IMPROVEMENT IN THE FUNCTIONAL PROPERTIES OF SAUSAGES BY ADDITION OF BIOPOLYMERS PREPARED FROM SOYBEAN PROTEIN AND MILK PROTEIN USING MICROBIAL TRANSGLUTAMINASE

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Background:

Gelation of muscle protein contributes to desirable texture and stabilization of fat and water in processed meat and meat products. Because of an increasing awareness of health and weight problems associated with excess dietary fat, consumers are demanding lower fat products. Poultry processors are meeting this demand with poultry and poultry products containing reduced amount of fat. Chicken is now being used to manufacture many further processed products traditionally made from pork. The texture of sausages is an important quality, which influences their preference and palatability. It has been difficult to obtain a desirable gel strength manufactured from chicken.

Transglutaminase (TG; protein-glutamine γ-glutamyltransferase, EC2.3.2.13) can catalyze the formation of ε- (γ-glutamyl) lysyl crosslinks among food proteins. This enzyme has been expected to be useful for improvement of rheological properties of food [1, 2].

Objectives:

In the previous study, we have shown that the texture of chicken sausages is improved through the formation of GL crosslinks by added TG in pork and chicken sausages [3]. Our objective in the present article was to improve protein functionality by cross-linking soybean protein, casein and WPI using microbial TG, and to determine the extent such improvement by measuring heat aggregation, and emulsifying properties of resulting biopolymers. Another objective was to improve the reological properties of chicken sausages by addition of biopolymers.

Materials and Methods

TG was prepared from the culture broth of a variant of Streptoverticillum mobaranse as previously described [4]. To examine the formation of biopolymers, SDS-polyacrylamide gel electrophoresis (SDS-PAGE) was carried out on gradient slab gels (7.5-17.5 % acrylamide) employing the discontinuous buffer system of Laemmli [5]. HPLC analysis using TSK Gel G4000SW (7.5 mm I.D. x 60 cm) gel filtration column was performed. The effects of heating on turbidity of protein solution were measured by inear heating method (3°C/min). Emulsifying properties were measured by the method of Pearce and Kinsella [6]. Sausages were prepared from chicken breast meat. Minced meat was chopped with 2% NaCl, 0.2% or 0.05% sodium tripolyphosphate, 0.3% sorbic acid, 10% pork fat, 3% bioporymers and 40% distilled water for 90 sec. Sausage batter was stuffed into polyvinylidene chloride tubes. Then the tubes were sealed and heated at 75°C for 30min. Gel strength of sausages was measured with a creep meter.

Results and Discussion

Estimation of formation mode of biopolymer by TG addition

When soybean protein and casein were treated with TG, band of biopolymer (P-2) having high molecular weight, which did not enter into the concentration gel of SDS-PAGE, was appeared (Fig. 1-A). When the WPI was treated with TG, the formation of band of the biopolymer (P-1), which did not enter into the concentration gel and band of the biopolymer (P-2) which did not enter into separation gel, were observed. The cross-linking of the protein component, which derives from soybean protein and casein or soybean protein and WPI were formed. The resistant fluorescence on the bands of formed biopolymer (P-2) derived from soybean protein and casein or the mixture of soybean protein and casein was observed (Fig. 1-B). On the other hand, the resistant fluoresce was observed in the biopolymers (P-1, P-2) other than in the band of β-lactoglobulin and α-lactalbumin of WPI. This fact indicates that the resistant intramolecular G-L combination in β-lactoglobulin and α-lactalbumin was formed.

When TG is added to soybean protein and casein, the peaks of the biopolymer, which the retention time is short, were appeared (Fig.2). When TG is added to the mixture of soybean protein and casein or the mixture of soybean protein and WPI, new peaks of biopolymers were appeared.

Estimation of heat aggregation property and emulsifying properties of biopolymer

As the protein suspension was heated, protein molecules continuously aggregated, resulting in a steady increase in turbidity. Changes in turbidity during linear heating (3°C/min) of protein samples were measured. It was found that the heat stability of protein is increased by TG reaction, and bioporimer with the high stability are incorporated into various food systems.

The emulsifying activity was improved, when TG was added in all samples. Especially, the emulsifying activity remarkably

increased, when TG was added to casein (Fig. 3). The emulsifying activity of soybean protein was lower than that of casein and WPI. However, the emulsifying activity approached to the value of casein, when the casein was mixed in soybean protein. The biopolymer formed from mixture of soybean protein and casein showed high emulsifying activity and emulsification stability. The increase in the emulsifying activity of the biopolymer of WPI prepared by TG reaction for 30 min could not be very much accepted. However, the emulsifying activity of the biopolymer of WPI prepared by TG reaction for 16 hr remarkably increased.

Effect of biopolymer on breaking stress of sausage

The effect of biopolymers on breaking stress of chicken sausages was investigated (Fig. 4). The breaking stress of sausage increased, when the biopolymers of soybean protein or WPI were added to sausage mixture in the presence of 0.05% trypolyphosphate. In addition, the breaking stress of sausage similarly increased, when the biopolymers of soybean protein and casein or soybean protein and WPI were added to sausage mixture. The value of breaking stress of sausage was higher than that of sausage prepared in the presence of 0.2% phosphate used in usual sausage manufacturing. These results indicate that the phosphate content in the sausage manufacturing by the addition of the biopolymers was decreased without losses in texture property.

Conclusions

Cross-linking soybean protein and casein or soybean protein and WPI provided biopolymers with improved heat stability and emulsifying properties. The texture of chicken sausages was improved by the addition of such biopolymers even in the presence of 0.05% tryporyphosphate. These results suggest that the texture of chicken sausages is improved through the formation of network structures contribute to stiffness of sausage gels by the addition of biopolymers, and the phosphate content in the sausage manufacturing by the addition of the biopolymers is decreased without losses in texture property.

References

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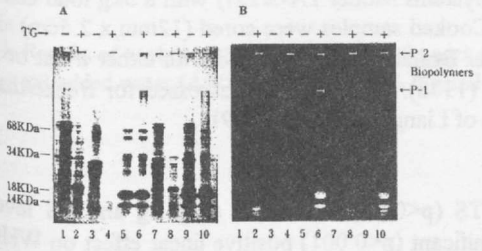

Fig.1 Electrophoretic patterns of biopolymers after incubation with microbial transglutaminase in the presence of monodansylcadaverine.
Protein solution (5 mg/ml) was incubated at 40℃ for 2hrs in a solution containing 5 mM monodansylcadaverine and 50 mM imidazole-HCl (pH 6.0) with or without TG (0.025 mg/ml). A, Coomassie Brilliant Blue stained protein bands; B, fluorescence of monodansylcadaverine incorporated into protein bands detected by illuminating with an UV lamp. Lanes 1 and 2, soybean protein; lanes 3 and 4, casein; lanes 5 and 6, WPI; lanes 7 and 8, mixture of soybean protein and casein; lanes 9 and 10, mixture of soybean protein and WPI.

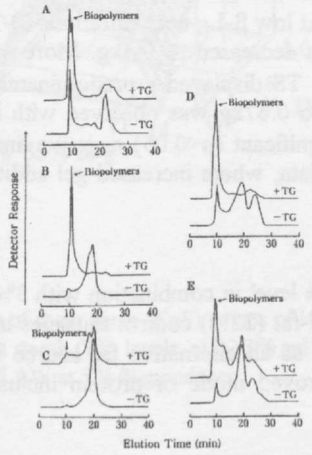

Fig.2 HPLC profiles showing biopolymers formed by TG treatment.
A, Soybean protein; B, casein; C, WPI; D, mixture of soybean protein and casein; E, mixture of soybean protein and WPI. Protein solution (5 mg/ml) was incubated at 40℃ for 30 min in a solution containing 50 mM imidazole-HCl (pH 6.0) with or without TG (0.1 mg/ml).

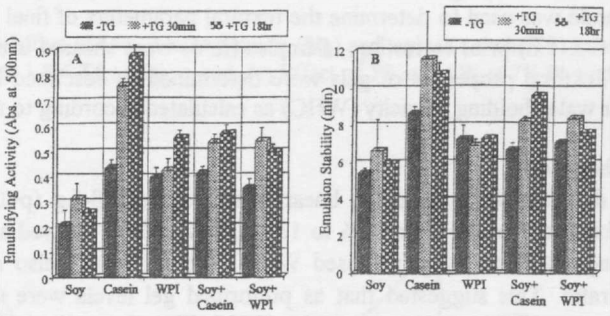

Fig.3 Emulsifying properties of protein samples.
Protein solution (10mg/ml) was incubated at 40℃ for 30 min or 18hr in a solution containing 50 mM imidazole-HCl (pH 6.0) with or without TG (0.5 mg/ml). (A), Emulsifying activity; (B), emulsion stability. Lane 1 , soybean protein; lane 2, casein; lane 3, WPI; lane 4 , mixture of soybean protein and casein; lane 5, mixture of soybean protein and WPI.

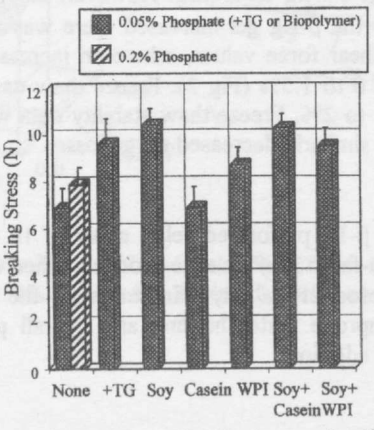

Fig.4 Effect of various kinds of biopolymers on breaking stress of chicken sausages prepared at 0.2% or 0.05% phosphate.