Measurement of the Binding Properties of Meat Used in Restructured Beef Products

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Summary

The dried weight of the material washed from meat surfaces by distilled water closely paralleled the binding strength between meat particles as measured by tensile strength testing. Sponges added to meat pieces during mixing were a poor estimation of protein extraction and binding strength.

Introduction

Processing meat pieces into restructured products that resemble intact roasts, steaks, and chops is a popular way of merchandising less valuable portions of a carcass. Mixing (massaging or tumbling) meat pieces brings soluble proteins to the surface. Adding salt enhances that protein extraction. The extracted, creamy, tacky proteins coat the meat particles, and upon cooking, will bond the meat particles together. The proper amount of extracted protein is important; either too much or too little will cause the meat particles to bind poorly.

For adequate quality control of restructured products, a method for measuring binding proteins is essential. Since a fast, reliable measurement does not exist, our objective was to evaluate techniques for the rapid quantitation of extracted proteins in a mixed meat system.

Experimental Procedures

Four A-maturity steers (two USDA Choice, two USDA Good) were slaughtered at the KSU meat laboratory. One side of each carcass was hot boned (HB) 1 hr postmortem and the other conventionally cold boned (CB) 24 hr after slaughter following chilling at 37 F. The clod and inside round from each side were removed, trimmed of all visible fat and heavy connective tissue, and ground through a three-hole kidney plate that yielded large, irregular chunks (3.7 x 1.8 cm). We formulated three batches intended to produce high, intermediate, and low levels of protein extraction. Salt aids in protein extraction, and HB meat yields more extractable protein than CB meat. Thus, for the high binding level (H) batch we added 2% salt to HB meat. The intermediate level (I) was achieved by adding salt to CB meat, and the low level (L) was obtained by using CB meat with no added salt. The batches were mixed for 15 minutes in a Hobart mixer equipped with a dough hook.

Two techniques were then used to measure the differences in extracted protein.

The sponge technique: We theorized that a dried cellulose sponge placed with the meat pieces during mixing would take up the extracted proteins in

proportion to how meat particles were coated by those proteins. Therefore, six preweighed, 1-inch cubes of dried sponge were added to each meat batch for the 15-min mixing cycle. The sponges were then removed, weighed wet, and weighed again after drying for 24 hr. The initial dry weight of the sponge was subtracted from both weights. All dried sponges were analyzed for percent crude protein.

The rinse technique: We also theorized that the protein brought to the surface by mixing could be washed from the meat pieces using water and vigorous agitation. Therefore, three 50-gm samples of meat pieces were randomly selected from the mixing bowl before (control) and after the 15-min mixing cycle.

The samples were placed in flasks and 100 ml of distilled water were added to each flask. The flasks were corked and placed on a shaker table for 1 minute. The flask contents were then strained through cheese cloth and the fluid was collected. Three 10 ml samples of this fluid were placed in preweighed aluminum trays, dried for 24 hr, and weighed. The remaining fluid was saved for crude protein analysis. Dry matter and protein content of extracts from unmixed meat were subtracted, so that results represented only material brought to the meat surface during mixing.

After the extracted protein was measured, the three meat batches were stuffed individually into 6.5 inch diameter prestuck casings and pressure clipped with a polyclip machine to create restructured "roasts". The roasts were steam cooked in a Vortron smokehouse for 45 min @ 130 F then 45 min @ 150 F, and held at 180 F until an internal temperature of 145 F was reached.

Physical test of binding: An Instron Universal Testing Machine was used to measure the strength of binding between the cooked meat pieces. One such measure was a compression test, in which a 1.0 inch diameter x 1.0 inch long core of cooked, restructured roast was placed between two compression plates and compressed 75% of its height (0.75 inch on the first stroke) and then decompressed. A graph of force vs. distance traveled resulted. Then a second compression was run. The ratio of the area under the first graph divided by the area under the second graph estimated the cohesiveness of the meat pieces. Higher values represent greater cohesion.

The tensile strength test involved measuring the force required to pull apart a strip of finished roast 1.0 in wide x 0.25 in thick. The force required was an estimate of the cohesion between meat pieces and was recorded from a curve as the height of the peak at the breaking point.

Results and Discussion

Table 16.1 shows that roasts made from HB and CB muscle with added salt (H and I) had greater tensile strengths (more extracted protein) than L roasts. Therefore, the differences that we attempted to create in binding were partially achieved. Because of the similarity of means and magnitude of standard deviations, compression testing does not clearly separate differences in binding strength.

The sponge method (wet or dry) does not appear to absorb the protein proportionally to meat binding (Table 16.1). The amount of crude protein absorbed

by sponges was inverse to tensile strength measures. This appeared to be due to different rates of moisture penetration into and evaporation out of the sponge among treatments, which reduced the reliability of this technique.

Dried weight of fluid from the rinse technique may be useful for measuring extracted protein (Table 16.1). The dry weight means for H and I are similar, but greater than those for L. This trend corresponds to tensile strength measures. The percent protein means do not appear to follow the same trend as do tensile strength means. Even though the percent protein means appear to have a reversed trend, based on the magnitude of the standard deviations, those means are likely not statistically different.

The rinse technique shows the most potential for use as a measure of extracted protein and binding strength of restructured products. However, more research should be done to determine its validity and application in other meat systems, which differ in particle size, ingredients, and restructuring methodology.

Table 16.1. Measurements of Meat Binding Properties by Treatment

Measures	Binding Level[a]		
	High (H)	Intermediate (I)	Low (L)
Physical Force			
Compression[b] (kg)	5.90 ± 0.97	5.17 ± 0.74	4.65 ± 0.87
Tensile strength[c] (kg)	0.41 ± 0.11	0.36 ± 0.15	0.09 ± 0.05
Sponge			
Wet Weight[d] (gm)	5.28 ± 0.76	2.42 ± 0.15	4.42 ± 0.57
Dry Weight[e] (gm)	1.04 ± 0.10	0.55 ± 0.04	0.76 ± 0.08
Protein[f] (%)	56.38 ± 5.77	66.84 ± 3.37	76.67 ± 5.22
Rinse			
Dry Weight[g] (mg)	88.58 ±14.37	70.78 ±20.94	34.75 ±12.88
Protein[h] (%)	0.67 ± 0.08	0.77 ± 0.11	0.82 ± 0.10

[a] High = HB with salt; Intermediate = CB with salt, Low = CB without salt.
[b] Area under 1st curve-Area under 2nd curve.
[c] Peak height of the curve.
[d] Weight of the sponge after mixing minus initial sponge weight.
[e] Weight of the sponge after mixing and drying minus initial sponge weight.
[f] Crude protein percentage of sponge after mixing and drying.
[g] Residue in 10 gm. rinse from mixed meat minus residue in 10 gm rinse from unmixed meat.
[h] Crude protein percentage of 10 ml of supernatant after rinsing.