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CHOLESTEROL LEVEL AND SENSORY EVALUATION FOR LAMBS OF VARIOUS HAIR X WOOL SHEEP CROSSES

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Abstract: The cholesterol level and sensory evaluation were compared in six lambs from each of the following genotypes: 1) St. Croix hair sheep, 2) St. Croix x wool sheep, 3) Callipyge wool x St. Croix, 4) Dorper hair sheep x St. Croix, 5) Dorper x wool, Callipyge wool x wool, and 6) wool x wool. Meat cholesterol was extracted by chloroform-methanol mixture and the cholesterol levels were determined by spectrophotometric measurement of the color generated by the reaction of cholesterol with glacial acetic acid-$FeSO_4$-H_2SO_4. A 9-point hedonic ballot was used for the sensory evaluation based on the following index: flavor, tenderness, juiciness and overall quality. Judges used a hedonic scale for evaluating samples ranging from 9 (like extremely) to 1 (dislike extremely). The general linear model (GLM) ANOVA procedures and Fisher's LSD multiple-comparison test were used to determine the difference among genotypes. Cholesterol levels (mg/100g fresh meat) were 249.6, 170.1, 73.2, 130.7, 149.2, 50.4 and 116.5, respectively. The cholesterol level in the hair sheep (St. Croix) is significantly higher ($P < 0.05$) than all the other genotypes and the lowest is in the Callipyge crosses. Significant differences ($P < 0.05$) existed between genotypes for every sensory characteristic measured. St. Croix had the highest overall sensory acceptance rating (6.8) and the lowest in the Callipyge wool x wool. As cholesterol correlates to fat composition, tissue differences may account for the differences found between crosses in the sensory evaluation data.

Key words: Cholesterol, Sensory evaluation, Sheep.

Introduction

Interest in raising hair sheep in the United States has increased dramatically in recent years (Shelton, 1991; Notter, 2000). This is partly due to the cost of shearing versus income from wool and the potential for accelerated meat production since most hair sheep have extended breeding seasons and high fecundity (Foote, 1991; Thomas, 1991). Hair sheep in the U.S. originated from the Caribbean St. Croix and Barbados Blackbelly breeds, the Katahdin composite breed and the South African Dorper (Wildeus, 1997). The Caribbean hair sheep came from African breeds. African sheep comprise the small thin-tailed West African breeds, the long-legged thin-tailed Sahelian breeds and the East and South African fat-rumpted and fat-tailed breeds (Bradford and Fitzhugh, 1983; Campbell, 1995; Notter, 2000). The Caribbean breeds were established from the thin-tailed West African stock (Bradford and Fitzhugh, 1983). The Dorper is a composite breed developed in South Africa from crosses between the Dorset and the Blackhead Persian (De Waal and Combrinck, 2000). This study compares the cholesterol level and sensory preference of various hair-wool sheep crosses maintained under feedlot conditions.

Materials and Methods

Forty-two lambs born at Utah State University during April were assigned to seven treatment groups according to genotypes. Six lambs each of the following genotypes were used for performance evaluation: Group 1, St. Croix hair sheep x St. Croix; Group 2, St. Croix x wool; Group 3, Callipyge wool sheep x St. Croix; Group 4, Dorper hair sheep x St. Croix; Group 5, Dorper x wool; Group 6, Callipyge wool x wool; and Group 7, wool x wool.

St. Croix rams and ewes were purebred. Dorper rams were purebred. Callipyge rams were 7/8 Suffolk and 1/8 Rambouillet-Dorset. Wool sheep rams were 7/8 Suffolk and 1/8 Rambouillet. Wool sheep ewes were 1/2 - 1/3 Suffolk and 1/2 to 1/4 Rambouillet. No Callipyge ewes were used because the Callipyge phenotype is not expressed when passed from the dam (Cockett et al. 1996; Charlier et al., 2001).

Lambs were penned by genotype groups and fed free choice whole barley and a commercial fattening ration that consisted of 16% protein, 20% fiber and 2% fat. Feed was weighed into each pen daily, with the weigh back of unused feed done weekly.

Lambs were weighed and body condition scored every two weeks. Target slaughter weights were 45 to 50 kg for the smaller framed genotypes (groups 1, 2, 3 and 4) and 52 to 57 kg for the larger framed genotypes (groups 5, 6 and 7). All lambs were slaughtered at the Utah State University abattoir. Carcasses were held in a drip cooler at 0.5 ˚C for 24 hr and then transported to the USU Food and Nutrition Science Meat Laboratory.

Seventy-two hours after harvest, wholesale cuts were fabricated and weighed. The leg, loin, rack and shoulder were fabricated with a trim standard of 6.35 mm external fat. All four cuts were prepared using procedures in the NAMP Meat Buyers Guide (1997). For each carcass, the leg, loin and rack were packaged and frozen at -27 ˚C for cholesterol measurement and sensory testing. A cut from the longissimus dorsi (LD) and leg were evaluated from each lamb carcass.

The cholesterol was extracted from 100 g fresh meat using the protocol developed by Folch et al. (1957) with minor modifications by others (Bohac et al., 1988). The calorimetric assay for determining the total cholesterol was based on the method developed by Searacy and Bergquist (1960) and modified by Bohac et al. (1988). Color was generated by the reaction of cholesterol with glacial acetic acid-$FeSO_4$-H_2SO_4. The color mixture had a peak absorbance at 490 nm and followed Beer's Law. The amount of cholesterol for each sample was determined by comparing the absorbance at 490 nm with appropriate standard samples as described by Searacy and Bergquist (1960). Three replicates were used for each meat sample with each replicate measured three times at 490 nm.

Matching loins and racks for each lamb group were removed from the freezer and stored in a cooler at 1 ˚C for 24 hr prior to each sensory evaluation. One hour prior to conducting a sensory panel, the LD muscle was removed and cut into 1.6 cm chops. The chops were then trimmed and portioned into two equal halves. Subcutaneous fat was removed to leave not more than 1.3 mm per chop. One leg from each lamb group was removed from the freezer 48 hours prior to sensory panel testing and stored in a cooler at 0 ˚C. The legs were prepared for roasting by removing the shank at the stifle joint and following the natural seam between the shank and heel (NAMP 3233 D, leg shank off). The pelvic bone was removed by sawing perpendicular to the femur bone 1.3 cm posterior of the pelvic bone. The legs were then oven roasted in the commercial convection oven (Hobart CN85-19) to 77 ˚C (170.6 ˚F). Legs were removed and held in a Westinghouse warming oven at 60 ˚C (140 ˚F) before serving. To insure thorough cooking, chops were portioned to 35 ± 0.02 g and cooked on racks in a commercial convection oven (Hobart CN85-19) with a preheat setting of 218.5 ˚C (425.5 ˚F). The chops were cooked to an internal temperature of 63.5 ˚C (146.3 ˚F).

Sensory training and evaluation of lamb samples were conducted for a 3-wk period. Twelve taste panels were conducted; 6 for the LD and 6 for the leg. At a given panel, each evaluator was served one half of a chop (composed entirely of LD) or a 0.6 cm slice of a leg (composed entirely of one of the following leg muscles semimembranosus, biceps femoris, or semitendinous) in a partitioned booth with a pass-through compartment. A taste panel evaluated one animal from each treatment group. A 9-point hedonic ballot was used for the sensory evaluation based on the following index: flavor, tenderness, juiciness and overall quality. Judges were asked to use a hedonic scale for evaluating samples ranging from 9 (like extremely) to 1 (dislike extremely).

Data of the cholesterol level and sensory evaluation were analyzed by the use of a general linear model (GLM) ANOVA. The Fisher's Least Significant Difference (LSD) at the 5% significant level ($P < 0.05$) was used to test the differences between group means. The Number Cruncher Statistical System (NCSS) computer software package (Hintze, 1997) was used for all statistical calculations.

Results

Cholesterol level (Table 1). Cholesterol level of hair sheep was higher than in the Callipyge crosses (Table 1). The St. Croix x Callipyge group was found to contain significantly less ($P < 0.05$) cholesterol than the St. Croix x St. Croix or the St. Croix x wool group. This phenomenon was also observed when comparing Callipyge x wool to wool x wool or Dorper x normal wool. The Callipyge crosses exhibited less cholesterol per 100 g tissue.

Sensory preference (Table 2). Significant differences existed between genotypes for every sensory characteristic measured (Table 2). Genotype had a greater impact on tenderness than on flavor or juiciness. Tenderness variations, sometimes large, were found between animals in a single genotype. Tenderness or its lack was more evident in the chop when compared to leg samples. Chop samples received more high scores and more low scores than did the leg samples.

Discussion

The cholesterol concentration of lamb in this study exhibited a broad range. The Callipyge genotypes, regardless of the cross with hair or wool, were found to have significantly lower cholesterol concentrations than the other hair or wool genotypes. This is probably due to the muscle hypertrophy that is consistent with the Callipyge trait. The non-Callipyge genotypes were found to have similar concentrations of cholesterol in their tissue when compared to each other with the exception of the St. Croix x St. Croix animals. As cholesterol correlates to fat composition of the tissue, these differences may account for the differences found between crosses in the sensory evaluation data.

The sensory analysis elucidated some distinct differences between the various genotypes. Significant differences existed between genotypes for every sensory characteristic measured. Genotype had a greater impact on tenderness than on flavor or juiciness. There is a strong correlation between sensory attributes. This means if a particular genotype received on average a low or high score for an individual attribute such as tenderness, then it usually received a low or high score for other attributes such as flavor, juiciness, and overall acceptability with respect to other genotypes. This can be easily explained in the case of the relationship between tenderness and overall acceptability because tenderness is known to be the largest determinant of consumer acceptability of meats. However, this observation becomes more interesting when comparing the respective scores for flavor and juiciness. The two organoleptic characteristics are two distinctly separate attributes but were nearly perfectly correlated with one another across genotypes. The genotypes that exhibited on average the highest scores for flavor were also found to exhibit the highest scores for juiciness in the exact same order. The hair sheep (especially St. Croix x St. Croix) were preferred to the wool sheep. The Callipyge phenomenon was clearly found less acceptable than the non-Callipyge genotypes using a trained panel for sensory analysis. Considering the sample sizes of this study, we did not attempt to extrapolate too much statistical significance from what was observed.

The sensory characteristics of flavor and juiciness showed a distinct pattern of differences not similar to the differences discussed regarding tenderness and overall acceptability. An invisible line became apparent after performing the analysis dividing the non-Callipyge crosses and the Callipyge crosses from one another. There was no significant difference between the top five scoring genotypes in the flavor and juiciness categories which were also the top performers in regards to overall acceptability and tenderness as well (St. Croix x St. Croix, Dorper x St. Croix, Dorper x wool, St. Croix x wool sheep, wool x wool sheep). Whereas, the Callipyge x St. Croix, Callipyge x wool sheep were scored significantly lower from the above genetic types and from each other with Callipyge x wool sheep exhibiting the lowest mean. Cross breeding Callipyge with St. Croix significantly improved the sensory characteristics of the meat but not enough to equal normal "meat" breed quality on overall quality.

Implications

The value of hair sheep is its overall meat quality, although it does not have as high a yield. The highest oval sensory preference was the St. Croix, however, it might be perceived by the consumer as less desirable because the cholesterol levels are higher in the meat product. The Dorper x St. Croix lamb may be a compromise to the St. Croix because it has high overall preference and a much lower cholesterol content. The Callipyge trait leads to a much larger overall yield and lower cholesterol levels, but because of its much lowered meat quality, it would rank low for consumer acceptability. Wool sheep lambs have a slightly lower overall consumer acceptability when compared to hair sheep, but the disadvantage is offset by a higher yield and a lower cholesterol level.

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Table 1. Cholesterol concentration (mg/100 g fresh meat) of finished lambs representing various hair and wool sheep breeds and their crosses.

Genome		Number of animals	Number of measurements (Triple for each sample)	Cholesterol mg/100g fresh meat
Sire	Dam			
St. Croix	St. Croix	6	18	249.6^{a}
St. Croix	Wool	6	18	170.1^{bef}
Callipyge wool	St. Croix	6	18	73.2^{c}
Dorper	St. Croix	6	18	130.7^{de}
Dorper	Wool	6	18	149.2^{bde}
Callipyge wool	Wool	5	15	50.4^{cf}
Wool	Wool	6	18	116.5^{de}

[a,b,c,d,e,f]Means in the same column with different superscripts differ ($P < 0.05$).

Table 2. Summary for sensory evaluation of chops and legs lambs representing various hair and wool sheep breeds and their crosses.

Genome		Flavor	Tenderness	Juicy	Overall
Sire	Dam				
St. Croix	St. Croix	6.7^{a}	7.2^{a}	6.4^{ab}	6.8^{a}
St. Croix	Wool	6.5^{ab}	6.2^{bc}	6.0^{ab}	6.1^{bcd}
Callipyge wool	St. Croix	6.3^{bc}	5.3^{bc}	5.9^{b}	5.9^{bc}
Dorper	St. Croix	6.7^{a}	6.6^{b}	6.4^{ab}	6.5^{abd}
Dorper	Wool	6.7^{a}	6.4^{b}	6.2^{b}	6.4^{b}
Callipyge wool	Wool	5.9^{c}	4.6^{d}	5.5^{c}	5.0^{e}
Wool	Wool	6.5^{ab}	5.8^{bc}	6.0^{ab}	5.9^{bc}

[a,b,c,d,e]Means in the same column with different superscripts differ ($P < 0.05$).