

A NOVEL FUNCTIONAL FOOD MATERIAL PREPARED FROM COLLAGEN-DERIVED PEPTIDES BY THE MAILLARD REACTION

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I. INTRODUCTION

During manufacture, storage and cooking of foods, various chemical reactions occur and change the color, aroma, taste, and nutritional value of foods. The Maillard reaction is a critical chemical reaction in such changes [1]. This reaction occurs between amines (e.g., amino acids, peptides) and carbonyl compounds, especially reducing sugars. A large number of products causing a change in color and flavor are brought by this reaction. As an example of foods closely related with the Maillard reaction, meat and meat products can be listed at the top of such foods [2]. Meat and meat products are very complex systems with numerous compounds and generally cooked before eating. Since Maillard reaction products present in foods are orally ingested by humans, it became apparent that their absorption by the gut and their metabolism into the body are important aspects of their nutritional and physiological properties. It has been reported that Maillard reaction products can exert several biological activities, such as the antioxidative, antibacterial, and ACE inhibitory activities.

Collagen exists in various meats and animal by-products [3]. This protein makes up to 70% of skin proteins. Thus, materials containing appreciable amounts of collagen can be obtained easily. Since collagen contains approximately 33% glycine, which is a nonessential amino acid, it has been considered of low nutritional value. However, glycine is a good source for the Maillard reaction with reducing sugars. In addition, collagen does not contain asparagine, which is a major amino acid in potatoes and cereals. Acrylamide, which is found in a range of fried and oven-cooked foods, is a known human neurotoxin and has been classified as probably carcinogenic in humans. The main formation pathway of acrylamide in foods is linked to the Maillard reaction and, in particular, the amino acid asparagine. Therefore, proteins without asparagine such as collagen are appropriate candidates for the process of the Maillard reaction. Since we have been trying to find novel meat protein-based functional food materials by the Maillard reaction [4], attention of this study was paid to develop a functional food material from collagen.

II. MATERIALS AND METHODS

Figure 1 shows the outline of the preparation process of the material (Maillard reaction products, MRPs) from collagen. Although collagen was prepared from broiler chicken skin in this study, origins of collagen are not critical for this process. Collagen was heated to transfer to gelatin and enzymatically digested by papain. Collagen-derived peptides were mixed with a reducing sugar (i.e., xylose) and a pH adjuster (i.e., sodium carbonate). The solutions were further heated at 90°C for the Maillard reaction. After heat treatment, freeze-dried Maillard reaction products were prepared and stored at 4°C.

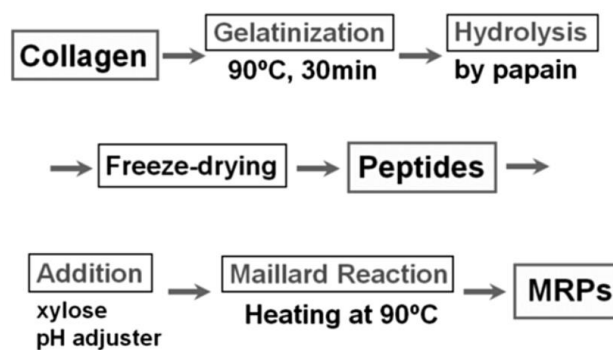


Figure 1 Preparation process of the novel food material from collagen-peptides by the Maillard reaction. From Arihara et al. (2013), Japan patent, 2013-5326489.

Above mentioned collagen-derived peptides and their Maillard reaction products were used for further experiments of both in vitro (antioxidative activities) and in vivo (suppression of oxidative stress, antihypertensive activities) assays.

III. RESULTS AND DISCUSSION

As shown in Figure 2, the antioxidative activities of the collagen peptide-based material (Maillard reaction products) were increased significantly by heat treatment (the Maillard reaction). Also, oral administration of the Maillard reaction products to mice suppressed the oxidative stress (i.e., hydroperoxide value of serum) significantly (Figure 3).

Continuous oral administration of the material prepared by the Maillard reaction to the spontaneously hypertensive rats suppressed the elevation of blood pressure caused by aging compared to collagen-derived peptides without heat treatment (Figure 4).

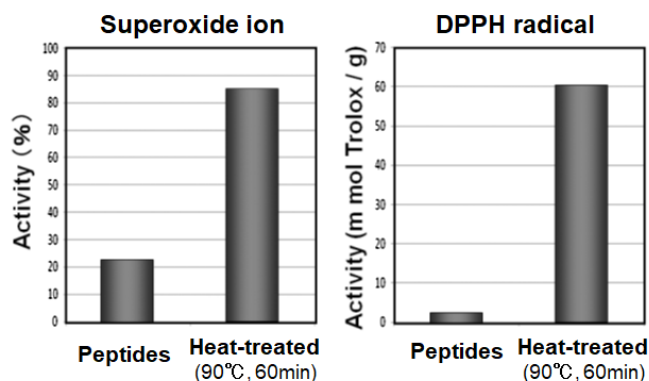


Figure 2 Antioxidative activities of Maillard reaction products prepared from collagen-peptides by heat treatment.

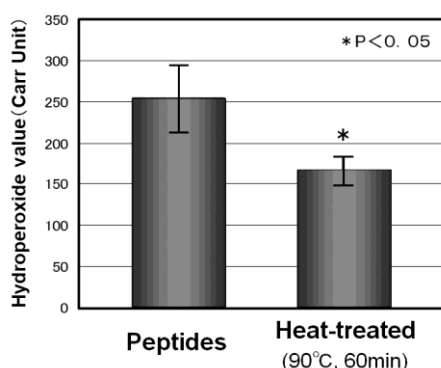


Figure 3 Hydroperoxide values of rat serum after oral administration of Maillard reaction products.

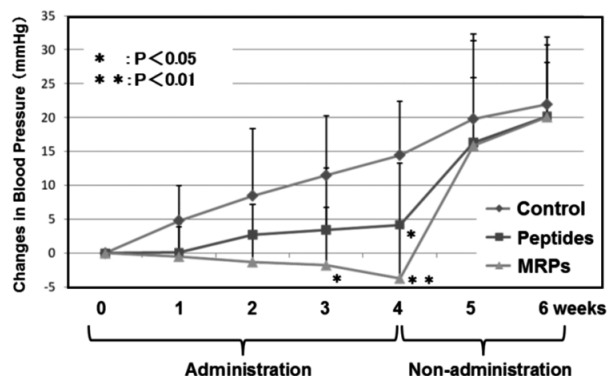


Figure 4 Antihypertensive activities of orally administered Maillard reaction products in spontaneously hypertensive rats.

These physiological activities seem to be due to the antioxidative activities generated by the Maillard reaction, since the Maillard reaction generates various antioxidative component such as melanoidins [4]. Collagen peptide-based material prepared in this study also showed satisfactory sensory properties [5].

IV. CONCLUSION

A novel material was developed from collagen-derived peptides by the Maillard reaction. It will be a possible functional food ingredient with preferable properties such as safety and flavor.

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