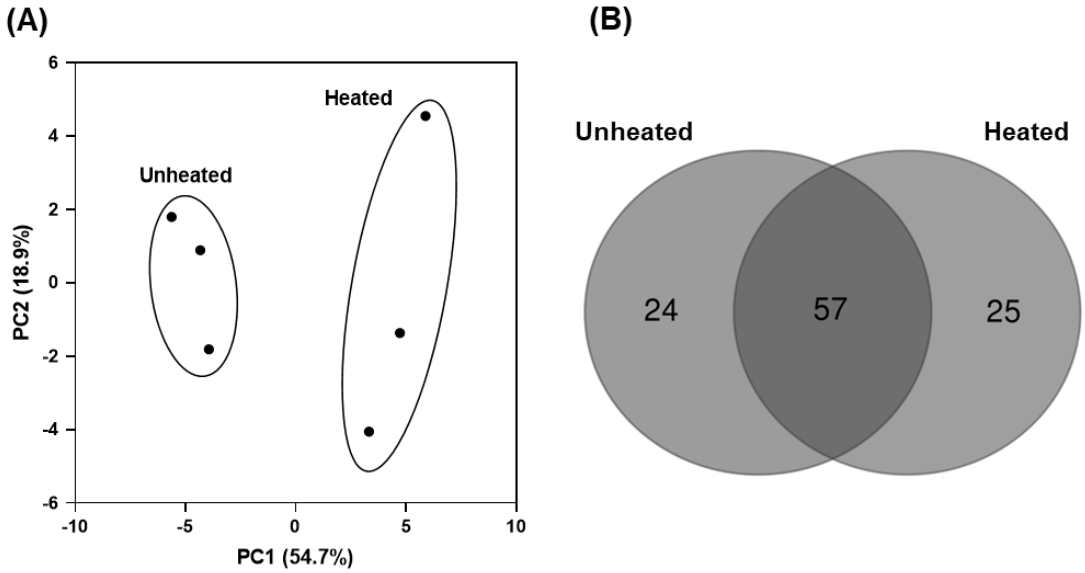


Figure 2. The result of volatile compounds of plant based-meat by SPME method

(A) Overall volatile compounds profile by principal component analysis (PCA). PB: plant-based meat. (B) Venn diagram of the volatile profile of unheated/heated PB-meat. The diagram indicates shared and unique volatile compounds between treatment.

IV. CONCLUSION

In this study, we found that the PB meat contains much fluorescent AGEs such as crossline, pentosidine, pyrropyridine even before heat treatment. This result suggests that the substrates for the Maillard reaction in PB meat would be utilized during many processing steps. Although the profile of volatile compounds in PB meat is altered by heat treatment, volatile compounds generated by the Maillard reaction do not contribute significantly. Our findings would be useful in discriminating between meat and PB meat and developing favorable products.

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