Influence of Wholesale Lamb Marketing Options and Merchandising Styles on Retail Yield and Fabrication Time[1]

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ABSTRACT: Lamb carcasses (n = 94) from five packing plants, selected to vary in weight class and fat thickness, were used to determine retail yield and labor requirements of wholesale lamb fabrication. Carcasses were allotted randomly according to weight class to be fabricated as whole carcasses (n = 20), three-piece boxes (n = 22), or subprimals (n = 52). Processing times (seconds) were recorded and wholesale and retail weights (kilograms) were obtained to calculate retail yield. Subprimals were fabricated into bone-in retail cuts or boneless or semi-boneless retail cuts. Retail yield for subprimal lamb legs decreased from 85.3 ± .6% for bone-in to 68.0 ± .7% for a completely boneless retail product. Correspondingly, processing times increased from 126.1 ± 5.4 s to 542.0 ± 19.2 s for bone-in and boneless legs, respectively. For all subprimals, retail yield percentage tended to decrease and total processing time increase as cuts were fabricated to boneless or semi-boneless end points compared with a bone-in end point. Percentage retail yield did not differ ($P > .05$) among whole carcass, three-piece box, and subprimal marketing methods. Total processing time was shorter for subprimals ($P < .05$) than for the other two marketing methods.

Key Words: Lamb (Meat), Retail Marketing, Time Allocation

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Introduction

Lamb is sold to the consumer principally as bone-in retail cuts with limited external fat cover (Harris et al., 1990). Wholesale lamb can be purchased as a whole carcass or vacuum-packaged and boxed as a three-piece carcass or as subprimal cuts. Although yields of lamb subprimals have been investigated (Garrett et al., 1990, 1992), little information exists for different retail merchandising fabrication styles. Consumers have welcomed the added convenience and preparation ease offered by boneless retail cuts of other meats. The purpose of this study was to investigate salable yields and fabrication labor requirements for retail cuts from different wholesale lamb purchasing options. The resulting data will be used to develop the Lamb CARDS (Computer Assisted Retail Decision Support) software package.

Materials and Methods

Product Selection. Ninety-four lamb carcasses were obtained from five packing plants representing different geographical regions of the United States. Carcass characteristics (Table 1) indicate a wide variation in the sample, which was selected to represent the variation in weight class and fat thickness seen in the lamb industry (Tatum et al., 1989). Carcasses were shipped to the E. M. Rosenthal Meat Science and Technology Center at Texas A&M University and were allotted to whole carcass, three-piece box, or subprimal fabrication style so that all weight classes were represented within each style. Cutting procedures for each fabrication style were developed with input from the Retail Advisory Committee and staff from the National Live Stock and Meat Board, along with representatives of the American Lamb Council, Texas State Technical College, and Texas A&M University. Universal Product Code (**U.P.C.**) descriptions (NLSMB, 1995a, 1995b) were used to identify the retail cuts obtained from each cutting style.

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Table 1. Carcass characteristics for lambs (n = 94) used

Characteristic	Mean	SE	Minimum	Maximum
Carcass weight, kg	28.4	.5	19.3	43.6
USDA yield grade	3.2	.2	1.4	8.4
Fat thickness, cm	.74	.05	.25	2.03
Body wall thickness, cm	2.39	.08	.89	4.57
Longissimus muscle area, cm^2	13.9	.3	7.4	20.0

Retail Fabrication. A simulated retail cutting room was constructed in the Rosenthal Meat Science and Technology Center as detailed in Garrett et al. (1991). The design of the room closely simulated an "average" retail store meat department.

Lambs (n = 20) fabricated as whole carcasses produced neck slices (U.P.C. 2926), arm chops (U.P.C. 2918), blade chops (U.P.C. 2922), lamb shank (U.P.C. 3010), breast (U.P.C. 3002), rib chops (U.P.C. 2948), rib roast (U.P.C. 2942), loin chops (U.P.C. 2955), sirloin chops (U.P.C. 2983), short cut leg (U.P.C. 2967), lamb breast extra trim "Denver style" (U.P.C. 3007), shoulder ribs (U.P.C. 2931), and lamb for stew (U.P.C. 3016). Lambs (n = 22) fabricated as three-piece boxes yielded neck slices (U.P.C. 2926), arm chops (U.P.C. 2918), blade chops (U.P.C. 2922), lamb shank (U.P.C. 3010), breast (U.P.C. 3002), rib chops (U.P.C. 2948), rib roast (U.P.C. 2942), loin chops (U.P.C. 2955), sirloin chops (U.P.C. 2983), American style leg (U.P.C. 2966), lamb breast extra trim "Denver style" (U.P.C. 3007), shoulder ribs (U.P.C. 2931), and lamb for stew (U.P.C. 3016).

Lamb shoulders (n = 52) similar to Institutional Meat Purchase Specifications (**IMPS**) #207 (USDA, 1975; NAMP, 1992) were fabricated into three different cutting styles. Style #1 yielded arm chops (U.P.C. 2918), blade chops (U.P.C. 2922), and shoulder ribs (U.P.C. 2931). Style #2 produced neck slices (U.P.C. 2926), boneless shoulder roast (U.P.C. 2929), and shoulder rib (U.P.C. 2931). Style #3 produced neck slices (U.P.C. 2926), shoulder eye roast boneless (U.P.C. 2932), outside shoulder roast boneless (U.P.C. 2934), and shoulder rib (U.P.C. 2931).

Lamb racks (n = 52) similar to IMPS #204 were fabricated into four different cutting styles. Style #1 generated rib chops (U.P.C. 2948) and lamb breast extra trim "Denver style" (U.P.C. 3007). Style #2 was fabricated into a French roast (U.P.C. 2945). Style #3 produced a ribeye roast bone-in Frenched style (U.P.C. 2946). Style #4 yielded lamb breast extra trim (U.P.C. 3007) and ribeye roll (U.P.C. 2947).

Lamb loins (n = 52) similar to IMPS #232 were fabricated into three different cutting styles. Style #1 yielded loin chops (U.P.C. 2955). Style #2 produced double bone-in chops (U.P.C. 2959). Style #3 was fabricated into a double boneless roast (U.P.C. 2958).

Lamb legs (n = 52) similar to IMPS #233 were fabricated into four different cutting styles. Style #1 was cut into sirloin roast (U.P.C. 2981), center roast (U.P.C. 2979), and shank half (U.P.C. 2969). Style #2 produced sirloin chops (U.P.C. 2983), center leg slices (U.P.C. 2980), hind shank (U.P.C. 2978), and lamb for stew (U.P.C. 3016). Style #3 was fabricated into shank (U.P.C. 2978) and boneless leg (U.P.C. 2973). Style #4 produced hind shank (U.P.C. 2978), top sirloin, tip roast (U.P.C. 2989), top roast (U.P.C. 2985), and bottom roast (U.P.C. 2987).

In addition to the above-mentioned retail cuts, fat trimmings, lean trimmings, and bone were generated from each subprimal during cutting.

Retail Yield Data. Weights were obtained on each lamb carcass, three-piece box, and subprimal before any cutting operations. Data, including weight in kilograms and number of pieces, were collected after the processing operation of trimming and traying. Weights of retail cuts, fat trimmings, lean trimmings, and bone were recorded. All weights were totaled and reconciled to within 99% of the starting weight of each carcass, three-piece box, or subprimal. Cutting loss and retail yield were calculated according to Lorenzen et al. (1996).

Timing Data. During the retail cutting operation, times were collected by non-cutting observers using hand-held stop watches. Times were recorded to the nearest .01 s. The meat cutting operation was divided into several steps with separate time data collection for each step. The actual meat cutting function was divided into four phases for lambs fabricated as carcasses: breaking (fabricating into wholesale cuts: legs, loins, racks, and shoulders), retail cutting (producing the retail products as described previously), trimming (reducing the external fat to no more than .32 cm), and traying (placing the individual retail cuts on plastic foam trays), and upgrading lean trim for ground lamb. For lambs fabricated as three-piece boxes, the meat cutting function was divided into five phases: box to table, breaking, retail cutting, trimming and traying, and upgrading lean trim. The meat cutting function for lamb subprimals was divided into six functions: box to table, splitting (bisecting the subprimal down the vertebral column), pretrimming (trimming the fat to produce a uniform layer no more than .64 cm thick), retail cutting, trimming and traying, and upgrading lean trim.

Statistical Analysis. Mean percentage yields of retail cuts and timing information and standard errors from

Table 2. Mean retail yields (%), processing times (s) and SE for lambs (n = 20) fabricated as carcasses

U.P.C.[a]	Retail cut	Mean	SE
Retail yield		%	
2926	Neck slices	2.2	.1
2918	Arm chops	4.2	.2
2922	Blade chops	9.3	.3
2931	Shoulder rib	1.2	.1
3010	Lamb shank	3.5	.1
3002	Breast	2.9	.1
3007	Lamb breast extra trim	3.1	.1
2983	Sirloin chops	4.4	.2
2955	Loin chops	5.8	.2
2948	Rib chops	2.6	.1
2942	Rib roast	3.0	.1
3016	Lamb for stew	.5	.1
2967	Leg, short cut, sirloin off	18.8	.5
	Lean trimmings	10.7	.6
	Fat trimmings	17.8	1.9
	Bone	9.0	.3
	Total retail yield	72.2	1.7
Processing time		s	
	Breaking	217.0	12.5
	Cutting	415.9	37.7
	Trim and tray	1,244.0	45.6
	Lean trim	454.1	31.7
	Total time	2,331.0	92.0

[a]U.P.C. = Universal Product Code.

lamb carcasses, three-piece boxes, and subprimals were computed within purchasing option and cutting style using SAS (1991). When analysis of variance dictated, Tukey's mean separation procedure (Ott, 1988) was used to determine differences in retail cut yield or timing segment across cutting style within purchasing option.

Results and Discussion

Means and standard errors for retail yields and processing times for lambs fabricated as carcasses or three-piece boxes are presented in Tables 2 and 3, respectively. Both purchasing specifications produced similar total percentage retail yields (72.2 and 72.9%, respectively). Total processing times were similar, differing by only 1.2 min. These similarities would be expected because both of the purchasing specifications were fabricated in a manner that differed only in the way that the leg was processed. In addition, when lamb is purchased in a three-piece box, all the portions of the carcass are received in the box.

Processing information for the different fabrication styles of lamb shoulders is presented in Table 4. Percentage bone was lower ($P < .05$) for fabrication style #1, which produced the highest volume of bone-in retail cuts. Style #1 had the greatest percentage of lean trimmings ($P < .05$) because the neck and region surrounding the scapula-humerus joint were boned out. Cutting time increased progressively ($P < .05$) as styles involved more knife work to prepare boneless cuts. Processing time spent in the trim and tray and lean trim segments was greatest ($P < .05$) for style #1; this increase in time was indicative of fabrication styles that produced a greater number of retail cuts. Fabrication style #3 had the longest total time ($P < .05$), which was due to increased cutting time ($P < .05$) required for this fabrication method.

Information relating to retail yields and processing times for lamb racks is presented in Table 5. As fabrication style dictated fewer bone-in cuts, total retail yield decreased ($P < .05$). Decrease in percentage retail yield can be attributed to an increase in percentage bone for both styles #3 and #4. The timing segments of box to table, splitting, and pretrimming were not affected ($P > .05$) by fabrication style. Overall, roasts took more time ($P < .05$) in the cutting segment and less time ($P < .05$) in the trim and tray segment than the traditional method of fabrication into chops. In addition, more time ($P < .05$) was spent increasing the value of the lean trimmings in styles #3 and #4; this was due to the greater percentage of lean trimmings produced by these styles ($P < .05$) compared to the other fabrication styles.

Mean retail yields and processing times for lamb loins are presented in Table 6. The differences ($P < .05$) in retail yields between the fabrication styles

Table 3. Mean retail yields (%), processing times (s), and SE for lambs (n = 22) fabricated as three-piece boxes[1]

U.P.C.[a]	Retail cut	Mean	SE
Retail yield		%	
2926	Neck slices	2.3	.1
2918	Arm chops	4.0	.2
2922	Blade chops	9.2	.3
2931	Shoulder rib	1.1	.1
3010	Lamb shank	3.5	.1
3002	Breast	2.5	.1
3007	Lamb breast extra trim	3.1	.1
2983	Sirloin chops	4.5	.2
2955	Loin chops	6.1	.2
2948	Rib chops	2.7	.1
2942	Rib roast	3.3	.1
3016	Lamb for stew	.7	.1
2966	Leg, American style	18.8	.3
	Lean trimmings	11.2	.5
	Fat trimmings	16.8	1.6
	Bone	9.6	.3
	Total retail yield	72.9	1.4
Processing time		s	
	Box to table	34.9	5.3
	Breaking	109.1	6.6
	Cutting	429.4	26.7
	Trim and tray	1,241.0	72.4
	Lean trim	445.3	26.9
	Total time	2,259.6	108.0

[a]U.P.C. = Universal Product Code.

Table 4. Mean retail yields (%) and processing times (s) ± SE for different fabrication styles of lamb shoulders

U.P.C.[a]	Retail cut	Style #1 (n = 52)	Style #2 (n = 52)	Style #3 (n = 52)
		%		
Retail yield				
2926	Neck slices	—	10.7 ± .3	10.7 ± .3
2918	Arm chops	19.0 ± .5	—	—
2922	Blade chops	38.4 ± .6	—	—
2931	Shoulder rib	4.8 ± 1	5.1 ± .1	5.1 ± .1
2929	Shoulder rst., bnls.[b]	—	56.1 ± .5	—
2932	Shoulder eye roast, bnls.[b]	—	—	14.7 ± .3
2934	Outside shoulder roast, bnls.[b]	—	—	35.5 ± .5
	Lean trimmings	13.5^{c} ± .5	3.8^{e} ± .4	6.8^{d} ± .5
	Fat trimmings	16.5^{cd} ± .8	15.6^{d} ± .6	18.5^{c} ± .7
	Bone	7.2^{d} ± .3	8.4^{c} ± .2	8.4^{c} ± .2
	Total retail yield	75.7^{c} ± .7	75.7^{c} ± .5	72.8^{d} ± .6
		s		
Processing time				
	Box to table	13.6 ± .2	13.8 ± .2	13.8 ± .2
	Splitting	5.6 ± .1	5.4 ± .1	5.4 ± .1
	Pretrim	15.4 ± 1.4	19.1 ± 1.8	19.1 ± 1.8
	Cutting	48.4^{e} ± 2.0	253.3^{d} ± 7.9	333.7^{c} ± 10.4
	Trim and tray	120.0^{c} ± 6.2	21.1^{d} ± 2.2	24.2^{d} ± 2.2
	Lean trim	91.7^{c} ± 5.7	17.2^{d} ± 2.2	23.5^{d} ± 2.6
	Total time	294.6^{d} ± 13.1	329.8^{d} ± 8.6	419.6^{c} ± 12.8

[a]U.P.C. = Universal Product Code.
[b]bnls. = boneless.
[c,d,e]Means within a row lacking a common superscript differ ($P < .05$).

Table 5. Mean retail yields (%), processing times (s) ± SE for different fabrication styles of lamb racks

U.P.C.[a]	Retail cut	Style #1 (n = 35)	Style #2 (n = 25)	Style #3 (n = 24)	Style #4 (n = 20)
		%			
Retail yield					
2948	Rib chops	46.3 ± 1.0		—	—
3007	Shoulder rib	13.4 ± .5		—	13.9 ± .5
2945	French roast	—	48.2 ± .9	—	—
2946	Ribeye roast, bone-in Frenched style	—		30.8 ± .7	—
2947	Ribeye roll	—		—	21.4 ± .5
	Lean trimmings	9.1^{d} ± .5	10.7^{d} ± .5	22.2^{b} ± .9	16.0^{c} ± .9
	Fat trimmings	22.5^{c} ± 1.3	24.4^{bc} ± 1.3	28.2^{b} ± 1.6	27.8^{bc} ± 1.6
	Bone	7.9^{d} ± .6	16.2^{c} ± .6	18.5^{c} ± .6	21.2^{b} ± .8
	Total retail yield	68.8^{b} ± 1.1	58.8^{c} ± 1.1	52.9^{d} ± 1.3	51.3^{d} ± 1.2
		s			
Processing time					
	Box to table	16.5 ± .2	16.7 ± .2	16.6 ± .2	16.7 ± .2
	Splitting	4.6 ± .2	4.7 ± .2	4.8 ± .2	4.8 ± .3
	Pretrim	1.7 ± .8	2.8 ± 1.0	2.9 ± 1.1	1.8 ±. 9
	Cutting	36.1^{d} ± 3.6	129.7^{b} ± 13.1	122.6^{b} ± 10.0	68.7^{c} ± 6.4
	Trim and tray	126.4^{b} ± 7.5	65.5^{c} ± 11.7	4.8^{d} ± 1.4	16.1^{d} ± 2.5
	Lean trim	55.5^{c} ± 4.4	40.5^{c} ± 5.0	84.1^{b} ± 4.5	81.7^{b} ± 7.3
	Total time	240.7^{bc} ± 12.2	259.8^{b} ± 17.4	235.7^{bc} ± 15.0	189.7^{c} ± 10.0

[a]U.P.C. = Universal Product Code.
[b,c,d]Means within a row lacking a common superscript differ ($P < .05$).

Table 6. Mean retail yields (%) and processing times (s) ± SE for different fabrication styles of lamb loins

U.P.C.[a]	Retail cut	Style #1 (n = 17)	Style #2 (n = 18)	Style #3 (n = 17)
		%		
Retail yield				
2955	Loin chops	53.7 ± 2.1	—	—
2959	Double bone-in chops	—	50.5 ± 1.8	—
2958	Double boneless roast	—	—	32.9 ± 1.7
	Lean trimmings	14.4 ± 1.0	14.5 ± 1.4	15.6 ± 1.5
	Fat trimmings	29.2 ± 2.3	32.7 ± 1.8	36.1 ± 2.6
	Bone	2.0[c] ± .2	1.5[c] ± .2	15.2[b] ± .9
	Total retail yield	68.1[b] ± 2.3	65.0[b] ± 1.8	48.6[c] ± 2.0
		s		
Processing time				
	Box to table	10.6 ± .4	10.5 ± .4	10.4 ± .4
	Splitting	4.4 ± .3	—	—
	Pretrim	31.8[c] ± 9.6	74.9[b] ± 10.0	75.3[b] ± 13.5
	Cutting	52.2[c] ± 7.2	33.8[c] ± 5.3	270.3[b] ± 17.6
	Trim and tray	240.8[b] ± 11.6	154.4[c] ± 9.7	1.4[d] ± .3
	Lean trim	86.9 ± 5.5	74.7 ± 7.7	73.1 ± 9.7
	Total time	426.7[b] ± 18.0	348.3[c] ± 12.4	430.4[b] ± 26.3

[a]U.P.C. = Universal Product Code.
[b,c,d]Means within a row lacking a common superscript differ ($P < .05$).

Table 7. Mean retail yields (%), processing times (s) ± SE for different fabrication styles of lamb legs

U.P.C.[a]	Retail cut	Style #1 (n = 35)	Style #2 (n = 35)	Style #3 (n = 35)	Style #4 (n = 35)
		%			
Retail yield					
2981	Sirloin	35.7 ± .6	—	—	—
2979	Center roast	27.0 ± .6	—	—	—
2969	Shank half	19.1 ± .5	—	—	—
2983	Sirloin chops	—	13.1 ± .4	—	—
2980	Center leg slices	—	27.1 ± .5	—	—
2978	Hind shank	—	5.8[b] ± .2	9.5[a] ± .2	9.5[a] ± .2
3016	Lamb for stew	—	6.7 ± .5		—
2973	Boneless leg	—	—	57.1 ± .6	—
	Top sirloin	—	—	—	6.3 ± .2
2989	Tip roast	—	—	—	11.0 ± .2
2985	Top roast	—	—	—	11.2 ± .2
2987	Bottom roast	—	—	—	4.9 ± .1
	Lean trimmings	3.6[d] ± .2	17.6[c] ± .6	4.7[d] ± .2	25.1[b] ± .6
	Fat trimmings	8.8[c] ± .7	11.5[b] ± .6	9.1[c] ± .5	12.3[b] ± .7
	Bone	5.6[d] ± .2	17.7[c] ± .4	19.6[b] ± .3	19.6[b] ± .3
	Total retail yield	85.3[b] ± .6	70.3[c] ± .6	71.2[c] ± .6	68.0[d] ± .7
		s			
Processing time					
	Box to table	20.1 ± .4	20.1 ± .4	20.0 ± .4	20.0 ± .4
	Splitting	8.8 ± .1	8.8 ± .1	8.8 ± .1	8.8 ± .1
	Pretrim	35.4[c] ± 2.1	41.2[c] ± 2.5	40.3[c] ± 2.1	67.7[b] ± 6.7
	Cutting	18.4[e] ± 1.9	114.6[d] ± 5.9	182.0[c] ± 9.1	310.1[b] ± 16.5
	Trim and tray	31.6[d] ± 2.2	151.3[b] ± 7.2	21.3[d] ± 2.2	67.7[c] ± 4.4
	Lean trim	11.9[d] ± 1.8	125.8[b] ± 8.2	26.8[d] ± 2.6	67.8[c] ± 4.8
	Total time	126.1[e] ± 5.4	461.7[c] ± 16.0	299.2[d] ± 11.6	542.0[b] ± 19.2

[a]U.P.C. = Universal Product Code.
[b,c,d,e]Means within a row lacking a common superscript differ ($P < .05$).

reflect the differences ($P < .05$) in percentage bone removed. Less pretrim time ($P < .05$) was spent for fabrication style #1, which had a lower numerical percentage of fat trimmings than the other two styles. Fabrication style #3, which was the only boneless fabrication style for loins, required the longest ($P < .05$) cutting time. Trim and tray time decreased ($P < .05$) as the total number of retail pieces decreased. Style #2 took the least amount of total time to process ($P < .05$); this was due to the additive effect of low cutting and trim and tray times.

Lamb leg retail yield and processing time data are presented in Table 7. Fabrication style #4 had the greatest percentage of lean trimmings ($P < .05$). The two boneless fabrication styles (#3 and #4) had a greater percentage of bone ($P < .05$) than the other fabrication styles. Total retail yield decreased ($P < .05$) as fabrication styles became increasingly more boneless. Conversely, cutting time increased ($P < .05$) as the amount of bone in the final retail product decreased. Trim and tray was longest ($P < .05$) for style #2, which had the greatest number of retail pieces. Total time was greatest ($P < .05$) for fabrication style #4 due to the cutting time segment, followed by style #2 due to the trim and tray segment, followed by style #3, which had a greater cutting time ($P < .05$) than style #1.

When subprimal fabrication styles for shoulder style #1, rack style #1, loin style #1, and leg style #2 were pooled, a comparison of similar retail cuts with lambs fabricated as carcasses or three-piece boxes could be made. Total retail yield for carcasses ($n = 20$), three-piece boxes ($n = 22$), and subprimals ($n = 6$) were 72.2, 72.9, and 68.5%, respectively, and did not differ ($P > .05$). Total processing times for carcasses, three-piece boxes, and subprimals were 2,331.0, 2,259.6, and 1,400.7 s, respectively, with subprimals taking a shorter ($P < .05$) time to process. No difference in retail yield and only a slight advantage in processing time would indicate that decisions retailers make on purchasing lamb should be based on the desired retail product mix.

We conclude that retail yield decreases and total processing time increases for more boneless or semi-boneless vs traditional bone-in fabrication methods when a comparison is made within subprimal. This agrees with Garrett et al. (1992), who reported that retail yield decreased, regardless of yield grade, when retail cuts were fabricated to boneless end points. When wholesale purchasing options were compared, total retail yield did not differ ($P > .05$). Subprimals had a shorter ($P < .05$) total processing time than lambs fabricated as whole carcasses or three-piece boxes.

Implications

Results from this study serve as the data base for the Lamb CARDS software package. Lamb CARDS can be used to quantify the relationship between retail yields and labor requirements so that retail prices for lamb reflect both areas in determining the potential profitability of lamb to be sold to the consumer. Increasing time required to perform boneless or semi-boneless processing procedures will increase retail price of the products due to increased labor costs. However, these retail cuts may be convenient and appealing to consumers who may be willing to pay higher prices for such features.

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