Graduate Student Research Poster Competition

Ph.D. DIVISION

Characterization of High-Added Water Beef Connective Tissue Protein Gels.

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Heating (<60°C) beef connective tissue (BCT) may enhance its ability to bind water due to partial conversion of collagen to gelatin. The objective of this study was to manufacture high-added water beef connective tissue protein gels and determine their properties. Flaked, desinewed beef shank connective tissue was heated at 70° for 30 min. with 100, 200, 300, 400, 500 and 600% added water (AW) to produce BCT protein gels weighing ~500 g. Proximate composition, pH, raw hydration, cooked stability, Hunter L*a*b*, objective textural measurements, proximate analysis, soluble and total collagen were determined for each gel. Raw BCT composition was 56.92% moisture, 18.47% fat and 25.49% protein. Added water decreased (P<0.0001) percent moisture, fat and protein. Percentages ranged from 80.27 to 94.00% (moisture), 7.88 to 2.66% (fat), and 14.31 to 4.66% (protein), for 100 and 600% AW, respectively. Increasing water decreased soluble collagen content, with values ranging from 17.94 to 0.67 mg/g and total collagen content from 85.69 to 27.18 mg/g (100 and 600% AW, respectively). Higher AW decreased L*, a* and b* values, COH and SPRING (P<0.01). AW affected HARD and CHEW (P<0.10), with 100% AW treatment approximately 4X harder (52.17 N) than 200% AW treatment (12.95 N). As AW increased, hydration and fat-free hydration values increased (P<0.01 and P<0.05, respectively), while cook stability decreased (P<0.0001). AW did not affect cook stability expressed on a BCT fat-free basis. Values ranged from 49.86% (100% AW) to 43.26% (600% AW). Results from this study indicate the feasibility of heating beef connective tissue to form a protein gel capable of binding large amounts of added water.

Antioxidant Activity of β-Carotene and α-Tocopherol on Myoglobin in Liposomes.

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Interrelationships of myoglobin autoxidation and phospholipid peroxidation were examined in model systems of liposomes, myoglobin, and myoglobin-liposomes. Antioxidants β-carotene and α-tocopherol at 0.01, 0.0001 and 0 M and gaseous atmospheres of 100/0, 80/20, 60/40, 40/60, 20/80 or 0/100 O_2%/CO_2% were used to create different oxidative conditions. Lipid instability (TBARS) and percentage metmyoglobin formation were measured on duplicate samples at 12-hr intervals for 96 hr. 100% O_2/0% CO_2 increased (P<0.05) oxidation of myoglobin and lipid peroxidation in myoglobin-liposome systems with lowest TBARS observed in anoxic conditions. α-Tocopherol was an antioxidant of lipid and myoglobin oxidation in the order of 0.10 > 0.0001 > 0M (P<0.05). With 0.01 M α-tocopherol, β-carotene at 0.01M had a slight prooxidant effect. In liposome systems, the delay of lipid peroxidation was in the order of 0% > 20 > 80 >40 > 60 > 100% O_2. Addition of β-carotene aided lipid stability when compared to no β-carotene, but there were no differences between 0.01 and 0.0001 M concentrations. T-tests showed higher (P<0.001) TBARS in myoglobin-liposome systems than in liposome systems and more (P<0.0001) metmyoglobin formation in myoglobin systems than in myoglobin-liposome systems. Incorporation of antioxidants, particularly α-tocopherol, retarded metmyoglobin formation and lipid peroxidation in different model systems and gaseous atmospheres.

Thermal Denaturation and Aggregation of Chicken Breast Muscle Myosin.

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To elucidate the roles of the head and tail portions of chicken breast muscle myosin in gelation, the thermal stability and aggregation behavior of myosin and seven subfragments in 0.6M NaCl, pH 6.5 were investigated, namely; myosin heavy chains, (MHC); light chains, (LC); heavy meromyosin, (HMM); light meromyosin, (LMM); rod, S-2 and S-1. Myosin had four independent cooperative endothermic transitions (Tm) at 47°C, 54°C, 57°C and 63°C and aggregated from 50°C to 70°C. The MHC endotherm had peaks at 46°C, 54°C and 64°C and aggregated between 45°C and 63°C. The head unfolded in a single transition, having a Tm of 47.7°C, and aggregated weakly from 49°C to 53°C. The rod had a melting range of 30°C to 63.3°C and continuously aggregated over this temperature range. Initial unfolding of the rod was attributed to the LMM region, whereas S-2 was primarily responsible for denaturation and aggregation above 50°C. Transition temperatures of 48°C and 57°C were recorded for LC; however, no aggregation occurred. It was concluded that the rod had the biggest influence on gel formation. LMM and S-1 contributed to gel structure at temperatures less than 50°C, whereas S-2 was responsible for matrix formation above 50°C.

Determination of Safe Endpoint Cooking Temperature in Beef Roasts by Immunoblot Analysis.

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Recent outbreaks of foodborne illness linked to undercooked meats have raised concerns about the safety of meat products. Development or rapid and accurate techniques to assess the maximum heating endpoint temperature achieved would aid regulators and quality control personnel, and assist in regaining consumer confidence in these products. Beef Semitendinosus roasts (n=120) were injected with a 10% brine of either 0% $Na_5P_3O_{10}$ (P) and 0% NaCl (S), 0%P 1%S, 0%P 2%S, 0%P 3%S, .5%P 0%S, .5%P 1%S, .5%P 2%S, or .5%P 3%S. Roasts then were left raw or cooked to 60, 62, 64 or 66°C. Protein concentration in extracts from roasts decreased with heating and addition of S, but increased with addition of P ($P<.05$). SDS-PAGE of extracts from roasts identified bovine lactate dehydrogenase isozyme 5 (LDH) as a protein band that disappeared over the range from 60 to 66°C in all treatments. LDH polyclonal antibodies were raised in rabbits and immunoblot analysis was performed. Results indicated that at the lower level of P and as level of S increased, standardized integrated intensities of banding declined in cooked treatments and prevented differentiating between roasts cooked over the range of 60 to 66°C ($P>.05$). However, immunoblot differentiation was possible ($P<.05$) between roasts cooked to 60 and 62°C in 0%P 0%S and typical commercial roasts (.5%P 1%S and .5%P 2%S).

Functionality of Carrageenan and Salt-Soluble Meat Proteins in Model Systems.

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The effects of κ-, ι-, and λ-carrageenans (CGN) on the rheological properties, water loss and ultrastructure of salt-soluble meat protein (SSMP) gels were evaluated. κ-CGN increased significantly the gel strength and water retention of SSMP, suggesting that a molecular interaction may have occurred. However, no indication of specific molecular interactions between κ-CGN and SSMP was observed upon addition of stabilizing/destabilizing reagents. Electron microscopy studies suggested that improvement of water retention and texture of combined SSMP/κ-CGN gels may be due to physical rearrangement of the κ-CGN and SSMP molecules rather than a molecular interaction. Myofibrillar protein (MP) gels and ground pork were also used as model systems to study the effect of CGN on the thermal stability of meat proteins. Addition up to 2% of carrageenan (CGN) to MP caused a very small change in the thermal denaturation of the meat proteins. Three transition temperatures were obtained in ground pork samples, which were characteristic of myosin (59.40°C), sarcoplasmic proteins (67.85°C) and actin (82.45°C). High ionic strength mixtures had lower thermal transition peaks. CGN did not cause major shifts in the transition temperature of meat proteins, suggesting that a molecular interaction between CGN and meat proteins did not occur.