CONCENTRATION-DEPENDENT EFFECT OF EUGENOL ON PORCINE MYOFIBRILLAR PROTEIN GEL FORMATION

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I. INTRODUCTION

This study is based on our previous findings that clove extracts significantly inhibited the formation of carbonyl groups, enhanced solubility and thermal stability, and improved the gel formation ability of myofibrillar protein (MPs) [1]. There are three main phenolic ingredients in clove extracts, namely eugenol (EG) (67.6%), eugenol acetate (16.8%), and trans-caryophyllene (10.8%). EG has been found to be equivalent to vitamin E as a natural antioxidant [2]. The current applications in the meat industry include adding eugenol to feed to reduce lipid oxidation and color degradation and to increase antioxidant activity in beef [3]. Navikaite-Snipaitiene et al. [4] found that the use of eugenol-containing cellulose acetate and acrylic component/hydrophobically modified starch films for packaging beef reduced lipid oxidation in beef and protected its color. In addition, EG is added to dental filling materials to protect pulp oxidation and prevent infection [5]. In this study, EG was selected because it is a good antioxidant and is abundant in spices commonly added to meat products as flavoring agents. We investigated the effect of different concentrations of EG on MPs' structure and gelling properties to select an appropriate EG concentration applied in comminuted meat batter to process a well-textured meat product. Physico-chemical, structural, and rheologic analyses were carried out to illustrate underlying interaction mechanisms.

II. MATERIALS AND METHODS

The MPs were extracted according to the method of Park et al. [6]. The extracted MPs were dispersed in a 15 mmol/L PIPES buffer to obtain a 40 mg/mL protein solution. Then, a 5 mg/mL EG solution was mixed with the myofibrillar protein solutions according to different ratios to obtain a series of EG–MPs' solutions. The final EG concentration gradients were 5, 10, 20, 50, and 100 mg/g protein, and no added EG was the control group. The above EG-MPs' solutions were heated to make gels for measuring gel properties. Results are presented as mean ± standard error (SE) and statistically analyzed using the General Linear Models procedure of the Statistix 9.0 software package (Analytical Software, St. Paul, MN, USA). Analysis of variance (ANOVA) with Tukey's multiple comparisons was used to measure the significance of the main effects ($p < 0.05$).

III. RESULTS AND DISCUSSION

Gel strength, cooking loss, gel whiteness and dynamic rheological changes, which are crucial indicators in evaluating myofibril gel properties, were found to increase significantly at EG concentration of 5 mg/g and decrease significantly at cooking loss, while the results of these three indicators were opposite at 100 mg/g. This result was also consistent with the dynamic rheological results. Based on the experimental analysis results, we propose a hypothetical mechanism for the effects of different EG concentrations on myosin gelling properties. As shown in Figure. 1, during the heating process of myosin, non-EG and lower concentration EG samples can pass through head-to-head (temperature < 50 °C) and tail-to-tail (temperature 50–60 °C) cross-linking to form an ordered three-dimensional gel network structure. However, for the higher concentration EG samples, the

normal heat-induced myosin cross-linking is influenced by the large amounts of EG. Regular cross-links of myosin could not occur, thus forming a rough and macro-porous gel matrix (temperature > 60 °C).

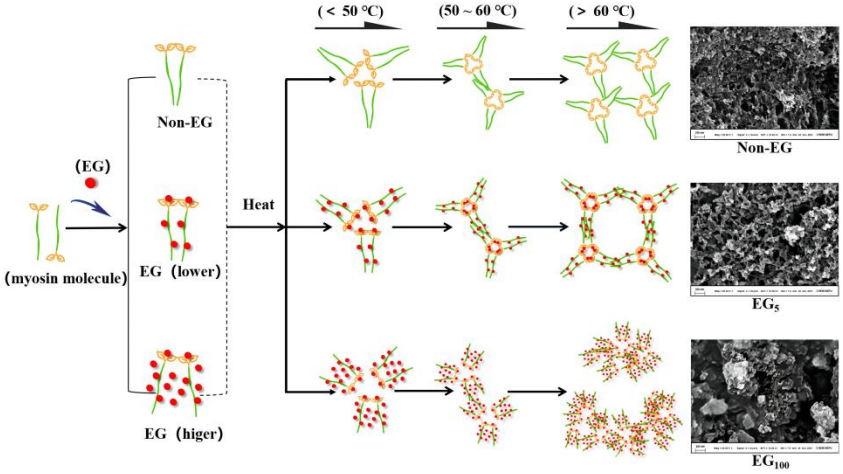

Figure 1. Prediction of interaction patterns between different concentrations' EG and myosin molecules during heating

IV. CONCLUSION

Overall, the effect of EG on MP gelation is highly concentration-dependent. Therefore, the incorporation of an appropriate EG concentration into a comminuted meat batter would not only allow good antioxidant effectiveness but also promote MP gelation leading to a well-textured, organoleptically desirable meat product.

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