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Thermal gelation and rheological properties of myofibrillar protein as affected by the addition of lard-based diacylglycerol at different NaCl concentration (#259)

Baohua Kong, Xinxin Zhao, Dongmei Zhen

Northeast Agricultural University, Department of Food Science, Harbin, China

Introduction

Myofibrillar protein (MP) is an important functional protein in muscle which is responsible for the thermally induced gelation properties of meat products, and its molecule is highly sensitive to the ionic strength. Fat is an important ingredient in meat products. However, excessive animal fat intake could bring about lifestyle-related diseases Triacylglycerol (TG) is a major component, while diacylglycerol (DG) is a minor component in various plant oils and animal fats. The taste, flavour, and texture of DG are similar to those of TG. Compared with TG, DG have unique nutritional properties, health benefits and specific physicochemical properties. The aim of this work was to investigate gelation and rheological properties of porcine MP as influenced by the addition of lard-based DG at different NaCl concentrations.

Methods

Lard-based (DG) was prepared according to the procedure of Zhao et al. [1]. After the reaction, the lipase was removed by filtration to obtain the unpurified DG (UDG), whose DG content was 46.91%. The UDG was purified by two-step molecular distillation (SPE10, manufactured in Haiyuan Biochemical Equipment Co. Ltd., Wuxi, China). The purified DG (PDG), which had a higher content of DG (83.10%). Myofibrillar protein (MP) was extracted according to the procedure of Xia et al. [2]. To prepare the emulsion gels, 10 mg/mL MP solution and 60 mg/mL MP solution were prepared in 50 mM piperazine-1, 4 bisethanesulfonic acid (PIPES) (pH 6.0) at various NaCl concentrations (0, 0.1, 0.3, and 0.6 M). Then, 2.1 g of completely melted pork fats (lard, UDG or PDG) were incorporated into 8 g of 10 mg/mL MP solution containing various concentrations of NaCl. The mixtures were then homogenized at 17,000 r/min for 1 min using an IKA T18 Ultra-Turrax (IKA-Werke GmbH & Co., Staufen, Germany) to obtain pre-emulsions. Each pre-emulsion was immediately mixed into 60 mg/mL MP solutions containing corresponding NaCl concentrations by gently stirring with a glass rod to prepare composites with a final concentration of 40 mg/mL protein and 8% (w/w) fat. MP and fat composites were stored at 4 °C overnight. Gel samples of MP and fat composites were formed by heating in a water bath at 75 °C for 20 min and cooled immediately in crushed ice. Gel strength of composite gels was determined according to Wu et al. [3]. Gel water-holding capacity (WHC) of composite gels was measured according to the procedure of Wu et al. [3]. The rheological properties of MP and fat composites during thermal gelation were tested using a Discovery HR-1 hybrid rheometer (TA Instruments Co., New Castle, DE, USA) equipped with parallel plates (40 mm diameter, 1 mm gap) according to the method of Xia [4]. Prior to measurement, gels were equilibrated at room temperature for 30 min.

Results

As shown in Figure. 1A, as the concentration of NaCl increased from 0 M to 0.6 M, the compression forces significantly increased ($P < 0.05$) and the maximum gel strength appeared at 0.6 M. Meanwhile, compared with the pure MP gel, the composite gels with fat resulted in significantly higher ($P < 0.05$) compression forces at the same NaCl concentrations. These results likely occurred because protein solubility was enhanced by increasing ionic strength [5]. The UDG- and PDG-composite gels had significantly higher ($P < 0.05$) compression forces than MP alone and lard-composite gels. As shown in Fig. 1B, the WHC of the gel at 0.6 M NaCl were both significantly higher than that of the corresponding control at 0 M NaCl ($P < 0.05$), which could be due to the formation of more hydrogen bonds in the gel network and increase in the degree of swelling as the ionic strength increased [6]. Meanwhile, UDG- and PDG-composite gels exhibited higher WHC than lard-composite gels ($P < 0.05$), and no significant differences between UDG- and PDG-composite gels were observed ($P > 0.05$). These results probably occur due to the presence of a (hydroxyl group) in the molecular structures of UDG and PDG. As shown in Fig. 2A, the G' of gels with or without fat at 0.6 M NaCl were significantly higher than those at 0, 0.1, and 0.3 M NaCl over the entire temperature range. This result was most likely due to excessive aggregation and low solubility of MP at low NaCl concentration, which could cause poor gel-forming ability. In addition, UDG- and PDG-composite gels displayed higher G' values than control and lard gels, which could in part be attributed to the hydrogen bond interactions between DG and MP.

Conclusion

The rheological and gelation properties of porcine MP can be improved by the increase in NaCl concentration and the incorporation of DGs, and lard-based DG displays potential for use in improving the quality of comminuted meat products.

Notes

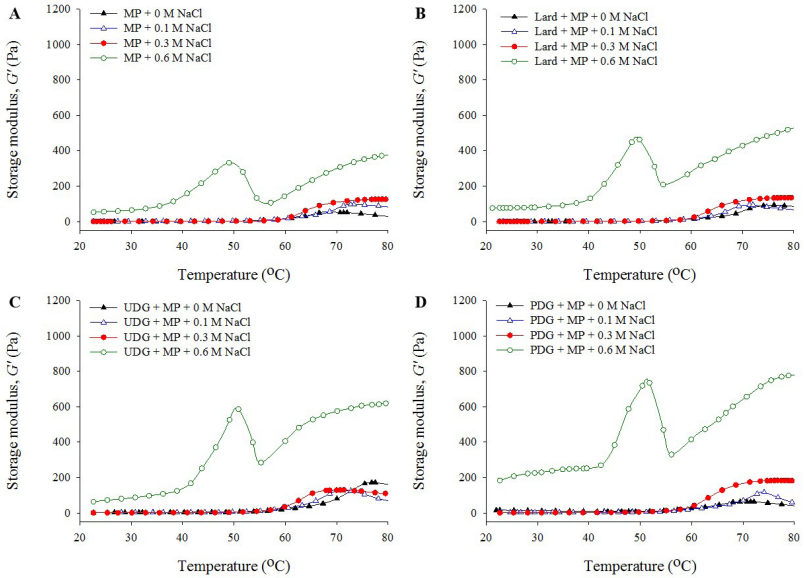

Fig. 2. Storage modulus (G') (A, B, C and D) values of gels prepared with myofibrillar protein (MP)

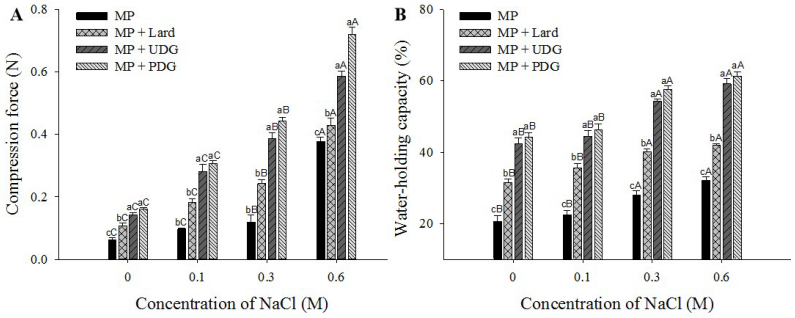

Fig. 1. Compression force (A) and water-holding capacity (B) of gels prepared with myofibrillar prot

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