Influence of meat cut, slice thickness and direction of muscle grain on the properties of beef stir-fry slices

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Introduction

It is predicted that along with meat cuts normally seen in the meat case, meat will increasingly become a component of complete meals that are only reheated. The meat may also be supplied as a raw material for the complete meal packaged together with the vegetable and starch component so the consumers can feel that they contributed to meal prepartion. Consistency is very important. Many processors entering this market are not meat processors and are more likely to have other types of food products as their main or original line of products. This makes it extremely important to be able to describe the beef product that is being supplied. Very little research has previously been done to assess the properties of beef for stir-fry or for addition to prepared meals. Currently, industry has no consensus as to the appropriate size and muscle cut for manufacture of these stir-fry strips.

Objective

The objective of this project was to evaluate different meat cuts, slice thickness and grain direction of beef stir-fry slices to increase the utilization of under valued beef cuts as a meat ingredient in prepared meals.

Materials and Methods

Inside round (*semimembranosus* muscle with *adductor*), outside round (*biceps femoris* muscle), eye of round (*semitendinosus* muscle), knuckle (*vastus lateralis*, *rectus femoris*, *vastus medialis* muscles), chuck clod (primarily *infraspinatus*, *deltoideus* muscles), and chuck tender (*supraspinatus* muscle) were obtained from six young Canada Grade A beef carcasses 3 days after slaughter. Right sides were used for slicing. Meat cuts were frozen at -40°C and then tempered to aid slicing. The cuts were tempered at -1°C for 5 days for the chuck tender and eye of round and 7 days for the other cuts. Slices (2, 4, or 6 mm) were removed from each cut. For cuts where the fibre direction was constant (eye of round, inside round and outside round), slices were removed perpendicular and parallel to the fibre direction. For cuts where muscle fibre directions changed greatly within the muscle, the slices were removed perpendicular to the long axis of the cut. Where muscles were large enough, a template was used to cut a standard slice size (11.0 cm x 7.0 cm).

Slices were cooked from frozen on a grill (Model QS12-23, Taylor Company, Rockton, IL) set at 167°C for a specific time period (2 mm, 70 s/side; 4 mm, 80 s/side; 6 mm 90 s/side) to an endpoint temperature of approximately 75°C. Temperature of each slice was taken with a copper constantan thermocouple (0.08 mm) inserted into the center of the slice. The dimensions of each slice were measured before and after cooking.

Warner-Bratzler Shear Measurement

Samples (6-10 –slice thickness x 1.3 x 2.54 cm) were cut from cooked, cooled slices from each muscle cut. Each sample was sheared perpendicular to the fibre or slice direction using a TMS-90 Texture System (Food Technology Corp., Rockville, MD) fitted with a Warner-Bratzler Shear attachment. The average of the maximum force necessary to shear the sample was used for statistical analysis.

Sensory

An eight member semi-trained panel evaluated stir-fry slices from four meat cuts (knuckle, inside round, eye of round and outside round). They had been trained/selected following procedures of the AMSA (1995). Panelists were served 2 warm strips (slice thickness x 1.3 x 3 cm) that had been dipped in a bland sauce (96.88% water, 2.66% modified corn starch [B990, Grain Processing Corp], 0.27% beef bouillion [Bovril Canada, Montreal, PQ] and 0.19% soy sauce powder [Griffiths Laborratories, Mississauga, ON]) to prevent desiccation. Strips were scored for tenderness, juiciness, flavor intensity, flavor desirability, connective tissue amount, overall acceptability) using six-point scales (6=very tender, juicy, intense, acceptable, no connective tissue, 1= very tough, dry, weak, unacceptable, abundant).

Statistics

All data were analyzed using SAS (SAS, 1986) analysis of variance. The significance of differences between means was determined using least significant differences (LSD). All treatments were applied to a single cut within a carcass so that carcass was considered a replicate. Six carcasses were used. Differences in sensory means were determined using LSD and defining the error term for main effects as the interaction between carcass, meat cut and thickness.

Results and Discussion

The goal of this experiment was to determine which muscles could be used to manufacture stir-fry slices for use in frozen combination meals or for sale in the retail meat case. During the slicing of the raw product, fibre direction could be determined much more easily from cuts from the round, which made slicing more consistent. Furthermore, the smaller diameter cuts such as the chuck tender and eye of round yielded small slices that may not be appropriate for use on high-speed industrial slicers. Slice thickness was more consistent if the meat was tempered than if it was completely thawed.

Meat cut used did not affect the cook yield of stir-fry slices (Table 1). However, cook losses were very large. Dimensional change in individual slices during cooking was significantly ($P<0.05$) affected by meat cut used. The greatest dimensional changes were seen in slices made from the inside and outside round. The least dimensional changes were seen in slices made from the chuck tender and

eye of round. Shear values of stir-fry strips from the different meat cuts used was similar. Strips from outside round, however, required significantly greater force to shear than did slices obtained from other meat cuts.

Slice thickness significantly ($P<0.05$) affected the cook yield and dimensional changes of the stir-fry slices (Table 1). The thicker the slice the greater the cook yield and the lower the change in length and width. As expected, the Warner-Bratzler shear values were lower for 2 mm thick slices than either 4 mm or 6 mm. The values were also lower for 4 mm than 6 mm. However, when the Warner-Bratzler shear values were expressed as max force required to shear the sample per mm thickness, the 2 mm slices had higher values than did the 4 or 6 mm slices. This is perhaps due the influences of the cooked meat surface on the shear values.

The fibre direction had no effect on dimensional changes of stir-fry slices. However, fiber direction did significantly ($P<0.05$) affect tenderness and tended ($P=0.06$) to affect cook yield. The slices that had been cut perpendicular to the fibre direction were more tender and had a higher cook yield than those cut parallel to the fibre direction. From this information it is important to make sure that stir-fry slices are removed perpendicular to the fibre direction to ensure a more tender product. This is especially important for the inside round where shear values for strips cut parallel to the fibre direction were twice the values for perpendicular cut slices (30.3 vs. 19.3 N).

Due to the limited number of slices obtained, sensory evaluation could not be performed on all treatments. Of the four meat cuts served to the sensory panel, stir-fry slices from the knuckle were the most tender, with the least connective tissue and most juicy (Table 1). Panel results agreed with Warner-Bratzler shear measurements in that the stir-fry slices from the outside round were the least tender. The panelists also found that the stir-fry slices from the outside round had the most connective tissue. Flavor intensity and desirability was the lowest in stir-fry slices from the eye of round. The thickness of the slice had no effect on the juiciness, flavor intensity or flavor desirability, however, panelists detected more connective tissue in the thicker slices.

Understanding the physical, chemical and processing characteristics of cuts from the chuck and round will permit greater utilization of under valued cuts for applications such as stir-fry. Close attention should be paid to fiber direction and alternative processing to improve yields.

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Table 1. Effect of muscle cut, slice thickness and fibre direction on the processing, objective tenderness and sensory characteristics of beef stir-fry slices

	Processing Characteristics				Sensory[1]				
Characteristic	WBS (N)	WBS/Thick (N/mm)	Cook Yield (%)	Shrink in Area (%)	Tenderness	Connective Tissue	Juiciness	Flavor Intensity	Flavor Desirability
Meat Cut									
Clod	20.2^{c}	6.3^{ab}	56.0	28.9^{bc}	---	---	---	---	---
Chuck Tender	20.1^{c}	6.3^{ab}	54.5	12.1^{e}	---	---	---	---	---
Knuckle	20.9^{b}	6.3^{ab}	54.9	22.4^{cde}	4.6^{a}	4.9^{a}	4.3^{a}	4.2^{a}	4.3^{a}
Inside Round	22.9	6.7^{a}	54.1	33.7^{ab}	4.2^{ab}	4.3^{b}	3.7^{bc}	4.1^{a}	4.2^{ab}
Eye of Round	20.2^{c}	5.8^{b}	54.2	16.1^{de}	3.9^{b}	4.4^{b}	3.5^{c}	3.7^{b}	3.8^{c}
Outside Round	25.3^{a}	6.6^{a}	54.6	40.2^{a}	3.9^{b}	3.7^{c}	3.9^{b}	4.2^{a}	4.1^{bc}
LSD	2.2	0.7	1.9	7.9	0.4	0.3	0.2	0.2	0.3
Slice Thickness									
2 mm	13.7^{c}	7.1^{a}	50.1^{c}	31.1^{a}	4.3	4.8^{a}	3.9	4.2	4.1
4 mm	21.0^{b}	6.1^{b}	54.4^{b}	25.5^{ab}	4.1	4.2^{b}	3.9	4.1	4.1
6 mm	30.1^{a}	5.8^{b}	59.5^{a}	20.1^{b}	4.1	4.0^{b}	3.8	4.0	4.1
LSD	1.5	0.5	1.1	5.6	0.3	0.2	0.2	0.2	0.2
Fiber Direction[2]									
Perpendicular	22.4^{b}	6.2^{b}	54.3	30.4	---	---	---	---	---
Parallel	33.4^{a}	8.8^{a}	57.3	30.2	---	---	---	---	---
LSD	3.2	0.7	3.3	6.6	---	---	---	---	---

[1] 6=very tender, juicy, intense, acceptable, no connective tissue, 1= very tough, dry, weak, unacceptable, abundant

[2] Fiber direction in the meat cut was identified and then slices were removed either parallel or perpendicular to the fiber direction.

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

--- not tested