EVALUATION OF COMMINUTION METHOD AND RAW BINDER SYSTEM ON RESTRUCTURED BEEF

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INTRODUCTION

Different binding systems have been investigated to manufacture value-added meat products that can be handled in the raw state. One of the main reasons this technology is under utilized is the lack of general information about the practical aspects of how the binders work and how processing methods affect the finished product. The objective of this experiment was to determine how different meat preparation techniques affect the binding of two binder systems, Fibrimex™ and alginate, for restructured beef products. The effect of different methods of particle size reduction (grinding, flaking, slicing) and particle size on the bind, and processing properties of restructured beef products were investigated.

MATERIALS AND METHODS

Meat preparation

Inside rounds (*semimembranosus* and *gracilus* muscles) were obtained from a federally inspected plant 4 - 5 days after slaughter. All fat was trimmed from the surface. The size of all meat was reduced to give particles that were approximately 2, 4 and 8 mm in size (machines were set for 2, 4, and 8 mm). Meat was either sliced using a Hobart 1612 slicer (The Hobart Mfg. Co. Ltd, Don Mills ON), ground through a Biro AMFG32 grinder (Biro, Marblehead, OH) or flaked through a Model 3600 Urschel Comitrol (Urschel Laboratories, Inc., Valparaiso, IN) equipped with heads 2K020060 (~2 mm), 2K-030150 (~4 mm) or 2K-030300 (~8 mm).

Product preparation

Alginate structured logs were made with 0.5% sodium alginate (Nutrasweet Kelco, Chicago, IL), 0.2% calcium carbonate, and 0.5% gluconodeltalactone. Ingredients were mixed into the meat sequentially for 30 s each, in a Berkel BA-20 mixer (Berkel, Taiwan) for a total mixing time of 1.5 min. The mixture was then stuffed into pre-stuck fibrous casings (Devro-Teepak, Inc, Scarborough, ON) using a Handtmann VF80 vacuum stuffer (Albert Handtmann, West Germany). Fibrimex™ logs were formed using 10 % fibrinogen/thrombin (FNA Foods, Inc. Calgary, AB) mixture at a ratio of 20 fibrinogen solution to 1 thrombin solution. Meat and Fibrimex™ were mixed for 30 sec in a Berkel BA-20 mixer (Berkel, Taiwan) and stuffed immediately into pre-stuck fibrous casings (Devro-Teepak, Inc, Scarborough, ON) using the same stuffer as above. Both systems were refrigerated overnight (~ 17 h) at 4°C. Logs were cut into 1.5 cm steakettes for analysis.

Bind of raw and cooked steakettes

The bind strength (Field *et al.*, 1984) of four 1.5-cm-thick steakettes of both raw and cooked samples was determined for each treatment using a TMS-90 Texture System (Food Technology Corp., Rockville, MD). The bind strength was measured as the peak force required for a 1.9-cm ball, with a cross head speed of 100 mm/min, to break through the meat steakette.

Cook yield and dimensional changes

Four steakettes from each treatment were weighed before and after being cooked. A fifth steakette was also placed on the cook tray and three copper constatan thermocouples were inserted into the geometric center to monitor temperature. Steakettes were cooked in a G34 Series Garland gas oven (Garland Commercial Ranges Ltd, Mississauga, ON) set at 218°C to an internal temperature of 74°C. Cook yield was calculated as the weight of the cooked steakette / weight of the raw steakette * 100. The average of four measurements was used for statistical analysis. The thickness and diameter of four steakettes per treatment were measured at 4 locations per slice before and after cooking. The average of four measurements was used to calculate the percent change in thickness and diameter. Dimensional changes were calculated as the raw diameter (thickness) - cooked diameter (thickness) / raw diameter (thickness) * 100. The average of four measurements was used for statistical analysis.

Statistical Analysis

All data were analyzed using SAS (SAS, Cary, NC) balanced analysis of variance. Least significant difference was used to separate means.

RESULTS AND DISCUSSION

The type of binder used significantly ($P<0.05$) affected the raw bind, cook yield and dimensional changes of restructured beef steakettes (Table 1). Beef steakettes manufactured with the alginate binding system had a significantly ($P<0.05$) higher raw bind value than did the beef steakettes manufactured with Fibrimex™. The raw bind values reported here for alginate beef steakettes are intermediate to the 11.9 N reported by Shand *et al.*, (1993), and the 6.7 N reported by Esguerra (1994). Shand *et al.* (1993) saw a reduction in raw bind values as added water increased. This could partially explain why the values reported by Esguerra are less than those reported here. Esguerra (1994) included 5% added water in the meat formulation. The large difference in bind values between the alginate steakettes and the Fibrimex™ steakettes indicate that alginate steakettes bind better at 4°C. Esguerra (1994) also reported that steakettes made with Fibrimex™ had lower raw bind values than alginate steakettes.

Bind of raw restructured beef steakettes was also affected ($P<0.05$) by method of size reduction. Slicing meat for the manufacture of restructured beef steakettes resulted in a higher bind than did either grinding or flaking the meat (Table 1). The higher bind values could be due to the larger particles making up the steakette and how they affect the movement of the ball through the steakette. Fibrimex™ restructured steakettes needed to be handled with care to prevent tearing but alginate restructured steakettes were easier to handle. Increasing Fibrimex™ content could increase raw bind but there is a danger of off-flavors (Esguerra, 1994) and raising the Fibrimex™ content would result in increased cost of the processor.

Cook yields of restructured beef steakettes were significantly ($P<0.05$) affected by binders but were not affected by either method of size reduction or particle size. Restructured beef steakettes made with alginates had higher ($P<0.05$) cook yields than steakettes made with Fibrimex™ (Table 1). Altered cooking methods could improve the yields of beef steakettes made with both Fibrimex™ or alginates.

Dimensional changes were significantly (P<0.05) affected by type of binder used to manufacture restructured steakettes but was not affected by method of size reduction or particle size of the meat used (Table 1). Berry et al. (1987) reported that restructured steakette distortion was more extensive in steakettes manufactured with large and small meat flakes compared to those processed from intermediate size meat flakes.

Significant (P<0.05) interactions were observed for the bind of cooked steakettes between binder and method of size reduction, binder and particle size and method of size reduction and particle size (Table 2). When alginates were used to make restructured steakettes the bind of the cooked product was less (P<0.05) when meat was sliced than when it was ground or flaked. However, when Fibrimex™ was used, bind was stronger when sliced meat was used. Bind values of cooked steakettes were similar for Fibrimex™ and alginate when sliced meat was used to manufacture the steakettes. Particle size affected the two binder systems differently. The alginate system resulted in higher bind values when the particle size was smaller but with the Fibrimex™ system values were higher when particles sizes were larger. This suggests that when using alginates to manufacture restructured steakettes, smaller particles can be used. However, with Fibrimex™ larger particles are need to get a similar result. In general, cooked steakettes made with 2 mm particle size had the lowest bind for the slicer and grinder but 8 mm particles were lowest for the flaker. The differences, however, are not significant for the grinder and flaker. This information suggests that different levels of binders may be needed for different size reduction methods to achieve the same bind in the cooked product.

CONCLUSIONS

Restructured beef steakettes can be manufactured with either sodium alginates or Fibrimex™. The method of size reduction used to get similar results in the finished product for each type of binder system was slightly different. If using Fibrimex™, larger particle pieces should be used so that the exposed surface area is smaller and there is more solution to coat individual pieces. Alginates, however, have better binding properties with increasing surface area.

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Table 1. Effect of binder, machine for particle size reduction and particle size on the raw bind, cook yield and dimensional changes of restructured beef steakettes.

Treatment	Raw bind (N)	Cook yield (%)	Diameter change (%)	Thickness change (%)
Binder				
Alginates	9.8^a	77.1^a	7.4^b	17.2^b
Fibrimex™	3.0^b	62.2^b	13.7^a	25.5^a
SEM*	0.2	0.8	0.3	0.7
Method of size reduction				
Slicer	7.3^a	69.8	10.9	20.1
Grinder	6.4^b	69.8	10.6	21.2
Flaker	5.7^b	69.4	10.1	22.7
SEM	0.3	0.9	0.4	0.8
Size				
2 mm	6.2	70.3	10.1	21.7
4 mm	6.6	69.9	10.5	21.3
8 mm	6.7	68.8	11.0	21.0
SEM	0.3	0.9	0.4	0.8

*SEM is the standard error of the mean

^{a,b} Means within a column and treatment, with the same superscripts are not significantly different (P<0.05)

Table 2. Interaction of binder, machine for particle size reduction and particle size for bind of cooked restructured beef steakettes.

Treatment interactions		Cook bind (N)
Binder * Method		
Alginate	Slicer	20.6^{bc}
	Grinder	23.9^{ab}
	Flaker	25.6^a
Fibrimex™	Slicer	21.4^b
	Grinder	17.5^{cd}
	Flaker	17.1^d
	SEM*	1.3
Binder * Size		
Alginate	2	24.6^a
	4	22.9^{ab}
	8	22.4^{abc}
Fibrimex™	2	16.8^d
	4	18.8^{cd}
	8	20.4^{bcd}
	SEM	1.4
Method * Size		
Slicer	2	18.2^b
	4	21.2^{ab}
	8	23.7^a
Grinder	2	20.2^{ab}
	4	20.7^{ab}
	8	21.3^{ab}
Flaker	2	23.7^a
	4	20.8^{ab}
	8	19.4^{ab}
	SEM	1.9

*SEM is the standard error of the mean

^{a,b,c} Means within a column with the same superscripts are not significantly different (P>0.05)

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