Yields, Chemical Composition, and Value of Beef Shank Tissues Obtained Using Baader™ Processing[1]

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ABSTRACT: This experiment was designed to determine yield of meat and sinew from beef shanks processed with a Baader™ desinewing machine and to determine whether this process added value to a beef carcass. Baader desinewing machines use belt pressure against a rotating, perforated steel drum to separate tissues. Boneless beef shanks had 9.8% fat and 14.1 mg/g of collagen. Using the Baader with a 5-mm drum, the first pass lean yield was 73.3% and had fat reduced to 7.1% and collagen to 10.5 mg/g. Second-pass lean yield through the 5-mm drum was 19.6% and had 16.1% fat and 13.8 mg/g of collagen, leaving 6.7% separated sinew. Using a 3-mm drum reduced first-pass lean yield to 66.1% and reduced fat content to 5.8%. Second-pass lean yield, using 3- and 5-mm drums, was 26.1% and had 18.6% fat and 27.8 mg/g of collagen with 6.8% sinew. Desinewed lean is worth more than whole shanks. Furthermore, 95% lean is worth more than 90% lean, and the sinew also has a salvage value. Upgrading shanks with this desinewing device can increase the value of a beef carcass by $2.01 using a 5-mm drum or by $3.20 using both 3- and 5-mm drums.

Key Words: Baader, Beef, Shanks, Composition, Yield, Value

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Introduction

Beef shanks are major sources of manufacturing beef; however, their high collagen (sinew) content (Wiley et. al., 1979) prevents their use as a sole lean source. Cross et al. (1976) showed that connective tissue particles adversely affect ground beef quality. Several studies found that desinewing improved product quality (Gillett et al., 1976; Cross et al., 1978). However, desinewing by hand reduced yields (Gillett et al., 1976) and increased labor costs. Some mechanical desinewing devices reduce labor cost, but quality and yield losses decrease profitability. Eilert et al. (1993) showed that the sinew portion of shanks can be used successfully in batter-type meat products. However, because they obtained their sinew from a commercial source, data on yields and how desinewing affects carcass economics were not determined.

Baader desinewing machines use belt pressure against a rotating, perforated steel drum to separate tissues. Belt pressure forces skeletal muscle through holes in the drum, and a scraper blade removes residual sinew and fat from the drum's outer surface as it rotates (Figure 1). This project investigated the yields and chemical composition of the products produced when using a Baader to process beef shanks. We also determined the potential for this process to add value to a beef carcass.

Materials and Methods

Equipment. Apparatus for this experiment included the following: a Baader belt press separator (model 696, Baader North America, New Bedford, MA) with 3- and 5-mm (hole size) drums; a Foss-Let fat analyzer (Foss Food Technology, Eden Prairie, MN); a Hobart model 4732 Grinder (Hobart, Troy, OH) with 10-mm and 3-mm plates; a Fairbanks scale (model H 90-5200, Class III, Fairbanks Scales, St. Johnsbury, VT); an Accumet model 620 pH meter (Fisher Scientific, Pittsburgh, PA); a Ross combination electrode (cat # 802000; ATI Orion Research, Boston, MA); B-620 barrier bags (30- 50ccO_2/m^2/24h/760torr/23°C; Cryovac, Duncan, SC); a Supervac vacuum packager (Smith Equipment Co, Clifton, NJ); a Stomacher 400 lab blender (Seward Medical, London, UK); and Stomacher bags, 400 mL (Fisher Scientific).

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Table 1. Means for yields, composition, and pH of whole and desinewed beef shanks

Tissue	Yield, %	(SD)	pH	(SD)	Composition, % Moisture	(SD)	Fat	(SD)	Collagen, mg/g	(SD)
Desinewed tissue: 1 or 2 passes through drum with 5-mm holes										
1st-pass lean	73.3[b]	(1.71)	5.99[c]	(.02)	72.0[a]	(1.12)	7.1[d]	(1.59)	10.5[e]	(.59)
1st-pass sinew	26.7[e]	(1.71)	—		—		—		—	
2nd-pass lean	19.6[f]	(1.46)	6.11[ab]	(.09)	61.6[c]	(1.68)	16.1[b]	(1.20)	13.8[cd]	(.87)
1st plus 2nd leans	92.9[a]	(1.46)	6.03[bc]	(.06)	69.1[b]	(.27)	10.1[c]	(1.53)	11.2[e]	(.19)
2nd-pass sinew	6.7[g]	(.16)	5.72[d]	(.06)	59.6[d]	(.94)	14.3[b]	(1.44)	29.5[a]	(.14)
Desinewed tissue: 1 pass through drum with 3-mm holes, 2nd pass through drum with 5-mm holes										
1st-pass lean	66.1[c]	(2.24)	6.05[abc]	(.02)	71.3[a]	(.46)	5.8[d]	(.45)	7.6[f]	(.41)
1st-pass sinew	33.9[d]	(2.24)	—		—		—		—	
2nd-pass lean	26.1[e]	(1.60)	6.12[ab]	(.02)	67.6[b]	(.96)	18.6[a]	(.77)	27.8[b]	(.26)
1st plus 2nd leans	92.2[a]	(.87)	6.14[a]	(.01)	67.7[b]	(.61)	10.1[c]	(.79)	13.2[d]	(.47)
2nd-pass sinew	6.8[g]	(.13)	5.65[d]	(.06)	59.6[d]	(.94)	14.2[b]	(1.43)	29.4[a]	(.11)
Whole shank	—		6.04[abc]	(.10)	69.0[b]	(.65)	9.8[c]	(.43)	14.1[c]	(.44)

[a,b,c,d,e,f,g]Means in a column with a different superscript letter are different ($P < .05$).

Raw Materials and Processing. Beef fore and hind shanks from A-maturity carcasses of fed cattle were obtained from the Kansas State University meat lab and commercial sources. Shanks were deboned and vacuum-packaged, frozen, and stored at –28°C for less than 6 mo. Freezing shanks permitted accumulation of sufficient shanks for three replications. Each replication involved different animals and occurred at a different time. Control shanks in each replication were ground first through a 10- and then a 3-mm plate. Shanks for desinewing were cut into three or four strips (approximately 4 to 6 cm thick) each and passed through the Baader twice.

Each experimental run on the Baader was prepared by weighing 23.70 ± .05 kg of shanks on the Fairbanks scale. To obtain accurate yields, one kilogram of shank meat was run through the Baader to “fill the drum,” which gained .59 ± .05 kg after removing any material not actually in the holes. The remaining shank meat was used for that specific experimental run. After each pass, the products of that pass were weighed and sampled. Where sample removed for analysis affected yield results, the data were adjusted for the material removed. Product loss was .4% for the 5-mm drum and 1.0% when using both the 3- and 5-mm drums. We believe that the additional loss was incurred when changing drums.

Belt tension settings on a Baader 626 are set with a hand lever into one of five slots (the higher the slot number, the greater the tension). Initial studies determined that higher lean yields were obtained with the settings described below than with other settings. For shanks processed using the drum with 5-mm holes, the first pass used a belt tension setting of 2 (1 = least, 5 = most belt tension); the second pass (“first pass sinew” was the feed material) used a belt tension setting of 4. The preliminary work indicated that using the 3-mm drum for both passes resulted in lower yields of desinewed lean. Therefore, shanks were processed using the drum with 3-mm holes and a belt pressure setting of 3 on the first pass. The second pass used the 5-mm drum and a belt setting of 4. First- and second-pass lean yields and sinew were weighed and sampled for proximate and collagen analyses. Treatment details are outlined in Table 1.

Analytical Procedures. Samples were pulverized in liquid nitrogen and analyzed using AOAC (1990) procedures for moisture and fat (Foss-Let). Total collagen was extracted (Hill 1966) and hydroxyproline determined (Bergman and Loxley, 1963). The pH was determined by placing a 10-g sample into a stomacher bag and adding 90 mL of distilled deionized water and stomaching for 30 s. The pH was read immediately following blending.

Value-Added Calculations. Shank yields of beef carcasses from the Kansas State University meat laboratory averaged 2.7% of chilled carcass weight.

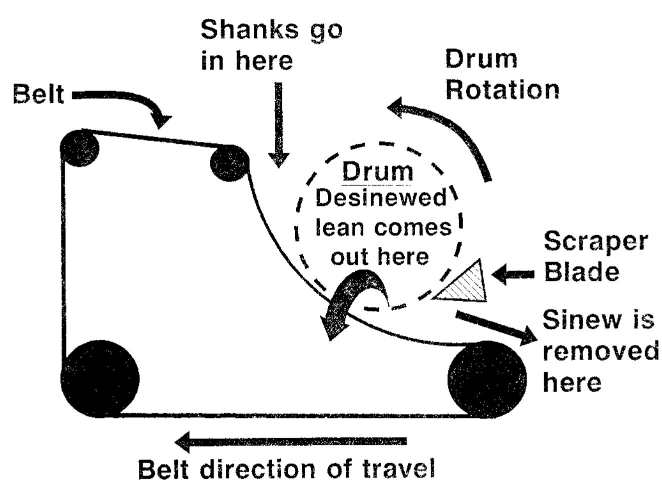

Figure 1. Schematic diagram of the Baader™ operation and essential parts.

Table 2. Estimate of value added to beef shanks from Baader™ processing

Product	% Fat	Yield per carcass, kg[a]	Fat free lean yield per carcass, kg[b]	Value, \$/kg[c]	Lean-point value, \$/kg of lean	Total value, \$
Whole shank	9.8	8.63	7.78[d]	2.53	2.72	21.83
Desinewed tissue: 1 or 2 passes through drum with 5-mm holes						
1st-pass lean	7.1	6.33	5.88	2.95	3.18	18.67
2nd-pass lean	16.1	1.69	1.42	2.68	3.19	4.53
Sinew	14.3	.58	.50	1.10	—	.64
Total value						23.84
Value added per carcass						**2.01**
Desinewed tissue: 1st-pass through drum with 3-mm holes, 2nd pass through drum with 5-mm holes						
1st-pass lean	5.8	5.70	5.37	3.28	3.48	18.70
2nd-pass lean	18.6	2.25	1.83	2.53	3.11	5.69
Sinew	14.2	.58	.50	1.10	—	.64
Total value						25.03
Value added per carcass						**3.20**

[a]Griffin et al. (1989).
[b]Lean yields based on KSU yield data (8.63/kg head).
[c]Prices per IBP quotes 9-24-93.
[d]$8.63 - (8.63 \times .098) = 7.78$.

This value was used in all calculations because it was more conservative than the lowest beef shank yields (3.26) reported by Griffin et al. (1989). Assuming an average carcass weight of 317.8 kg, each carcass would yield 8.63 kg of shank meat. Because reporting services do not quote prices for shanks, we used a price for shank meat quoted by IBP Inc. on September 24, 1993. The IBP quotes for 70, 80, 90, and 95% lean were also used because they were within \$.05 of the prices quoted in other sources for that day. All shank and lean prices used for calculation were within the range of prices for the first 9 mo of 1993. Lean-point value was calculated by dividing the price per kilogram by the percentage of lean; thus, if 70% lean were \$1.00 per kg, the lean-point value would be 1.00/.70 = \$1.42 (see Table 2). Lean-point value is the value of fat-free lean; this concept is used in the value calculations of this paper because the marketplace values very lean (<5% fat) meat more highly on a lean-point basis than fatter “lean meat” (Brester et al., 1993). Thus, when the Baader decreases the fat content of shanks, value is added.

Statistical Analysis. Data were analyzed for the three replications, by analysis of variance for a completely randomized design, and mean separation was achieved using Fisher’s LSD test (SAS, 1990).

Results and Discussion

Yields and Composition. To achieve lean meat yields of 85% or higher, shanks had to be passed through the Baader twice. Two passes are normal industry practice (M. King, personal communication).

Yields for the Baader separator are shown in Table 1. Total lean yield (first + second passes) was more than 92%, and separated sinew yield averaged 6.8% regardless of which drums were used. These yields are similar to industry yields of lean meat from desinewed shanks (M. King, personal communication). First-pass lean yields for 5- and 3-mm drums were 73 and 66%, respectively. First-pass yields may be economically important as the demand for leaner raw material increases (Brester et al., 1993). First-pass lean from a 5-mm drum (7.1% fat) was 28% leaner, and first-pass lean from a 3-mm drum (5.8% fat) was 41% leaner than whole shank. Because low-fat meat is worth more than high-fat meat on a lean-point basis (Brester et al., 1993), this reduction in fat content may have an economic impact for beef processing. Collagen contents of first-pass leans were 10.5 and 7.6 mg/g for 5- and 3-mm drums, respectively, which are reductions of 26 and 46%, respectively, compared with whole shanks. This collagen reduction corresponds with the fat reduction, indicating that fat preferentially remains with the collagen matrix of the shank. Collagen reduction also may improve palatability and functionality in finished products (Gillett et al., 1976; Cross et al., 1978). Lean from shanks had a higher pH (5.99 to 6.15) than sinew (5.65 to 5.72). Yield of desinewed lean from the Baader (avg 92.6%) was higher than those from machines (71 to 87%) studied by Gillett et al. (1976).

Added Value. Table 2 shows how desinewing can add value to beef shanks. Shanks from one carcass were worth \$21.83. Sinew can be used in meat products (Hunt and Campbell, 1992; Eilert et al., 1993), so it also has value. If all the lean and sinew were used in meat products, the Baader with a 5-mm drum could add $2.01 to carcass value. Using a 3-mm drum on the first pass, 94% lean (6% fat) meat can be produced from beef shanks, enhancing value $1.19 more per carcass than desinewing with a 5-mm drum. This is because very lean meat is more highly valued on a lean-point (value per unit of fat-free lean) basis than fatter meat (Brester et al., 1993). In this study, the lean-point value of the first-pass lean with a 3-mm drum was increased by $.76/kg over lean from whole shank and by $.30/kg over lean obtained with only the 5-mm drum. Therefore, with optimal utilization, the Baader desinewer could add more than $3.00 to the value of a beef carcass. This estimate of added value does not include the additional reduction in labor that occurs from eliminating any need to hand-trim the large tendons at the end of shanks after they are removed from the bone. It also does not include initial costs of two Baader machines in series (1 machine for each pass) and maintenance; however, the initial cost and maintenance is more than covered by labor reduction (T. C. Calhoun, personal communication).

Implications

These results demonstrate that Baader processing can improve quality and add value to beef shanks by removing the sinew and increasing the lean percentage of the desinewed lean. Because sinew is now approved as a sausage ingredient, no component is lost in the Baader process, and the value of the processed parts is considerably greater than the value of the whole shanks. Application of this technology has potential to increase beef carcass value by more than $3.00.

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