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COMPARATIVE ANALYSIS OF NUTRITIONAL COMPONENTS AND SENSORY PROPERTIES IN PATTIES MADE FROM HANWOO BEEF AND PLANT-BASED MEAT ANALOGUES

Soomin Oh[1], Yousung Jung[1], Dongwook Kim[1], and Aera Jang[1*]

[1] Department of Applied Animal Science, College of Animal Life Sciences, Kangwon National University, Chuncheon, Korea

*Corresponding author email: ajang@kangwon.ac.kr

I. INTRODUCTION

Beef from Hanwoo, Korean native cattle, is popular among consumers due to its nutritional value, desirable sensory characteristics, and convenience [1]. However, excessive meat consumption can pose challenges to the environment, human health, and animal ethics. As a result, plant-based meat analogues (PBMAs), which can mimic the fibrous appearance, flavor, and nutritional properties of meat, have gained attention as potential substitutes for conventional meat products [2]. However, there are nutritional differences between animal-based and plant-based foods, and PBMAs are specifically manufactured to mimic processed meat products, which can result in variations in their nutritional composition [2, 3]. Therefore, this study compared the nutritional and sensory properties of PBMAs patty (PP) and Hanwoo beef patty (HP).

II. MATERIALS AND METHODS

Three types of HP and three types of PP were purchased from Korean online shopping malls. For nutritional analysis, the samples were mixed using a food mixer and stored at –18 °C until analysis. For sensory evaluation, the samples were stored unground at –18 °C prior to sensory evaluation. Proximate composition was analyzed using AOAC methods [4]. Mineral and sugar analyses were performed according to the methods outlined in the Food Code [5], using inductively coupled plasma optical emission spectrometry for mineral analysis and high-performance liquid chromatography with a refractive index detector for sugar analysis. Sensory evaluation was conducted using a 9-point hedonic scale with 70 students and faculty members from Kangwon National University, assessing appearance, color, off-flavor, taste, flavor, juiciness, tenderness, and overall acceptability. This process was approved by the institutional review board of Kangwon National University (KWNUIRB-2021-05-003-001). The data were analyzed using SAS software with one-way analysis of variance and Tukey's test. Each product was measured in triplicate, and the average values of the three products for each analysis parameter were calculated to compare HP and PP.

III. RESULTS AND DISCUSSION

In this study, differences in the proximate composition of HP and PP were observed (data not shown). Protein is an essential macronutrient indicator for evaluating the nutritional properties of meat and PBMAs [2]. Crude protein in HP was significantly higher at 15.61% compared to 13.29% in PP. Fat is a crucial component in meat products, enhancing juiciness, tenderness, and overall palatability, while carbohydrates such as methylcellulose, carrageenan, and modified starches are often added during the production of PBMAs to create a fibrous structure similar to that of meat [1]. In this study, the crude fat content of HP was significantly higher at 30.68% compared to 14.10% in PP. Additionally, carbohydrates were not detected in HP but were measured at 9.68% in PP.

Minerals are essential micronutrients required for maintaining human health throughout life. While plant-based foods are generally known to contain insufficient levels of iron and zinc, animal-based foods are widely recognized as superior dietary sources of these minerals [3]. Iron content was significantly higher in PP than in HP (Figure 1A). This is considered to be a result of nutrient fortification in the production of PBMAs [2]. However, zinc content was significantly higher in HP than in PP (Figure 1A). Sodium is known as a flavor-enhancing mineral [1], and in this study, its content was higher in PP than in HP ($P<0.05$).

Sugars can be added as flavor enhancers in processed products, and particularly, glucose and fructose, as reducing sugars, can serve as precursors for the Maillard reaction, contributing to meat-like aroma formation [1]. The contents of glucose, sucrose, and fructose were significantly higher in PP than in HP (Figure 2A). Sensory evaluation results of HP and PP are presented in Figure 2B. During the production of plant-based meat analogues, soy and legume-based ingredients often exhibit undesirable flavors and inherent off-notes, which can negatively impact consumer acceptance. Compounds such as saponins, isoflavones, catechins, and phenolics are known to impart astringent and bitter tastes [1]. In the study the scores for appearance, color, taste, flavor, and overall acceptability were significantly higher in HP than in PP, whereas the scores for off-flavor, juiciness, and tenderness were significantly higher in PP than in HP.

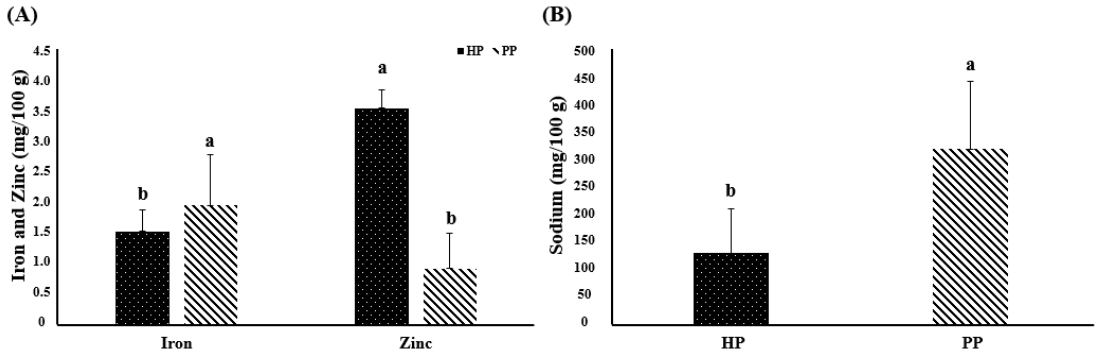


Figure 1. Mineral contents of the commercial patties made from Hanwoo beef and plant-based meat analogues. [a, b] Mean value between HP and PP with different superscript differ significantly at P<0.05. Iron and zinc contents (A) and sodium contents (B) in commercial patties made from Hanwoo beef and plant-based meat analogues. HP, Hanwoo beef patty; PP, plant-based meat analogues patty.

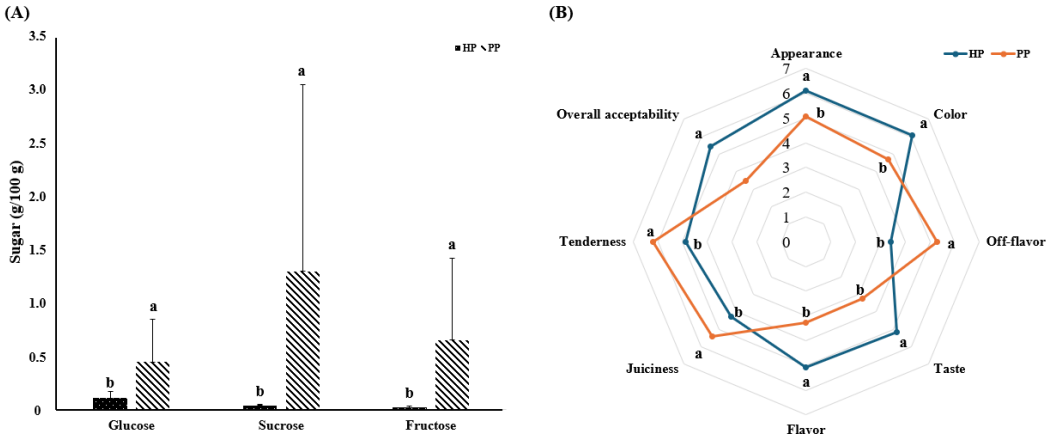


Figure 2. Sugar contents and sensory properties of the commercial patties made from Hanwoo beef and plant-based meat analogues. [a, b] Mean value between HP and PP with different superscript differ significantly at P<0.05. Sugar contents (A) and sensory properties (B) in commercial patties made from Hanwoo beef and plant-based meat analogues. HP, Hanwoo beef patty; PP, plant-based meat analogues patty. Appearance, color, taste, flavor, overall acceptability (1=very bad, 9=very good); off-flavor (1=very weak, 9=very strong); juiciness (1=very dry, 9=very juicy); tenderness (1=very tough, 9=very tender).

IV. CONCLUSION

This study evaluated the nutritional and sensory properties between HP and PP. In this study, the zinc content was higher in HP than in PP. In addition, although PP had higher levels of sodium and sugar, which are known to enhance flavor, HP received more favorable evaluations than PP in sensory attributes such as taste, flavor, off-flavor, and overall acceptability. Therefore, future PBMAs development needs to enhance zinc content and improve sensory properties related to flavor.

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