COMPSITE GELS – EFFECT OF INERT PARTICLES ON THE TEXTURE OF COMMINUTED MEAT BATTERS

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Abstract – The effects of using inert glass beads to investigate the behavior of comminuted meat batters and their response to increasing volume fraction of the particles was studied. Hydrophilic glass beads were selected for their unique surface chemistry, which influences the particle/gel interfacial interactions. All composites were found to be stable up to 0.5 volume fraction filler, based on low cooking loss and coherent structure of the cooked gels. The behavior of the Young's modulus, when increasing particle size and volume fraction, was compared to that predicted by particle-reinforcement theories proposed by van der Poel and Kerner. The results indicate that filler size, and incorporation level strongly affect the physical characteristics of gelled comminuted composite meat system.

Key Words – Meat, structure, texture

I. INTRODUCTION

Using particulates to reinforce composite materials is a common procedure used in a variety of applications, from the production of cement to the reinforcement of rubber. The addition of filler particles to a continuous matrix can induce a variety of desirable traits such as resistance to compression an increase in shear and elastic moduli, and a higher fracture stress (Meid et al., 2012). The effect of such fillers depends on a variety of parameters. These can include the mechanical properties of the continuous matrix, the physical and mechanical properties of the filler, and the extent of filler/matrix interactions. The effects of a dispersed phase on the mechanical attributes of a composite material is relevant to food systems, as many food matrices can be described as a complex mixture of materials which form a gel matrix containing particulate inclusions. In food systems, the influence of these fillers is relatively complex, as the dispersed phase generally consists of liquid droplets stabilized by emulsifiers which can be selected to either promote or hinder filler/matrix interactions. The objective of this study was to examine the effect of adding different volumes of inert particles to a finely comminuted meat batter and relate the results to particle size and volume fraction of the added particles.

II. MATERIALS AND METHODS

A lean meat batter was prepared form chicken breast meat as the basic gel matrix. Glass beads in four size ranges (0.045-0.090 mm, 0.15-0.21 mm, 0.425-0.60 mm, and 1.0-1.4 mm) were used as a filler material in the production of composite gels to study the effect of using inert material at different volume fractions. The meat betters were prepared, heat processed and cooled down mimicking commercial sausage manufacturing. Cook loss and texture profile analysis (using a texture analyzer Model TA.XT2 , Stable Micro Systems, Texture Technologies Corp., Scarsdale, NY) were evaluated to determine the influence of the hard particles added to the matrix. A randomized complete block design with three replications was used.

III. RESULTS AND DISCUSSION

No instability was noted in any of the composites prepared up to a volume fraction of 0.5, as determined by the cook loss test and some microscopy observations. Water retention actually increased with increasing the volume fraction of the glass beads, and also improved with decreasing particle size. Figure 1 shows a summary of the effect of added filler particles on the Young's modulus of the composite meat gels. Overall, the Young's modulus of bound glass bead-

filled gels was positively correlated to volume fraction. This appears to be in agreement with the general behavior reported by others in non-food materials. The Figure also demonstrates that there is a distinct effect of filler particle size on the extent of reinforcement, particularly at higher volume fraction, where filler reinforcement is most prominent. In other systems containing pliable fillers such as filled emulsions, the particle size distribution dictates the texture and influences the theoretically-predicted modulus of the system (Dickindon, 2012). The experimental data was fit to the van der Poel theor, which considers the particle/ matrix interactions. Reasonable fits were achieved for most particle size ranges, with the exception of the 1.0-1.4 mm glass beads, as the imposed constraints were not always satisfied. It should be mentioned that the second-order simplification to van der Poel theory could be used in this case.

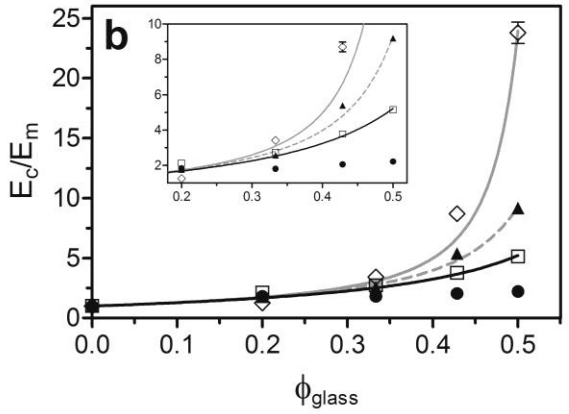

Figure 1. Effect of glass beads size, and volume fraction filler (ϕ) on the Young's modulus(Ec) of particle-filled comminuted meat protein gels. Experimental data were fit to the van der Poel model. Particle size ranges ●: 1.0-1.4 mm, □: 0.50-0.60 mm, ▲: 0.15-0.21 mm, ◊: 0.045-0.090 mm, ▼: < 0.50 mm.

IV. CONCLUSION

The experiment demonstrated the effects of rigid filler particles dispersed in finely comminuted meat gels. The gels were stable and lost minimal amount of liquid and their texture was related to the particle size and volume fraction. The glass beads did not form very strong interactions with the meat matrix but had a pronounced effect on the Young's Modulus. The Young's modulus was found to be positively correlated to volume fraction for all but the largest glass bead (1.0-1.4 mm). The research highlights the complex role particle/filler interactions play in dictating the mechanical characteristics of particle-filled comminuted meat gels. It should provide insight into the mechanisms responsible for the observed responses. It is hoped that the results could be transferable to practical aspects of meat batter preparation.

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