MUSCLE GROWTH RATES OF CALLIPYGE AND NORMAL LAMBS

G.D. Snowder[1], S.K. Duckett[2] and N.E. Cockett[3]

[1]USDA, ARS, U.S. Sheep Experiment Station, Dubois, Idaho 83423
[2]Department of Animal Science, Moscow, Idaho 83844
[3]Department of Animal, Dairy and Veterinary Science, Logan, Utah 84322-4700

SUMMARY

Muscle growth rates of the thoracic limb, torso and pelvic limb of normal and callipyge wether lambs between 6 and 77 kg were estimated by regression using dissected muscle data. Regression equations predicting muscle growth rates accounted for 88 to 97 % of the variation. Growth rates of thoracic limb muscles were not greatly influenced by the callipyge gene. Growth rates of longissimus and psoas major were higher in callipyge lambs (37 and 27 %, respectively). Growth rates of all pelvic limb muscles were also significantly higher in callipyge lambs; the semimembranosus grew 45 % faster in callipyge lambs. Further studies are needed to determine the muscle specificity and biological nature of the callipyge gene for enhancing lamb carcasses.

Keywords: lamb. muscle, growth, callipyge

INTRODUCTION

The ovine callipyge phenotype results in muscle specific hypertrophy and an enhanced carcass (Jackson et al., 1993; Snowder et al., 1994). The phenotypic expression of the callipyge gene deviates from normal Mendelian inheritance (Cockett et al., 1996) and is developmental with age. Muscle characterization of the callipyge phenotype has been limited to ram lambs of similar slaughter weights (54.5 kg; Jackson et al., 1997). However, characterization of individual muscle growth rates in commercial slaughter wether lambs during the developmental stage of the callipyge phenotype is unknown; and such knowledge would increase our understanding of the muscle specificity and biological nature of the callipyge phenotype. Therefore, the objective of this study was to compare muscle growth rates in callipyge and normal wether lambs.

MATERIALS AND METHODS

Animals. A serial slaughter of wether lambs weighing from 6 to 77 kg was conducted to measure muscle growth rates on normal (n=25) and callipygous (n=27) lambs. Lambs were offspring from heterozygous callipygous Columbia/Dorset rams (*CLPG/clpg*) mated to normal Columbia ewes (*clpg/clpg*). Because the callipyge phenotype cannot be distinguished with accuracy before 10 weeks of age, lambs under 25 kg were genotyped with microsatellites for the callipyge locus (Cockett et al., 1996). Lambs over 25 kg were phenotyped for the heavy muscling characteristic of the callipyge expression or for normal muscling.

Muscles. Muscles were dissected from the pelvic limb, torso and thoracic limb of the right half of each carcass within 24 hr post slaughter and chilling (1 C). Each dissected muscle or muscle group was separated from seam fat and individually weighed. Disssected pelvic limb muscles included the biceps femoris, semitendinosus, semimembranosus, adductor, the quadriceps femoris group (rectus femoris, vastus medialis, vastus intermedius, and vastus lateralis) and the gluteal group (gluteus medius, gluteus profundus and gluteus accessories). The torso muscles included the longissimus dorsi, psoas major and psoas minor. The supraspinatus and infraspinatus were dissected from the thoracic limb.

Statistical procedures. Differences in muscle growth rates were estimated by regressing the weight of individual muscles on the fixed effect of genotype (normal vs callipyge), the linear and curvilinear effects of carcass weight and the interaction of linear and curvelinear effects of carcass weight with genotype. Reduced statistical models were performed to remove nonsignificant effects ($P > .05$). Genotypic differences in growth rates of individual muscles or muscle groups were detected by significant interactions between growth rates and genotypes. Parallel lines among genotypes suggest that intercepts differ (ie., genotypes vary in initial muscle weights) but growth rates are similar.

RESULTS AND DISCUSSION

Raw means of carcass weight and individual muscles over the slaughter weight range are described in Table 1. The heavier carcass weights of the callipyge lambs were due to their higher dressing percent at similar live weights compared to normal lambs. All muscles were heavier for callipyge lambs ($P < .05$) except for the supraspinatus ($P = .26$).

The regression analyses were significant for all muscles. Model R-square values ranged from .88 to .97. The full statistical model was only significant for the adductor muscle. The interaction of the linear term for carcass weight and genotype was important for all muscles except the supra- and infraspinatus muscles Genotype of the lamb was a significant factor for all muscles except supraspinatus.

Table 1. Means of carcass and muscle weights from callipyge (n=27) and normal (n=25) wether lambs.

Trait	Normal	Callipyge	SE
Carcass weight, kg	18.3[a]	20.2[b]	1.8
Adductor, gm	145[a]	191[b]	13
Gluteus group, gm	209[a]	284[b]	23
Quadriceps group, gm	401[a]	449[b]	35
Biceps femoris, gm	272[a]	384[b]	32
Semitendinosus, gm	100[a]	129[b]	10
Semimembranosus, gm	284[a]	414[b]	32
Longissimus dorsi, gm	519[a]	723[b]	59
Psoas major, gm	86[a]	113[b]	8
Psoas minor, gm	33[a]	42[b]	3
Infraspinatus, gm	115[a]	124[b]	10
Supraspinatus, gm	113[a]	116[a]	9

The growth rates of the thoracic limb muscles (supra- and infraspinatus) were not influenced by genotype. This supports previous studies that the supraspinatus muscle does not hypertrophy in callipyge lambs (Carpenter et al., 1996; Jackson et al., 1997). Curvilinear lines for the growth rate of the infraspinatus muscle of callipyge and normal lambs were parallel but the distance between the lines was small. The larger regression intercept value for the callipyge infraspinatus suggests it is heavier earlier in life compared to normal lambs.

Growth rates of the longissimus dorsi and psoas major were influenced by lamb genotype. Psoas minor growth rates were similar but parallel for normal and callipyge lambs Callipyge lambs had a faster linear growth rate for the psoas major (27%) compared to normal lambs.

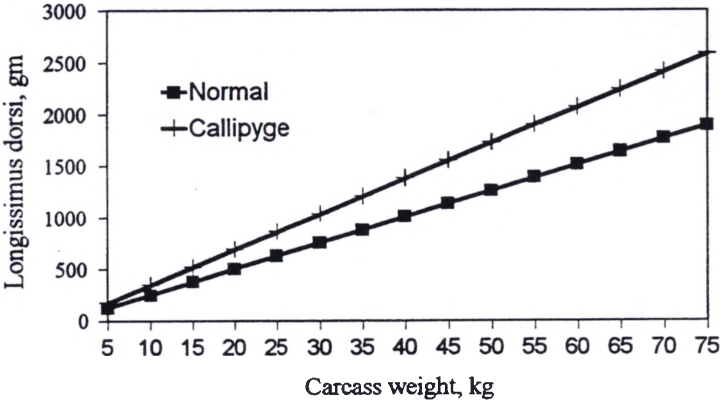

Figure 1. Linear growth rates for l. dorsi of normal (57.5 + 25.2X; R^2=.95) and callipyge (28.5 + 34.5X; R^2=.94) lambs

The longissimus muscle grew in a curvelinear manner but only the linear rate varied between genotypes (Figure 1). The increased growth rate of the callipygous longissimus muscle helps to explain the development of heavier retail and wholesale loins (Jackson et al., 1993; Snowder et al., 1994).

All of the muscles observed in the pelvic limb were influenced by the callipyge phenotype. Significant curvelinear growth rates were found for each muscle. However, the linear growth rate differed for all pelvic limbs muscles. The adductor muscle also differed among genotypes for the quadratic term of carcass weight. Differences in linear growth rates between callipyge and normal lambs were large (Table 2). Lambs with the callipyge phenotype will have growth rates for pelvic limb muscles that are 13 to 45 percent higher than those of normal lambs.

The effect of genotype on the growth rate of the adductor muscle differs from that of the other pelvic muscles. From the quadratic equation for growth rate of the adductor muscle in normal lambs ($-1.21 + 12.18x - .20x^2$; $R^2 = .92$) it is obvious that the growth rate of adductor tapers off and reaches a maximum size. However, in callipyge lambs the adductor continues to grow over the carcass weight range evaluated in this study ($13.23 + 11.08x - .08x^2$; $R^2 = .94$).

The increased growth rates of most torso and pelvic muscles contribute to our understanding of the biological effect of the callipyge gene on the lamb's phenotype. The obvious increased loin width and muscling depth in the buttocks region in callipygous lambs are related to the increased muscle growth rates. The influence of the callipyge gene affects muscle fiber type distribution, muscle cell hypertrophy (Carpenter et al., 1996) and muscle growth rate of specific muscles. Most of the muscles that are favorably influenced by the callipyge gene are economically important muscles related to consumer desirable cuts. Further research should determine the biological mechanisms controlling these muscle specific responses.

Table 2. Comparison of linear growth equations for pelvic limb muscles of normal and callipyge wether lambs

Muscle/Genotype	b_0	b_1	R^2	Contrast[1], %
Biceps femoris				
Normal	20.3	13.8	92	
Callipyge	13.3	19.0	93	38
Semitendinosus				
Normal	16.5	4.5	91	
Callipyge	17.1	5.6	92	22
Semimembranosus				
Normal	49.9	12.8	88	
Callipyge	40.7	18.5	91	45
Gluteal group				
Normal	26.1	10.0	94	
Callipyge	22.0	13.0	89	30
Quadriceps group				
Normal	70.1	18.0	94	
Callipyge	40.3	20.3	95	13

[1] Higher growth rate of callipyge lambs compared to normal lambs.

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