Meat cut and injection level affects the tenderness and cook yield of processed roast beef

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Background

The look of the fresh meat case in the grocery store is changing. Pot roasts have given way to stir-fry and sweet and sour pre-cut meats and marinated kebabs or pre-cooked meat products. Currently little beef is used for further processing (25% vs 70% for pork and chicken). The major reason sited for not using beef for further processing is the cost and variability of the raw material. Information about the processing capability of individual beef cuts could help reduce the variability by allowing processors to sort meat differently than what has traditionally been done. Information about the changes in processing characteristics due to specific cut would allow the processor to specify what type of product they want and to improve the utilization of beef. Very little information is available about the characteristics of different beef muscles for processing.

Objective

The objective of this project was to determine the effect of different meat cut and level of injection on processing characteristics and tenderness of retail ready cooked roast beef.

Methods

Beef cuts used were from the chuck and round from Canada A grade carcasses. The cuts chosen were ones that have traditionally been used for pot – roast or other cuts normally recommended for moist heat cookery. The meat cuts obtained for comparison in the processing of roast beef were inside *(semimembranosus)*, outside (*biceps femoris*), eye of round (*semitendinosus*), knuckle (*vastus lateralis*, *rectus femoris*, *vastus medialis)*, chuck clod (*infraspinatus*, *deltoideus)*, chuck roll (*seratus ventralis*, *complexus*, *longissimus thoracis*) and brisket (*pectoralis profundus)*. Meat cuts were cut into four small roasts (750 g) and then injected at three levels (110%, 125% and 150% over raw roast weight) with the fourth roast used as a non-injected control. Brines were formulated to give 1.8% salt, 1% sugar and 0.3% sodium phosphate in the finished product (adjusted for expected cook yield). After injection, roasts were tumbled 30 min (8.5 rpm) under vacuum. Roasts were then steam cooked to a final endpoint temperature of 73°C. The processing characteristics measured on each roast were actual injection level, brine retained after tumbling, and cook yield. Warner Bratzler shear (WBS) was also determined on eight - ten (1.27 x 1.27 x 2.54 cm) cores from each roast. All data were analyzed using SAS (SAS, 1986) analysis of variance. The significance of differences between means was determined using least significant differences and Dunnetts test. All treatments were applied to a single carcass so that carcass was considered a replicate. Eight carcasses were used with the location within each muscle balanced within the experiment.

Results and Discussion

The muscle cuts used to manufacture cooked retail type roast beef (non-injected samples) had significantly ($P<0.05$) different processing characteristics and tenderness (Table 1). Cook yield was highest when chuck roll, outside and inside round were used to manufacture the roasts. Part of the difference seen in cook yield can be explained by pH, especially when the chuck roll was used to manufacture roasts. The muscle used to manufacture the roast beef significantly ($P<0.05$) affected the tenderness of the finished product. Roast beef made from outside round, clod and chuck roll were significantly more tender than roast beef made from the other meat cuts.

Injection of muscles for the manufacture of roast beef significantly ($P<0.05$) affected the processing characteristics and tenderness of the cooked roast beef (Table 2). Cook yields were increased substantially by the injection of brine. Boles and Swan (1997) reported an increase in cook yield between injected (110%) and non-injected pre-rigor cooked roast beef. Other researchers have also reported increased cook yields when salt and phosphate are added to roasts. As expected, the pH of the cooked roast beef increased with addition of brine containing alkaline phosphates (Hamm, 1986; Bernthal et al., 1991). Tenderness of cooked roast beef was significantly ($P<0.05$) increased by the introduction of brine. In addition, variability within a sample was reduced in injected roasts.

The injection level significantly ($P<0.05$) affected the processing characteristics and tenderness of cooked roast beef (Table 2). Actual injection levels achieved were very close to target levels for the 110% and 125% injected roasts, but was considerably less than the target for the 150% injection level. Achieving the highest level of injection was very difficult with a single pass through the injector. There seems to be resistance in the beef muscles to adding high levels of liquid. Injection level significantly ($P<0.05$) affected cook yields, however the expected higher yields with higher injection levels did not occur. Cook yields were highest when 125% of brine was injected followed by 110% injection level, followed by 150% injection level (Table 2). A possible explanation for the difference in cook yield is the low ionic strength required in 150% brine to achieve the targeted salt and phosphate levels in the finished product. Increased ionic strength would result in more solublization (Offer and Trinick, 1983) of muscle proteins and thus an increase in the cook yield of the product.

Muscle cut significantly ($P<0.05$) affected the actual injection level (Table 3). The average injection level was highest in the chuck roll and lowest in the eye of round and inside round. This suggests that different muscles responded differently to the level of injection. Cook yield was also significantly ($P<0.5$) affected by meat cut used. Cook yield was highest for roasts made from the chuck roll and lowest for roasts made from eye of round. Injection with a salt/phosphate brine reduced Warner-Bratzler shear values up to 50% of the uninjected value and reduced the variability between samples.

Conclusions

Muscle cuts from the chuck and round can be used to successfully manufacture cooked mini roast beef. However, the use of small roast resulted in cook yields that are considerably less than what would be expected with large intact muscle roasts. Some variation in tenderness between the muscles was seen, but when muscles were injected there was a significant increase in tenderness and a reduction in the variability within the muscle. Roasts injected to 125% above green weight resulted in the highest cook yields. However, with these beef mini roasts, 150% injection was not successfully achieved while industry can readily achieve this with pork and poultry.

Information about the changes in processing characteristics due to cut used will allow processors to alter processing techniques to fit individual muscle cuts. However, there is much to be done to improve the quality and yields of processed beef products. Challenges to increasing utilization of various beef muscles for new consumer ready beef products include: developing new technologies to deal with smaller product sizes, reducing variability in tenderness and ensuring a safe palatable product that still meets the demands of competitiveness for the industry.

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Table 1. Effect of muscle cut on the processing characteristics and tenderness of cooked roast beef.

	Muscle Cut							
	Clod	Chuck Roll	Brisket	Knuckle	Inside	Eye	Outside	LSD (5%)
Cook yield (%)	67.0^{bc}	69.8^{a}	67.4^{bc}	64.7^{d}	67.9^{abc}	66.3^{cd}	68.7^{ab}	1.9
WBS (N)	72.7^{c}	74.4^{c}	89.7^{a}	74.3^{c}	75.7^{bc}	86.3^{ab}	65.5^{c}	11.9
pH	5.74^{b}	5.86^{a}	5.61^{c}	5.68^{bc}	5.65^{bc}	5.65^{bc}	5.61^{c}	0.10

^{abcd} Means within a row with the same superscripts are not significantly different (P>0.05)

Table 2. Effect of injection level on the processing characteristics and tenderness of cooked roast beef.

	Injection Level					
	0%	10%	25%	50%	LSD (5%)[1]	Dunnett's
Actual injection (%)[2]	---	109.0^{c}	123.9^{b}	134.5^{a}	2.1	---
Retention (%)[2]	---	110.2^{c}	123.9^{b}	134.5^{a}	1.7	---
Cook yield (%)[2]	67.4^{c}	91.8^{a}	93.6^{a}	84.4^{b}	1.8	2.4
WBS (N)	77.0^{a}	50.3^{b}	45.2^{c}	45.6^{c}	3.0	4.5
pH	5.69^{c}	5.98^{b}	6.03^{a}	5.98^{b}	0.03	0.04

^{abc} Means within a row with the same superscripts are not significantly different (P>0.05)

[1]Used for comparing among three injection levels.

[2]Percentage of green weight (original meat weight)

Table 3. Effect of injection[1] and muscle cut on the processing characteristics and tenderness of cooked roast beef.

	Muscle Cut							
	Clod	Chuck Roll	Brisket	Knuckle	Inside	Eye	Outside	LSD (5%)
Actual injection (%)	123.7^{b}	130.2^{a}	124.3^{b}	125.0^{b}	119.3^{cd}	117.4^{d}	122.0^{bc}	3.1
Retention (%)[1]	125.2^{b}	134.2^{a}	122.8^{b}	125.0^{b}	117.0^{d}	116.1^{d}	120.0^{c}	2.7
Cook yield (%)[1]	93.5^{b}	98.6^{a}	86.9^{cd}	93.1^{b}	85.2^{de}	83.5^{e}	88.7^{c}	2.9
WBS (N)	40.9^{d}	39.7^{d}	62.4^{a}	38.7^{d}	48.6^{bc}	52.7^{b}	46.1^{c}	4.6

^{abcde} Means within a row with the same superscripts are not significantly different (P>0.05)

[1]Averaged across injection level (110, 125, 150%)

[2]Percentage of green weight (original meat weight)