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EFFECTS OF PATTY THICKNESS, WEIGHT AND FILL SYSTEMS ON TEXTURAL AND JUICINESS PROPERTIES OF GROUND BEEF PATTIES

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Introduction: Factors such as fat replacers and cooking methods have been recently considered in the manufacture of low-fat ground beef. Processing technologies relative to size, weight and formation of patties have not received much attention. An increase in patty size has been shown to increase sensory tenderness and juiciness with 20% fat ground beef (Cross and Berry, 1980). Recently there has been new developments for forming raw patties, which have been promoted as improving texture and allowing for faster chilling and cooking times. The objective of this study was to evaluate the use of patty formation systems and patty thicknesses and weights on juiciness and tenderness properties of low-fat (10%) ground beef products.

Material and Methods: The meat block was comprised of 90% lean cow meat (of which 1/2 was rounds and 1/2 chucks) and 50% fat trimmings. The meat block was divided into two replications and underwent an initial grind through a 1.91 cm plate using a Weiler and Company grinder (Model 1109, Whitewater, WI). Each replication was mixed using a Hobart mixer-grinder (Model 4356, Troy, OH) for 7 to 10 minutes. Fat analysis was performed on each replication using Anyl Ray (Model M201, Anyl Ray Corporation, Davenport, IA). Fat level was adjusted to 10% and then final grinding was made through a 0.32 cm plate using a Hollymatic grinder (Model 4356, Whitewater, WI). Ground beef was formed into eight treatments using Hollymatic patty machines (Model 518, Whitewater, WI). Two types of Hollymatic filling systems were evaluated, Multi-Flow and Roto-Flow. Multi-Flow filling system forces a mass of meat into the mold, whereas the meat is gently twisted through small holes into the mold with the Roto-Flow filling system. Two different hole diameters through which the meat was forced in the Roto-Flow system were evaluated (0.39 and 0.48 cm). Two weights were evaluated for each treatment, 90 and 113 g and within the Multi-Flow system, two patty thicknesses were evaluated 0.95 and 1.27 cm. Treatments were as follows: 133 g, 1.27 cm thick Multi-Flow; 90 g, 1.27 thick Multi-Flow; 113 g, 0.95 cm thick Multi-Flow; 90 g, 0.95 cm thick Multi-Flow; 113 g, 0.95 cm thick Roto-Flow (0.39 cm); 90 g, 0.95 cm thick Roto-Flow (0.39 cm); 113 g, 0.95 cm thick Roto-Flow (0.48 cm); and 90 g, 0.95 cm thick Roto-Flow (0.48 cm). Patties were placed four to a stack and frozen at -25ºC for 48 hours. Frozen patties were vacuumed packaged and kept at -25ºC until used. Two commercially prepared 17% fat ground beef products (90 g and 0.95 cm thick), one with a majority of cow meat and the other with a high percentage of fed beef, were used as controls.

Frozen patties were cooked on a preheated (163ºC) Farberware (Model 260 SP, Walter Kidde and Co.,Inc., Bronx, NY) electric griddles until the internal temperature reached 71ºC. Temperature was monitored with hypodermic probe-type iron-constantan thermocouples connected to a recorder (Honeywell Co., Ft. Washington, PA). Patties were cooked on the first side for 2 min, the second side for 2 min, and then turned every min until 71ºC was reached.

A seven member sensory panel, trained according to the procedures of Cross et al. (1978), evaluated ground beef patties for tenderness in separate panel sessions than juiciness properties. All of the samples for one replication and the two controls were evaluated within a day and assigned randomly to one of two sessions, in that day. Each replication was evaluated on five separate days. Texture parameters evaluated were firmness after three chews, rate of breakdown after six chews, and size and number of pieces after ten chews. Initial juiciness was evaluated after 3 chews, while final juiciness scores were evaluated after fifteen chews. Tenderness parameters and juiciness were evaluated on an eight-point structured scales (8 = extremely soft, all pieces subject to molar contact are disconnected, small size and many separate chewed pieces, and extremely juicy; 1 = extremely hard, sample basically in 1 or 2 pieces with many tooth marks, large size and few chewed pieces, and extremely dry). Cooked patties were cut into approximately 10 g wedge-shaped servings. Panelists consumed unsalted Melba toast (Devonshire Melba Div. of Arnold Foods Co., Inc., Greenwich, CT) and warm (30ºC) water between samples.

Ten patties from each processing treatment/replication and both controls were cooked following the same procedures described earlier and then cooled to 24 to 28ºC. One 2.5 cm wide strip was removed from each patty and sheared in three separate locations with a straight edge blade attached to an Instron Universal Testing Machine (Model 1122, Instron Corp., Canton, MA). Crosshead and chart speeds were set at 25 cm/min and a full scale load of 50 kg was used. Instrumental values obtained included peak load and peak load expressed as Newtons (adjusted for sample height).

Data was analyzed using the PROC MIXED procedure of SAS (SAS Institute, Cary, NC). When differences in treatments were found, means differences were evaluated using the Least Significant Difference (Steel and Torrie, 1958).

Results and Discussion: The effects of ground beef patty thickness, weight and filling system on sensory and physical parameters are shown in Table 1. For Multi-Flow patties, increasing the thickness from 0.95 to 1.27 cm, resulted in a significant ($P < 0.05$) decrease in sensory firmness and an increase in initial juiciness. When the weight of the patties was increased from 90 to 113 g, there tended to be a decrease in sensory firmness, faster rate of breakdown, smaller and more chewed pieces and greater juiciness. An increase in weight from 90 to 113 g significantly decreased the firmness, increased the rate of breakdown and size and number of chewed pieces of the thick (1.27 cm) Multi-Flow treatments, and increased the initial juiciness of the Roto-Flow (0.39 cm) treatments. Similar trends due to increase in patty size were also seen by Cross and Berry (1980) with 20% fat products and was attributed to the larger size patty being able to withstand cooking effects.

Roto-Flow fill system treatments tended to be more tender, have a faster rate of breakdown, yield smaller and more pieces, with a higher initial juiciness in comparison to the Multi-Flow fill system treatments. The 1.27 cm, 113 g Multi-Flow treatment provided one of the four highest mean values for firmness, rate of breakdown, size and number of pieces and initial juiciness, but was not different ($P > 0.05$) than most Roto-Flow treatments. Thin (0.95 cm) Multi-Flow patties had similar sensory properties to the two controls. Control patties made from mostly cow meat were significantly lower in rate of breakdown than all of the other treatments. There was no significant ($P > 0.05$) difference for any of the sensory attributes resulting from the Roto-Flow hole sizes, with the exception of the 90 g treatments, in which the 0.39 cm flow hole size had significantly more and smaller chewed pieces than the 0.48 cm flow hole size. Although, significant ($P < 0.05$) differences were found in final juiciness, there were no trends evident respective to thickness, weights or flow systems.

Control patties with a majority of cow meat had a significantly higher peak load (kg) than the other treatments. Multi-Flow treatments and the control with a high percentage of fed beef, had significantly higher peak loads (kg) than Roto-Flow treatments, with the exception of the 113 g, 0.95 cm thick Roto-Flow (0.39 cm flow hole size), which was only significantly different from the control with cow meat. Each of the controls were significantly different from the other, and had significantly higher peak loads (Newtons) than the other treatments. The 1.27 cm thick Multi-Flow treatments had a significantly lower peak load (Newtons) than the 0.95 cm thick Multi-Flow treatments and the Roto-Flow treatments with smaller flow hole size (0.39 cm). The 113 g, large flow size hole (0.48 cm) Roto-Flow treatment produced a significantly lower peak load (Newtons) than the 0.95 cm thick Multi-Flow treatments. There was no effect of difference of Roto-Flow hole size or patty weights within the Roto-Flow treatments on the physical measurement of firmness of the samples. These differences in expressions of peak loads were due to the differences in the treatment patty thicknesses. When the peak load was adjusted to the patty height, the only major change was the thicker (1.27 cm) Multi-Flow treatments, which had a much greater decrease in value in comparison to the other treatments. Both the thick (1.27 cm) Multi-Flow treatments and the Roto-Flow treatments were found to improve sensory tenderness and decrease peak load (Newtons) in comparison to the 0.95 cm thick Multi-Flow treatments and the two controls.

Conclusions: Results of this study indicate that tenderness and juiciness characteristics can be improved by employing appropriate beef patty processing technologies. In general, Roto-Flow fill system treatments and 1.27 cm thick Multi-Flow treatments, were found to best improve tenderness, have a faster rate of breakdown, produce many and smaller size chewed pieces, have greater initial juiciness and lower peak load (Newtons) than the 0.95 cm Multi-Flow treatments and the two control formulations. Some improvement in tenderness was seen by increasing the weight of the patty from 90 to 133 g.

References:

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Table 1. Effects of ground beef patty thickness, weight and filling system on sensory and physical parameters

Treatment	Sensory Panel Attributes[a] Firmness (3 Chews)	Rate of Breakdown (6 Chews)	Size and Number of Pieces (10 Chews)	Initial Juiciness (3 Chews)	Final Juiciness (15 Chews)	Physical Measurements Peak Load (kg)	Peak Load (Newtons)
Multi-Flow, 113 g, 1.27 cm thick	3.9^{l}	4.3^{l}	5.0^{l}	5.4^{lm}	5.1^{lm}	4.0^{m}	1.3^{p}
Multi-Flow, 90 g, 1.27 cm thick	3.5^{m}	4.0^{mno}	4.7^{op}	5.5^{l}	5.2^{l}	3.8^{m}	1.2^{p}
Multi-Flow, 113 g, 0.95 cm thick	3.2^{no}	3.9^{no}	4.7^{nop}	5.2^{nop}	5.0^{lmn}	3.9^{m}	1.4^{n}
Multi-Flow, 90 g, 0.95 cm thick	3.1^{op}	3.7^{o}	4.5^{pq}	5.1^{nop}	5.0^{lmn}	4.0^{m}	1.5^{n}
Roto-Flow (0.39 cm), 113 g, 0.95 cm thick	3.6^{m}	4.2^{lm}	5.0^{lm}	5.6^{l}	5.0^{lmn}	3.7^{mn}	1.4^{no}
Roto-Flow (0.39 cm), 90 g, 0.95 cm thick	3.7^{lm}	4.4^{l}	5.1^{l}	5.2^{mno}	4.9^{mn}	3.3^{n}	1.4^{no}
Roto-Flow (0.48 cm), 113 g, 0.95 cm thick	3.7^{lm}	4.4^{l}	5.0^{lmn}	5.5^{l}	5.2^{l}	3.4^{n}	1.3^{op}
Roto-Flow (0.48 cm), 90 g, 0.95 cm thick	3.4^{mno}	4.2^{lmn}	4.8^{mno}	5.4^{lmn}	5.0^{lmn}	3.4^{n}	1.4^{nop}
Control - Cow Meat	2.8^{p}	3.4^{p}	4.3^{q}	5.0^{p}	4.9^{n}	5.5^{l}	2.3^{l}
Control - Fed Beef	3.4^{mn}	3.8^{o}	4.5^{opq}	5.1^{op}	4.9^{mn}	4.0^{m}	1.9^{m}

[a] 8 = extremely soft, all pieces subject to molar contact are disconnected, small size and many separate chewed pieces, and extremely juicy; 1 = extremely hard, sample basically in 1 or 2 pieces with many tooth marks, large size and few chewed pieces, and extremely dry.

[lmnopq] Means within column with different superscripts are significantly different ($P < 0.05$).