RIB AND LOIN YIELD AND SHEAR FORCE OF FROZEN GOAT MEAT FROM AUSTRALIA AND THE UNITED STATES

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Abstract – The research was conducted to determine yields of primal ribs and loins of frozen and thawed goat carcasses from U.S. and Australian origin (n=30 from each source). Warner-Bratzler shear force values were determined on 6 rib chops and 6 loin chops from each carcass. Chops from Australian goat carcasses were more tender than chops from U.S. goat carcasses. Rib chops were more tender than loin chops from each source, Australian or U.S. goat carcasses.

I. INTRODUCTION

Goat meat is a source of protein for much of the world. Increased quantities of frozen goat meat are imported into the U.S. from Australia and New Zealand to meet the demand for goat meat, primarily from ethnic consumers. Imports of goat meat, usually frozen from Australia and New Zealand, have increased over the past two decades with more than 15,832,543 kg imported into the U.S. in 2012 [1]. Type of cut accounted for 68% of the variation in respondent preferences, followed by product source, price and color that accounted for 15%, 14% and 3% of consumer preference, respectively, in an online survey of 2,000 goat meat consumers. This implies that the type of cuts offered for sale is the most important attribute among goat meat consumers, with a demonstrated preference for cuts, chops and cubes [2].

There are differences in palatability of meat that vary with the location on the carcass. Trained sensory panels gave similar tenderness scores when determining palatability of lamb from young animals, but rib chops were rated higher than loin chops from older sheep [3]. Leg steaks from young Angora and Spanish goats were rated less juicy and tender than loin chops by trained sensory panelists [4]. This might be because rib portions had higher levels of total lipids than loin chops from young and older lambs [5] and from market weight pigs [6].

Most of the goat meat from Australia is in frozen form. Freezing meat prolongs the shelf life, but freezing and thawing processes affect the quality of the meat. Tenderness of meat as peak force is generally thought to increase with freezing and thawing [7], but this tenderizing effect may be negated when the meat is sufficiently aged before freezing [8].

The present study was designed to compare primal cut yields and Warner-Brazler shear force of rib and loin chops from representative frozen Australian goat carcasses and from representative U.S. kid goats after frozen storage of the carcasses. The hypotheses were that frozen U.S. goat meat carcasses had higher percentages of rib and loin primal cuts than frozen Australian goat carcasses and that rib and loin chops from frozen U.S. goat carcasses would have lower Warner-Bratzler shear force measurements than rib and loin chops from frozen Australian goat carcasses.

II. MATERIALS AND METHODS

Kid goats (n=30) were purchased from local domestic sources and live measurements were taken before humane slaughter. After overnight chilling at 4°C, carcasses were measured and conformation evaluated before splitting into left and right sides. Left sides were wrapped in layers of a 0.6 mil PVC barrier film before being frozen in a -33°C blast freezer. Frozen Australian goat carcasses (n=30) were obtained from a commercial vendor and transferred to a -33°C storage freezer upon receipt. The carcasses were chilled for approximately 8 hours (4°C), then blast frozen for approximately 24 hours at -30°C before being loaded into shipping containers at -21°C. Transit time from Australia to Philadelphia port of entry was 4 weeks [9].

After 6 weeks in frozen storage, all sides or carcasses were removed from the freezer and hung on hooks from hock joints in a 3°C

storage cooler for 3 days. Imported carcasses were weighed, split in half, and all thawed carcasses were separated into loins, racks, ribs, shanks, and whole leg primal cuts. Racks were cut at the 4th thoracic vertebrae and separation of loins was behind the last rib to the pelvic bone. Loin and rack primal cuts were sliced (1.25 cm) into loin chops and rib chops that were weighed before cooking on open electric grills to 70°C. After cooking, the rib and loin chops were re-weighed and chilled to 10°C. Cores were removed for Warner-Bratzler shear force using a Texture Technologies TI-HDi. An average shear value for rib chops and for loin chops for each carcass was obtained using the values of cores from 6 rib chops and 6 loin chops from each goat carcass.

Prior to data analysis, all weights were converted to percent of side weight for comparative purposes. Primal cut yield data were analyzed by proc gchart (y-axis=percent rack/loin x-axis=side weight) to determine the relation between percent rack or percent loin with side weight. Warner-Bratzler shear force data were analyzed using proc t-test to compare differences between tenderness of loin chops and rib chops for the entire samples (n=60) with an additional proc t-test to determine the same difference within groups (domestic was USA and imported was Australian). Differences in tenderness between loin chops and rib chops from U.S. and Australia were determined with another proc t-test with class of country and variable Warner-Bratzler shear force. Variances were unequal so the Satterthwaite values were used for the statistical tests.

III. RESULTS AND DISCUSSION

The percentages of loin primal and rack primal cuts from domestic and imported goat carcasses are in Table 1. The percentages of loin primal cuts were higher (P<0.05) than for rack primal cuts from both domestic and imported frozen carcasses. There were no differences in percentages of primal cuts with source of the frozen carcasses. These percentages were similar to those reported previously for domestic and imported goat carcass cut yields [10].

Table 1. Percentages of rib and loin primal cuts from frozen U.S. or Australian goat carcasses.

Source	Loin	Rack	Loin and rack
U.S.	15.20	9.43	24.63
Australia	15.18	9.15	24.32
Combined	15.19	9.29	24.48

Even though the percentages of rack and loin primal cuts were similar between Australian and U.S. goat carcasses, there was no correlation of thawed side weight with the percentage of loin and rack (Figure 1).

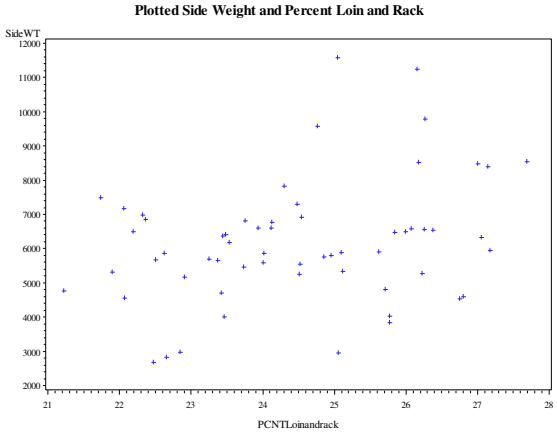

Figure 1. Scatterplot of percentage loin and rack against side weight for all frozen and thawed Australian and U.S. goat carcasses.

The Warner-Bratzler shear force mean values for the loin chops from frozen imported and domestic goat carcasses are in table 2. The shear force of loin chops from Australian carcasses was less (P<0.05) than loin chops from U.S. carcasses. The slaughter and aging times before freezing were as similar as possible for the two sources so the difference in shear force might be the rate of freezing, which will affect the ice crystal size formation and thus the amount of protein disruption upon thawing, or the length of total frozen storage time [7].

Table 2. Warner-Bratzler shear force (g) of loin chops.

Country	n	Mean	Std. Dev.	Std. Err.	Min.	Max.
Aus	30	3106.7b	941.4	171.9	1942	5284
US	30	4499.4a	1467.0	267.8	1524	7317
Difference		-1392.7	1232.6	318.2		

Means with different letters are different (P<0.05).

The frequency distribution of shear forces for the samples of loin chops from U.S. and Australian goat carcasses are in Figure 2. The loin chops from Australian carcasses tended to have a skewed distribution toward lower shear force values while there was a more normal distribution of the shear force around the mean

for chops from U.S. carcasses. The unequal variances caused the use of the Satterthwaite values for the statistical comparisons.

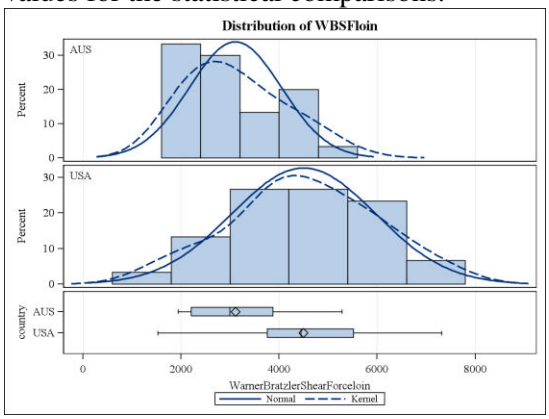

Figure 2. Frequency distribution of shear force of loin chops from frozen Australian (top) and U.S. (bottom) goat carcasses.

The Warner-Bratzler shear force mean values for the rib chops from frozen imported and domestic goat carcasses showed that, similarly for loin chops, the rib chops from Australian carcasses had lower shear force (P<0.05) than loin chops from U.S. carcasses (Table 3).

Table 3. Warner-Bratzler shear force (g) of rib chops.

Country	n	Mean	Std. Dev.	Std. Err.	Min.	Max.
Aus	30	2768.7b	709.8	129.6	1651	4314
US	30	3389.2a	1035.9	189.1	1431	5346
Differ-ence		-620.5	887.9	229.3		

Means with different letters are different (P<0.05).

The frequency distribution of shear forces for the rib chops showed that the rib chops from Australian goat carcasses also tended to have a skewed distribution toward lower shear force values while there was a more normal distribution of the shear force around the mean for rib chops from U.S. goat carcasses (Figure 3).

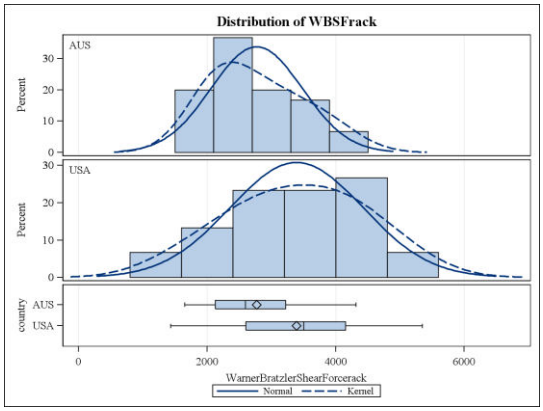

Figure 3. Frequency distribution of shear force of rib chops from frozen Australian (top) and U.S. (bottom) goat carcasses.

Because the ages of the goats were unknown, it was thought that carcass side weight might be an indicator of age and thus influence the Warner-Bratzler shear values that were measured. However, the correlation coefficient between shear force and side weight was only 0.25, with no major trend shown in the scatterplot (Figure 4).

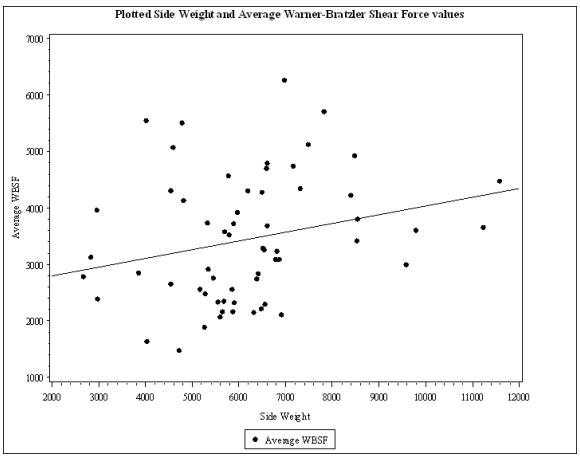

Figure 4. Scatterplot of side weight and average Warner-Bratzler shear force.

Table 4 shows the mean differences between shear force values for rib and loin chops from frozen U.S., Australian, and combined group goat carcasses. With a mean difference of 724.1, with groups U.S. and Australian combined, rib chops were more tender (P<0.0001) than the loin chops.

Table 4. Warner-Bratzler shear force (g) differences between rib chops and loin chops from frozen goat carcasses.

W-B shear force difference between rib and loin chops	U.S.	Australian	Combined
Mean	1110.2	337.9	724.1
Std. dev.	923.9	569.2	854.6
Std. err.	168.7	103.9	110.3
Min.	-664.5	-625.0	-664.5
Max.	3221.0	1151.3	3221.0

Figure 4 shows that the frequency distribution of the differences in shear force between rib chops and loin chops from all carcasses, both U.S. and Australian, was nearly normalized in appearance. This is in contrast to the non-normalized distributions of the differences in shear force between rib chops and loin chops when the frequency difference was plotted for frozen Australian (Figure 5) or frozen U.S. goat

carcasses (Figure 6). Both of these figures showed non-normal distribution of shear force differences.

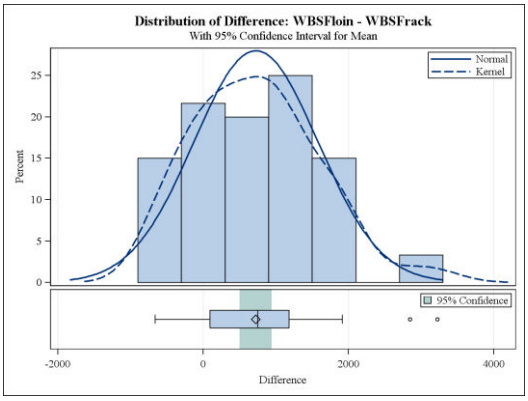

Figure 4. Frequency distribution of the difference in shear force of rib chops from frozen Australian and U.S. goat carcasses.

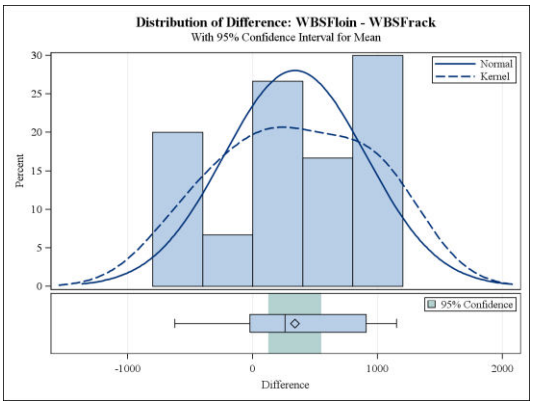

Figure 5. Frequency distribution of the difference in shear force between rib chops and loin chops from frozen Australian goat carcasses.

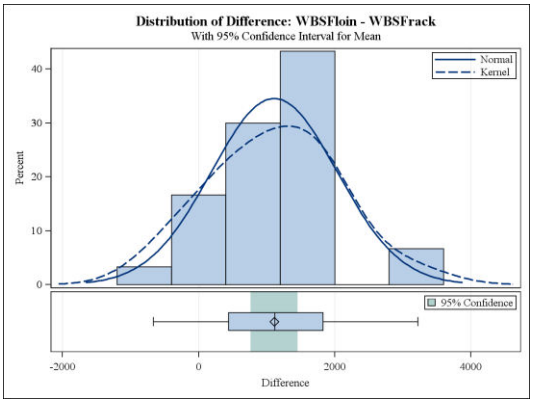

Figure 6. Frequency distribution of the difference in shear force between rib chops and loin chops from frozen U.S. goat carcasses.

IV. CONCLUSION

Rib chops and loin chops from frozen and thawed Australian goat carcasses were more tender than chops obtained from frozen and thawed U.S. goat carcasses. Rib chops were more tender than loin chops from each source of the goat carcasses.

ACKNOWLEDGEMENTS

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