THE EFFECT OF INJECTED SOY PROTEIN CONCENTRATE ON RESTRUCTURED BEEF

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SUMMARY

This study examined whether a portion of the meat in algin/calcium restructured beef (SMR) can be replaced with a solution of dispersable soy protein concentrate. Specifically, the study evaluated the effects of soy protein injection and tumbling on product cohesion, appearance and palatability. Algin/calcium restructured meat was made with beef rib lifter meat, or with beef injected (18 or 30% replacement) with a soy protein concentrate solution (5%), with or without one hour of tumbling. Injected meat had acceptable binding- Tumbling of the injected meat resulted in even higher bind. The aroma and mouthfeel of products with 18% soy protein solution were similar to SMR product. Additional studies should optimize formulations and derive products of more acceptable eating qualities, cook yields and costs. This study has demonstrated that the algin/calcium SMR binding process is operational even in beef which was injected with large amounts of soy protein concentrate solutions.

INTRODUCTION

The algin/calcium meat restructuring system provides acceptable cohesion and colour in the raw and cooked state (Means 1985; Means and Schmidt 1986; Means et al. 1987). The process (SMR) has been patented (Schmidt and Means 1986) and approved by the United States Department of Agriculture (FSIS 1986) for use in meat products.

Since previous work had shown isolated soy protein injection improved cohesion and cooking yield of hams (Siegel et al. 1979a, 1979b, 1979c), the objective of this study was to determine whether a portion of the meat in algin/calcium restructured beef (SMR) can be replaced with a solution of dispersable soy protein concentrate. Major specific objectives included determination of the effects of soy protein concentrate injection and tumbling on product cohesion, appearance and palatability.

EXPERIMENTAL METHODS

Beef rib lifter meat was obtained approximately 20 days postmortem from a commercial processor (Monfort, Greeley, Colorado). The meat was divided into six treatments of 5 kg each (Table 1). Treatments consisted of all meat, (AM); 5 kg meat, 0.4% sodium alginate, (Kelco; Division of Merck and Co., San Diego, CA), 0.075% calcium carbonate (Gamma Sperse 80, Georgia Marble, Tate, GA) and 0.6% encapsulated lactic acid/calcium lactate (Cap-Shure® LCL-135-50, Balchem Corp., Slate Hill, NY), (SMR); beef injected to replace 18% of the meat with a 5% solution of dispersable soy concentrate (Functional-DS Type, Central Soya, Fort Wayne, IN) (SMR-18). After injection, the meat was ground and mixed with the dry ingredients. SMR-30 was similar to SMR-18 except 30% of the meat was substituted with the soy protein concentrate solution prior to grinding. SMR-18T was the same as SMR-18 but the meat was tumbled for one hour after injection and prior to grinding. SMR-30T was the same as SMR-30 but the meat was tumbled for one hour after injection and prior to grinding. The experiment was replicated twice and the material was frozen within 30 hours after product preparation.

The dispersable soy protein concentrate was suspended at a 5% level in a water solution by use of a wisk and was injected with a 10 needle pickle injector (Koch/Gunther P1-10, Koch, Kansas City, MO).

The meat was tumbled for one hour at 45 revolutions per minute in a 70 cm diameter tumbler. Meat was ground through a kidney plate with openings 2 cm x 3 cm, mixed in a 10 kg capacity, double shaft, vacuum mixer for a total of five minutes, stuffed with a 20 kg capacity piston stuffer into number 8 fibrous cellulose casings with a stuffed diameter of 120 mm, (Viscase, Chicago, IL), manually tensioned, stuck and clipped. The material was

Table 1. Variables and Experimental Design to Study the Effect of Partial Meat Substitution With Solutions of Dispersible Soy Protein Concentrate In SMR Restructured Beef Steaks.

Treatment	0.4% Sodium Alginate[a]	0.075% Calcium Carbonate[b]	0.6% Cap-Shure[R]	Meat Replace-%[d]	Tumbled 1 hr[e]
AM	-	-	-	0	-
SMR	+	+	+	0	-
SMR-18	+	+	+	18	-
SMR-30	+	+	+	30	-
SMR-18T	+	+	+	18	+
SMR-30T	+	+	+	30	+

AM = all meat; SMR: algin/calcium restructured; SMR-18: SMR injected with 18% soy protein concentrate solution; SMR-30: SMR injected with 30% soy protein concentrate solution; SMR-18T: SMR injected and tumbled; SMR-30T: SMR injected and tumbled.

Table 2. Influence of injection with soy protein concentrate solution and tumbling on the binding of algin/calcium restructured beef (SMR).

	Raw Product Bind		Cooked Product Bind	
Treatments	Sensory (score)	Instrument (N)	Sensory (score)	Instrument (N)
AM	1.1^{c}	0.6^{b}	2.3^{b}	4.2^{c}
SMR	4.3^{ab}	5.6^{a}	4.7^{a}	14.7^{ab}
SMR-18	3.9^{b}	4.9^{a}	4.8^{a}	10.5^{b}
SMR-30	3.9^{b}	5.5^{a}	4.6^{a}	10.5^{b}
SMR-18T	4.4^{ab}	7.3^{a}	4.8^{a}	18.1^{a}
SMR-30T	4.7^{a}	7.4^{a}	4.7^{a}	17.3^{a}

Treatment designation described in Table 1. Score of 1: virtually no bind; score 6: very strong bind/intact muscle. Means in the same column with different superscript letters are significantly ($P<0.05$) different. N=Peak Newton Force to break a 1 cm thick sample.

Table 3. Influence of injection with soy protein concentrate solution and tumbling on color intensity and discoloration of algin/calcium restructured beef (SMR).

Treatments	Color Intensity Score	Discoloration (%)
AM	4.8[a]	5.5[a]
SMR	4.8[a]	5.1[b]
SMR-18	3.1[c]	4.9[b]
SMR-30	3.2[c]	4.8[b]
SMR-18T	3.7[b]	4.8[b]
SMR-30T	2.9[c]	4.8[b]

Treatment designations described in Table 1. Score 1 = >80% discoloration or dark purple color intensity; score 6 = no discoloration or light cherry red color intensity. Means in the same column with different superscript letters are significantly (P<0.05) different.

Table 4. Influence of injection with soy protein concentrate solution and tumbling on sensory parameters of algin/calcium restructured beef (SMR).

	Sensory Evaluation Scores			
Treatments	Aroma	Flavor	Mouthfeel	Juiciness
AM	5.7[a]	5.6[a]	5.4[a]	3.8[a]
SMR	5.2[b]	4.7[b]	4.6[b]	3.9[a]
SMR-18	5.1[b]	3.8[c]	4.4[b]	4.1[a]
SMR-30	4.7[b]	2.5[d]	3.9[c]	3.9[a]
SMR-18T	5.1[b]	3.9[bc]	4.6[b]	4.1[a]
SMR-30T	4.7[b]	2.9[d]	4.1[bc]	4.0[a]

Treatment designations described in Table 1. Scores: Aroma, 1: very strong off-odor, 6: no off-odor; Flavor, 1: strong off-flavor, 6: no off-flavor; Mouthfeel, 1: very strong mealy/slippery, 6: like intact muscle; Juiciness, 1: dry, 6: very juicy.
Means in the same column with different superscript letters are significantly (P<0.05) different.

Table 5. Influence of injection with soy protein concentrate solution and tumbling on pH, cook yield and thaw purge of algin/calcium restructured beef (SMR).

	Product pH			
Treatments	Raw	Cooked	Purge(%)	Cook Yield(%)
AM	5.51[a]	5.74[a]	5.3[a]	71.4[b]
SMR	5.49[a]	5.66[a]	6.0[a]	76.4[a]
SMR-18	5.60[a]	5.67[a]	6.2[a]	67.4[c]
SMR-30	5.62[a]	5.79[a]	5.4[a]	63.1[d]
SMR-18T	5.56[a]	5.70[a]	7.1[a]	70.7[b]
SMR-30T	5.64[a]	5.81[a]	7.1[a]	66.3[cd]

Treatment designation described in Table 1. Means in the same column with different superscripts are significantly (P<0.05) different.

refrigerated for 24 hours at 2-5°C, vacuum packaged in 3 ml thick vacuum pouches and frozen. The material was shipped frozen and evaluated 40 days after preparation according to procedures described by Means and Schmidt (1986) and Means et al. (1987) after slicing 1.3 cm thick. Colour intensity, percent discoloration and raw bind were evaluated by four panelists on six point scales.

Slices were cooked on Farberware open hearth electric broilers (170°C) for 6.5 min and 5 min per side to a medium degree of doneness. Mouthfeel, aroma, flavour, juiciness and cooked product bind were evaluated according to previously described methods on six point descriptive scales (Means and Schmidt 1986; Means et al. 1987). Raw and cooked product pH was determined in meat:water (1:9) slurries. Product binding was also measured instrumentally as the peak force (N) required to break 1.10 cm thick raw and cooked slices with a 1.8 cm diameter steel ball (Field et al. 1984) using a J.J. Lloyd Model T5002 tensile tester. Crosshead spread was 110 mm/min. Cooked yield and thaw purge were expressed as percent of raw product.

RESULTS AND DISCUSSION

Product Bind:

The results of Table 2 demonstrate the effectiveness of the algin/calcium gelation mechanism (SMR) in binding meat. Meat injected with a solution of soy protein concentrate had acceptable binding properties when processed with the SMR system. Tumbling ot the injected meat resulted in even higher increases in product bind.

Although injection with soy protein concentrate solutions significantly ($P < .05$) reduced colour intensity of the restructured products, percent discoloration was only slightly more extensive in the soy protein containing products (Table 3).

The sensory evaluation scores for cooked products are presented in Table 4.

The aroma, flavour and mouthfeel of the products became progressively less acceptable as the level of soy protein concentrate injection increased to 18% and especially 30% (Table 4). The aroma and mouthfeel scores, however, of products with 18% soy protein concentrate injection were very similar to those of the SMR product. None of the products, however, was completely unacceptable.

Product pH in the raw and cooked state, was in the range of 5.49-5.64 and 5.66-5.81, respectively (Table 5). Restructuring with the SMR process, both in the absence or presence of soy protein injection resulted in no major changes in product pH.

Purge loss during product thawing was not significantly different ($P < 0.05$) among treatments. Injection with 18% or 30% solutions, however, resulted in slightly higher purge. Cook yields were lower with injection especially at the 30% level, and tumbling improved cook yields (Table 5). It should be noted that the treatment with higher purge and cook losses contained only 82% or 70% meat and 18% or 30% soy protein solution. Thus, losses in these treatment consisted mostly of added water.

CONCLUSION

Additional studies are needed to optimize formulations and derive products of more acceptable eating qualities, cook yields and costs. The results

of this study have demonstrated that the algin/calcium SMR binding process is operational even in beef which was injected with large amounts of soy protein concentrate solutions.

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