51st International Congress of Meat Science and Technology
August 7-12, 2005 – Baltimore, Maryland USA

IMPACT OF SOLUBILIZED BEEF PROTEIN ON THE TEXTURE PROPERTIES OF FRANKFURTERS

D. Vann*, C. Raines, C. Mireles Dewitt

Oklahoma State University Stillwater, OK USA

Key Words: Frankfurter, solubilized protein, salt, pH

Introduction

The undesirable tastes, colors and odors characteristic of meat byproducts, has resulted in a significant amount of research to improve palatability and functionality (James and Mireles Dewitt, 2003). A method designed to retain myofibrillar protein functionality is the acid solubilization isoelectric precipitation (SIP) process (Kelleher and Hultin, 1999). Acid-SIP was first patented in 1999, and subsequent research led to the finding that the myofibrillar proteins recovered retained their functionality and could still be used to create good quality meat gels. (James and Mireles Dewitt, 2003). In addition, research has shown that the Acid-SIP treatment decreases fat and produces strong gels without the addition of salt (James and Mireles DeWitt, 2003). Theoretically, this process of protein recovery will help meat processors recover valuable protein with enhanced protein functionality

Objectives

The objective of this research was to evaluate how a solubilized protein affects the textural properties of a processed meat product.

Methodology

Preparation of Beef Round

A highly trimmed beef inside round was obtained 3 days postmortem and cut into approximately 2.54 cm square cubes and ground through a General MC-100 meat grinder (Red Goat Disposers, Mufreesboro, TN, USA) using a 5 mm extrusion die at refrigeration temperature.

Preparation of Solubilized Protein

The solubilized protein samples were prepared according to DeWitt and others (2002). A 1:9 (w/v) mixture of beef round to 2mM citrate buffer was blended in a vacuum chopper (UMC 5 Electronic, Stephan Machinery Corp., Columbus, OH, USA)

for 3 min. at 5°C. The pH was lowered to 2.5 with 2N HCl and centrifuged at an average 9,000-10,000 x g, and the supernatant was collected. The pH of the supernatant was raised to 5.5 with 2N NaOH to precipitate and ultimately recover the myofibrillar proteins. Precipitated protein was recovered with cheese cloth and excess water was removed by centrifuging the recovered precipitated protein at 3,000 x g at 4°C for 20 min. Cryoprotectants (4% sucrose, 4% sorbitol, and 0.3% sodium tripolyphosphate) were added according to Kelleher and Hultin (2000). Initial moistures were determined (AOAC, 1995) and the samples were blast-frozen overnight in vacuum-sealed Cryovac bags (Sealed Air Corp., Saddle Brooks, NJ).

Preparation of the Treatments

A basic frankfurter formulation was used as a control (CL, 2% NaCl and 0% solubilized protein: Table 1). Beef in the control formula was substituted with solubilized protein at pH 5.5 or pH 7. Salt was varied in the substituted formulas at 1 or 2%. The four modifications of the substituted formulas were:

- A = 2% NaCl and 2% solubilized protein
- B = 2%NaCl and 20% solubilized protein
- Y = 1%NaCl and 2% solubilized protein
- Z = 2% NaCl and 20% solubilized protein

The quantity of sodium tripolyphosphate was adjusted according to the amount present in the solublized protein with added cyroprotectants. Each sample was blended in a vacuum chopper (UMC 5 electronic, Stephan Machinery Corp., Columbus, OH, USA) for 4 min at 5°C. The resulting batters were then stuffed (American Harvest Jerky Works Kit, 12.7 mm horn, The Metal Ware Corp., Two Rivers, WI) into two-21 mm cellulose casings (Viskase, E-Z Peel® Nojax, Willowbrook, IL), around 70 cm long, and rolled into links about 10 cm long. Liquid smoke was applied to the links and they were cooked under normal conditions in an Alkar smokehouse(Lodi, WI). The cooked links were then chilled overnight (4°C), peeled, and vacuum packaged (Cryovac bags, Sealed Air Corp., Saddle Brooks, NJ, USA).

Table 1. Control Formula

Control Formula	Weight	% Raw Composition
Beef	906 grams	70.5
Water	272 grams	21.2
Salt	25.78 grams	2.0
Spice	21.6 grams	1.7
Puracal	26.3 grams	2.0
Corn Syrup	18.14 grams	1.4
Dextrose	13.15 grams	1.0
Cure	2.26 grams	0.2

Analysis of Cooked Frankfurters

Texture was evaluated with a Stable Micro Systems Texture Analyzer (Model TA-XT2i, Texture Technologies, Inc., Scarsdale, NY, USA) with 2 cm skinned portion tempered to room temperature. The Texture analyzer measured the tertiary texture attributes as (www.texturetechnologies.com):

- Hardness = Peak force of the 1st Compression
- Cohesivness = Area 2nd Compression / Area 2nd Compression
- Gumminess = Hardness x Cohesivness
- Springiness = Length of 2nd Compression / Length of 1st Compression
- Chewiness = Gumminess x Springiness
- Resilience = Area withdrawal of 1st Compression / Area 1st Compression

All tests were performed in at least triplicate.

Statistical Analysis

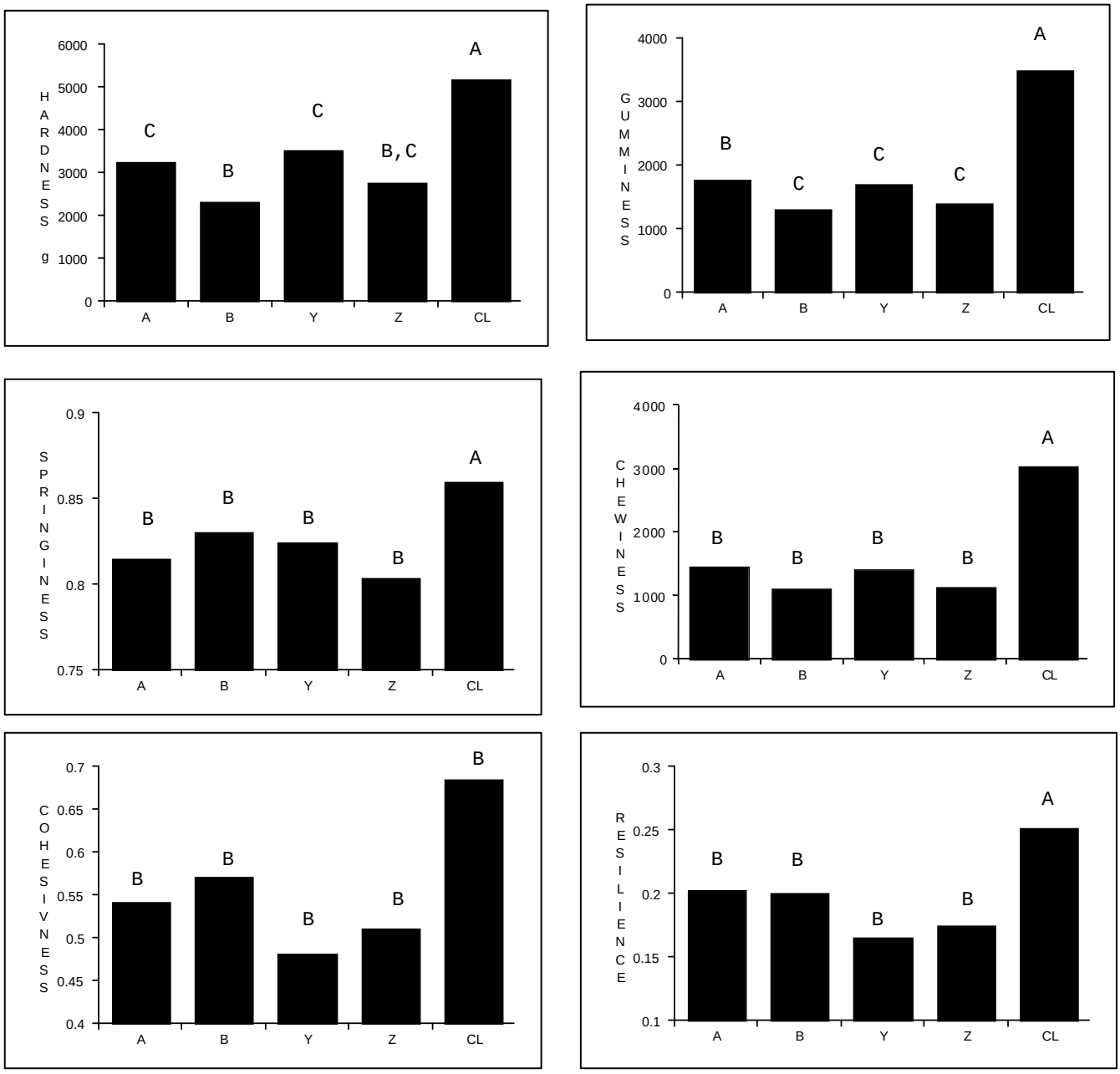
The data was analyzed using 2-way ANOVA (Sigma Stat 8.0, Rockware, Inc. Golden, CO). The model included treatment and NaCl levels as main effects. All interactions among treatment and NaCl were included in the model. Mean separation was accomplished using Least Significant Difference.

Results and Discussion

Solubilized Protein, pH 5.5

In each of the texture analyses (Figure 1), the Control performed statistically better than any of the treatments containing solubilized protein. For springiness, chewiness, cohesivness, and resilience, there was no difference between the treatments. However, in the case of cohesiveness and resilience, substituted formulas with 1% NaCl performed poorer. For chewiness and hardness, treatments containing 20% solubilized protein were less chewy than those containing 2% solubilized protein.

Figure 1. Solubilized Protein at pH 5.5
Texture Profile Analyses of Different Treatments



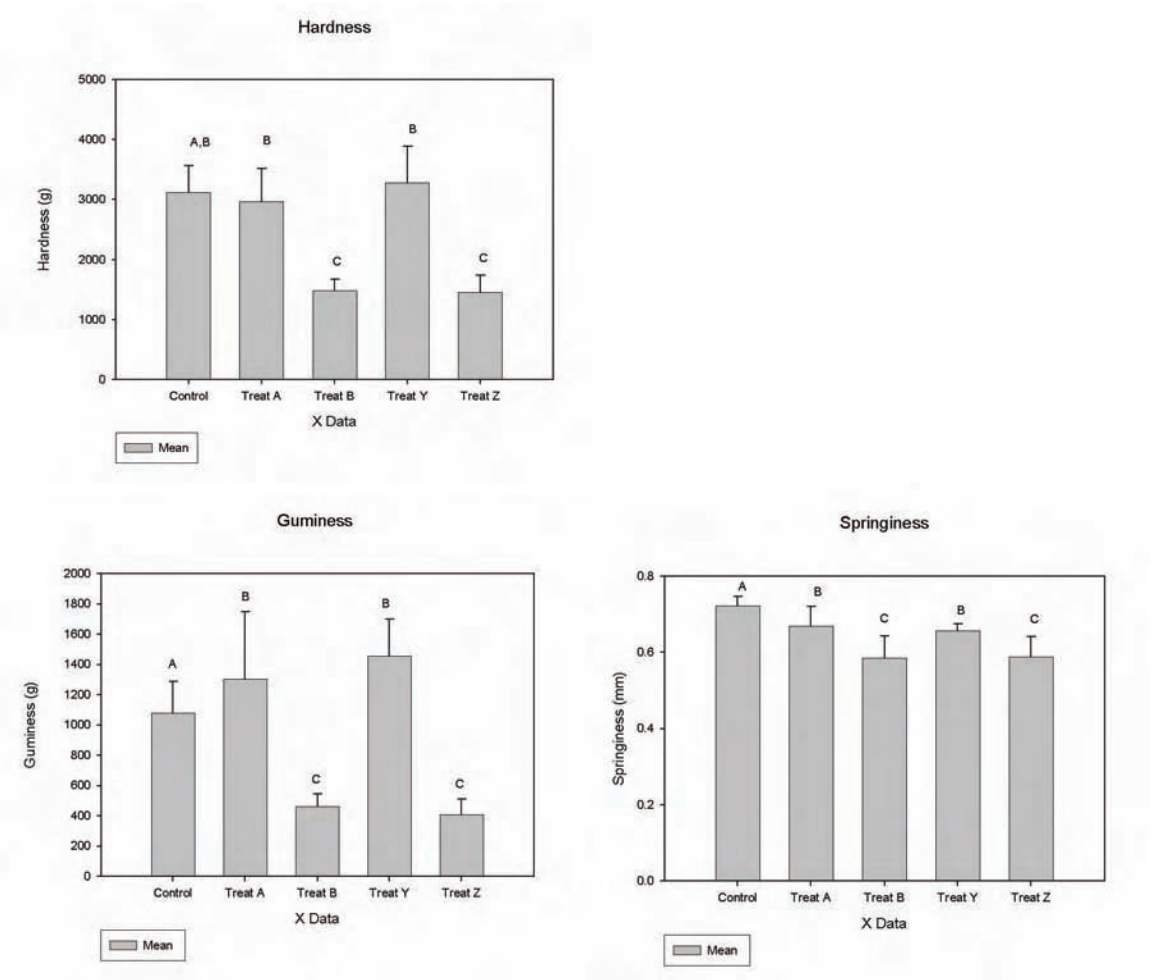
Texture Profile Analysis (TPA) of cooked links containing Acid-SIP BR protein. a,b,c means lacking a common superscript differ ($P<0.05$).

A = 2% Salt, 2% Acid-SIP B = 2% Salt, 20% Acid-SIP Y = 1%Salt, 2% Acid-SIP
Z = 1% Salt,20% Acid-SIP CL = 2% Salt, 0% Acid-SIP

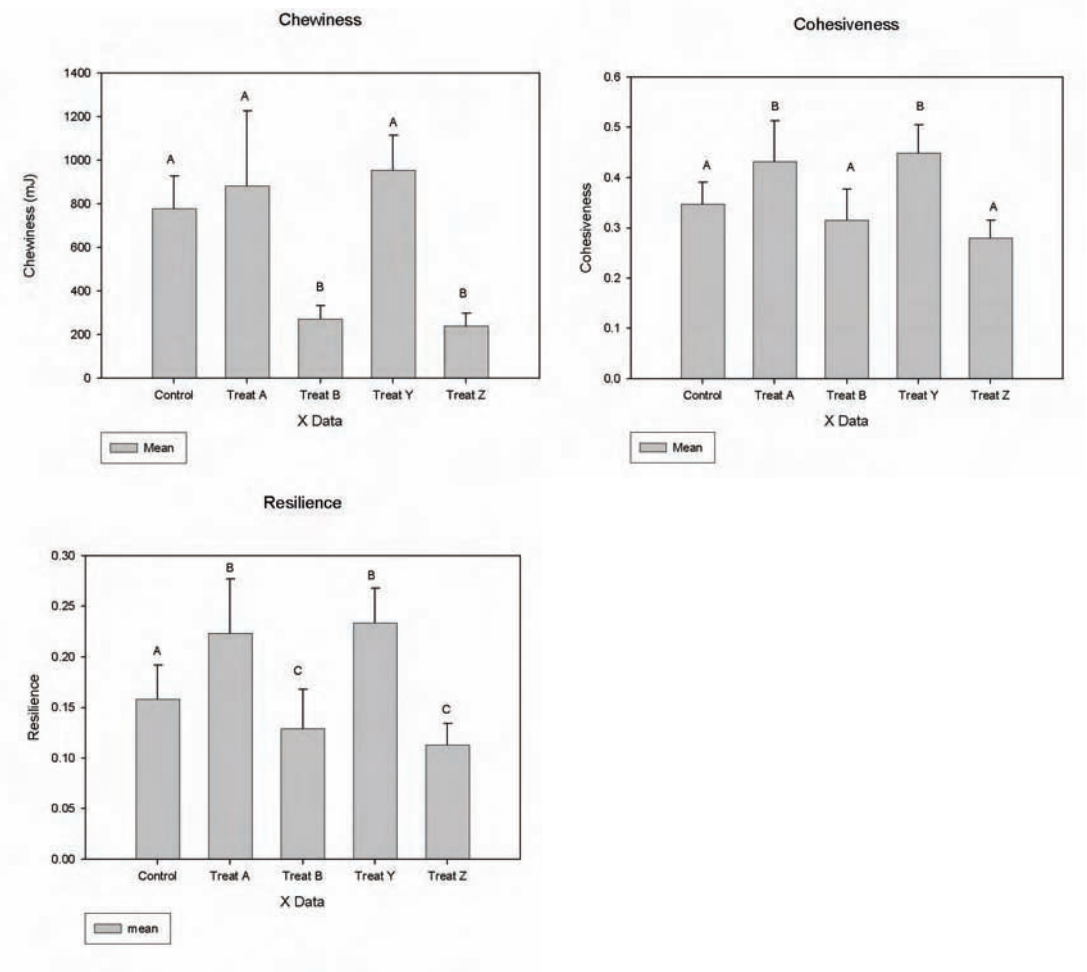
Solubilized Protein, pH 7

Frankfurters were formulated with solubilized protein and adjusted to pH 7 using sodium bicarbonate. Texture analysis was conducted on the five different treatments (Figure 2). Overall salt did not have an affect on texture analysis. For hardness the frankfurters with 20% solubilized protein were significantly softer than the control and 2% solubilized protein formulas. Springiness decreased significantly as the amount of solubilized protein present in the frankfurter increased. For cohesiveness the 2% solubilized protein increased overall cohesiveness and the 20% solubilized protein showed no improvement over the control formula. Gumminess increased significantly with the addition of 2% solubilized protein but decreased significantly with the addition of 20% solubilized protein as compared to the control formula. Chewiness was not significantly affected by the addition of 2% solubilized protein but was significantly lower in the 20% protein formulas. It was also shown that resilience values in the 2% solubilized protein formulas were significantly higher then the control while 20% solubilized protein were significantly lower.

Figure 2. Solubilized Protein at pH 7
Texture Profile Analyses of Different Treatments



Texture Profile Analysis (TPA) of cooked links containing solubilized protein. Mean lacking a common subscript differ ($P<0.05$).
Control= 2% Salt, 0% Solubilized Protein Treat A = 2% Salt 2% Solubilized Protein Treat B= 2% Salt 2% Solubilized Protein Treat Y= 1% Salt 2% Solubilized Protein Treat Z= 1% Salt 20% Solubilized Protein



Conclusion

Frankfurters made with solubilized protein at pH 7 performed closer to the control than frankfurters made with solubilized protein at pH 5.5. Formulations with solubilized proteins at pH 7 the 2% solubilized protein formulations performed as well or better then the control. However, 20% protein formulations performed poorly and were generally softer than the control.

Purposed future work for this project includes using a formulation to make the frankfurters with beef from the inside round or clod as opposed to using ground beef. In addition, it is suggested that lower levels of protein such as 2, 5, and 10% be evaluated for texture properties using texture profile analysis and sensory evaluation in order to optimize solubilized protein substitution.

References

AOAC. (1995). Official Methods of Analysis (15th ed.). Washington, DC. USA: Association of Official Analytical Chemistry.

Kelleher SD, Hultin HO. 2000. Functional chicken muscle protein isolates prepared using low ionic strength, acid solubilization/precipitation. In: 53rd Annual Reciprocal Meat Conference: Meat Science in the New Millenium 2000. Savoy, IL: American Meat Science Association. p 76–81.

Hultin HO, Kelleher SD. 1999. Process for isolating a protein composition from a muscle source and protein composition. Patent # 6,005,073 (Dec 21).

Mireles DeWitt CA, Gomez G, James JM. 2002. Protein extraction from beef heart using acid solubilization. J. Food Sci., 67:3335–3341.