USDA Goat Grant and Live Goat, Carcass, and Cut Information

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Introduction

The numbers of meat goats in the U.S. have declined since the early 2000s when the meat goat industry was the most rapidly growing livestock category, but the tonnages of imported frozen goat meat from Australian and New Zealand have continued a steady increase (Pinkerton and McMillin, 2013). The structure of the meat goat industry is very disorganized with few market studies compared with other red meat and poultry industries (Pinkerton, 1995). Production practices have not been linked with live goat traits or specific meat characteristics. Early work on branded goat meat specifications showed that ethnic consumers could not distinguish between goat meat from young animals of different sources except for meat from yearling goats that had low conformation (McMillin et al., 1998). Institutional Meat Purchase Specifications (IMPS) for goat meat (USDA, 2001) originated from some of these studies. The IMPS for other species are the basis for boxed beef primal cuts and retail cuts sold to restaurants, prisons, schools, and other institutional meat purchasers. A USDA funded project on standardized market communication for goats and goat meat resulted in publication of the internationally distributed "Meat Goat Selection, Carcass Evaluation & Fabrication Guide" (McMillin and Pinkerton, 2008).

Widespread use of IMPS standards for goat meat would require knowledge of the lean yields and palatability of goat meat from the many sources currently supplying goat meat consumers. Detailed information has been needed about each segment in the goat meat industry to promote identification of potential market and product linkages. A preliminary proposal submitted a proposal to the USDA National Institute for Food and Agriculture grant program in 2009 indicated feasibility of research in this area, but the initial effort was not funded. A subsequent proposal that added investigators from Texas, Georgia, and Alabama resulted in funding in 2010. The major purpose of the project has been to identify production practices and product traits at each segment of the meat goat industry to increase the net economic benefits and productivity of meat goat producers. Specific research objectives included the determination of purchase and consumption patterns for goat meat through a national survey of consumers; the evaluation of live, carcass, and meat traits of kid and yearling goats representative of meat goats being marketed in the U.S.; and a survey of producers on production and marketing practices needed to increase net margins and productivity within the next 5 years. This project was designed to collect and collate information from the multistate investigation to recognize relationships among the production, processing, and retail market sectors and to articulate the results to goat producer and industry audiences.

Materials and Methods

A total of 725 kid, yearling, and aged doe meat goats of differing conformation classes, sex, and breed groups to represent the goats currently being marketed in the major goat producing states were selected in 21 groups from 2009 to 2012 from private goat producers in seven states (Texas, Georgia, Louisiana, Kentucky, Tennessee, Missouri, and California) and Texas auction markets. Some goats had known breeding (453 Spanish and Boer purebred or crossbred goats, 73 kid goats with Savanna breeding, 42 Nubian or Nubian crossbred goats, 39 aged Boer crossbred does, 58 Kiko and Kiko crossbred kid goats) and 60 other goats were purchased at Texas auctions. After transport of the goats to one of three university meat laboratories (LSU, Angelo State University, Fort Valley State University) or commercial slaughter facilities, live linear measurements (Figure 1), evaluation of live conformation, and weight were obtained before humane slaughter. After 24 hours of cooler chilling, trained personnel evaluated carcasses for cold carcass weight, carcass conformation, circumference measurements of the rear legs and chest, flank color score, external fat score, and kidney, heart, and pelvic fat (McMillin and Pinkerton, 2008). One side of each carcass was fabricated into shank, hind leg, fore arm, shoulder, rib, and back primal cuts before lean muscles were obtained by manually deboning of the hind leg, fore leg, shoulder, and back. *Semimembranosus* muscles from each carcass were vacuum packaged and frozen for proximate composition (moisture, fat, protein, ash %) and evaluation of palatability by Southern University Agricultural Research and Extension Center sensory panels. Some data has been analyzed and the remaining information to be studied will elucidate relationships among the three project segments of production types; animal, carcass, and meat traits; and perceptions of meat eating quality.

Figure 1. Linear dimensions of chine length, loin length, rump length, heart girth, barrel circumference, height at withers, height at hip, chest depth, chest width, and shoulder width measured on live goats in the USDA NIFA project.

Results and Discussion

The average slaughter weight of goats in 2012 was 65 pounds (29.5 kg) in commercial slaughter (NASS, 2013), with 31 pound (14 kg) carcasses. The amount of lean meat obtained from goat is a major concern by meat goat purchasers. The yield of lean meat was based on manual separation from the major primal cuts; shanks and ribs were not deboned. Lean yield is dependent on carcass weight or size, degree of muscling (conformation), and the amounts of subcutaneous and kidney and pelvic fat. Degree of muscling in other red meat species is determined by the *Longissimus dorsi* muscle (LD) area, but it is difficult to accurately measure the area of the small LD found in most carcasses weighing 31 pounds on average. There is minimal fat covering over the LD in young kid goats unless they are overly fat over the entire carcass so fat score is an estimation of the amount of fat behind the shoulders and over the ribs of the carcasses. Conformation scores of goats in the project ranged from 1^{50} down to 3^{30} with amounts of external fat from barely distinguishable to fat scores above 3, which is indicative of a large amount of fat covering the side of the carcass. Dressing percentage (DP) is the carcass portion of the live animal, usually about 48% in this project, but DP varied by as much as 5 to 7% above or below, depending upon the type and source of the goats.

Purebred and crossbred Boer kid wether goats were obtained in consecutive years from a Texas meat goat producer. Year was a factor ($P<0.05$) for most live, carcass, and cut variables. Live slaughter weight was 25.6 kg in year 1 and 19.3 kg in year 2 ($P<0.05$) and was likely due to the higher energy supplement in the first year compared with the second year. Year was used as a covariate and breed as the independent variable in re-analysis of the data for statistically valid comparisons of all of the breed compositions.

Live and carcass conformation scores; chine, loin, and rump lengths; withers and hip heights; barrel circumferences; shoulder widths; kidney and pelvic fat estimations, flank color, and circumferences in center of hind leg, barrel, and chest were not different with breed composition. Least squares means of live and carcass traits that were different ($P<0.05$) with breed composition are in Table 1. The % Boer composition did not change the percentage of cold side weight for carcass kidney and pelvic fat, fore legs, fore trotters, fore shanks, shoulders, necks, boneless shoulders, rear legs, rear trotters, rear shanks, boneless rear legs, LD, and *Psoas major* muscles. The primal cut percentage least square means of fore legs with the trotters removed, boneless fore legs, trimmed ribs, and back differed ($P<0.05$) with breed composition are in Table 2. The table also gives the least square means for primal cut yields and boneless lean yields that varied ($P<0.05$) with percentage of Boer breed composition. This was a herd grading up to purebred so the superior purebred and 7/8 (88%) Boer crossbred goats in the herd had previously been sold as sire bucks. It has been anecdotally observed by meat goat producers, but not reported in the scientific literature, that 50% and 75% breed composition of meat goats increase growth and meat deposition compared with 88% and purebred goats.

Table 1. Live and carcass trait differences of Boer crossbred and purebred wether kid goats.

	% Boer breeding, remainder Spanish				
Variable	50	75	88	100	s.d.
Live slaughter weight, kg	24.4a	23.2ab	23.2ab	19.6b	4.1
Heart girth, cm	67.0a	64.9ab	64.4ab	60.8b	4.4
Chest width, cm	59.8a	42.6a	43.0a	36.3b	12.8
Chest depth, cm	43.3a	35.2a	35.5a	20.3b	11.9
Dressing percentage	62.4a	58.6a	59.1a	52.7b	6.0
Carcass fat score, 0 to 3	1.6a	1.3ab	1.2ab	0.8b	0.7
Leg circumference at tail, cm	46.6a	46.5a	46.3ab	42.7b	3.8
Carcass length, cm	64.2a	61.3ab	61.6ab	58.1b	4.4

Least square means in the same row with different letters are different ($P<0.05$).

Table 2. Primal cut and yield differences of Boer crossbred and purebred wether kid goats.

	% Boer breeding, remainder Spanish				
Variable, % of cold side weight	50	75	88	100	s.d.
Fore leg, trotters removed	18.3b	18.9ab	18.3b	19.8a	1.3
Boneless fore leg	10.1a	9.7ab	9.8a	8.6b	1.1
Ribs, trimmed	9.9a	8.2ab	8.3a	6.3b	2.1
Back	14.3b	15.1b	15.1b	17.4a	1.8
Primal cut yield	86.0a	84.3ab	84.3ab	79.6b	3.9
Boneless lean yield	39.7a	37.9ab	38.9ab	36.5b	2.7

Least square means in the same row with different letters are different ($P<0.05$).

Primal cut yield was positively correlated ($P<0.0002$) with live weight, chine length, heart girth, and hip height of live animals and dressing percentage, leg circumference measured at the tail, body circumference measured at the ribs, and length of the carcass from the first rib to the aitch bone. Boneless lean yield was also correlated ($P<0.0002$) with live weight, heart girth, dressing percentage, circumference of the leg at the tail, body circumference at the ribs, and carcass length.

Primal cut yield was positively correlated (P<0.0002) with percentages of fore shank, boneless fore leg, trimmed ribs, rear leg and boneless rear leg and negatively correlated (<0.0002) with percentages of the back primal cut and boneless back muscles. Boneless lean yield was positively correlated (P<0.0002) with percentage of boneless fore leg, boneless shoulder, trimmed ribs, and boneless rear leg.

Kiko kid goats and Kiko x Spanish crossbred kid goats raised on pasture or with grain were compared in another group from the project. Kiko x Spanish goats finished on grain were slightly heavier with a higher dressing percentage, percentage of leg primal cut, and lean percentage while Kiko x Spanish goats finished on pasture had slightly lower live weight, higher live and carcass conformation scores, less kidney and pelvic fat, and smaller leg circumference (Table 3).

Table 3. Live and carcass traits of Kiko kid goats and Kiko x Spanish kid goats on two finishing diets.

	Kiko	K x S	K x S
Trait		Grain	Pasture
Live weight	49.4	51.0	48.2
Live conformation	na	270	298
Dressing percentage	45.4	51.6	49.3
Carcass conformation	276	280	294
Kidney and pelvic fat	2.2	1.6	0.9
Leg circumference	17.7	16.2	15.8
Leg primal cut percentage	16.8	17.8	17.6
Lean percentage	38.1	41.1	40.6

A third group of goats in the project were also slaughtered in consecutive years, with ¾ Boer and ½ Spanish 3/8 Boer kid buck and doe goats in the first year and ½ Boer and Spanish kid buck and doe goats in the second year. A few Savannah crossbred goats were also harvested, but were of variable breed percentages insufficient for determining any trends. As shown in table 4, there were low numbers of ¾ and ½ Boer goats, but buck kid goats were heavier at slaughter and generally had larger leg circumferences, loin eye areas, % fore legs, and % boneless lean than does when there was Boer influence.

Table 4. Live, carcass, and cut traits of Boer x Spanish buck and doe kid goats.

	¾ Boer		½ Boer		½ Spanish 3/8 Boer		Spanish	
	Buck	Doe	Buck	Doe	Buck	Doe	Buck	Doe
Number	2	3	3	3	8	13	14	23
Live weight, lb.	56	33	51.7	48.3	46	34	49.6	46.2
Barrel circumference, in.	30.4	24.1	28.6	27.6	27.3	24.3	28.8	28.2
Live conformation score	230	243	270	263	266	263	258	241
Dressing percentage	47.3	41.4	51.7	59.3	45.9	43.4	50.1	54.3
Hot carcass weight, lb.	31.5	22.3	26.0	28.7	26.5	20.1	25.3	25.1
Carcass conformation score	280	257	243	237	266	274	258	255
Kidney, heart, pelvic fat, %	2.6	1.2	0.8	0.8	1.9	1.1	1.0	3.5
Fat score	1	0.8	1.2	1.3	1.2	0.8	1.1	1.5
Leg circumference, in.	17.9	14.9	16.7	16.5	16.2	14.6	16.6	16.7
Chest circumference, in.	25.1	19.9	23.4	23.5	22.8	20.2	23.0	22.4
Loin eye area, square in.	1.3	1.0	1.3	1.1	1.3	0.9	1.2	1.2
Last rib backfat, in.	0.03	0.02	0.02	0.01	0.03	0.01	0.01	0.03
Foreleg, %	15.4	15.1	15.1	14.9	15.8	15.8	15.3	14.0
Shanks, %	8.6	8.9	8.2	8.0	8.5	9.1	8.7	7.7
Ribs, %	20.3	18.1	9.0	9.7	19.5	18.7	9.8	10.2
Back, %	20.2	17.6	21.6	20.3	17.9	18.2	18.5	20.7
Rear leg, %	21.5	24.6	22.1	22.7	22.9	24.1	22.7	22.4
Trotters, %	2.4	2.9	2.3	2.6	2.8	3.1	2.5	2.2
Boneless lean, %	38.4	36.9	32.6	30.9	37.4	36.7	37.0	39.5

Conclusions

Live, carcass, and cut characteristics are highly dependent upon the source, breed, feeding, and other management practices, which validates the purpose of the USDA NIFA project. The developmental patterns of fat and muscle are different in meat goats than in other livestock meat species so conformation was measured instead of area of the *Longissimus dorsi* muscle and fat covering the side was measured instead of backfat thickness to provide estimations of muscling

and fat in the goat carcasses, respectively. Lean yields from goats in the studies were variable with source, breed, and sex, ranging from 30.9 to 41.1%. The preliminary data indicates that size of goats and carcasses appear to be more highly related to lean yields than indicators of muscling or fat. Additional results of the project will be released as the data is analyzed and relationships of live measurements, carcass characteristics, and fabrication results are determined.

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