Muscle Distribution in Farm Animals: Comparison Between Goats and Other Farm Animals

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Abstract

Eight male goats were slaughtered at 36 kg live weight (approximately two thirds of mature weight) and dissected into individual anatomic muscles. Weights of individual muscles were then grouped into 8 functional units and compared with published data on bulls, rams and boars. There was a wide species difference in "size index" muscles. Abdominal wall index was highest in boars followed by goats, bulls and rams, the values being 108, 100, 93 and 90 respectively. Goats had higher indices in four functional units: agility, locomotion, supporting muscles and specialised functional muscles. Muscle data of goats indicated that goats are most aggressive followed by bulls, rams and pigs.

Keywords: Muscle distribution, Goats, Farm animals.

Introduction

It has been stated in many writings that, relative to other farm animals, goats are more active and more mobile. These differences in agility and mobility are likely to be related to muscle distribution. Berg and Butterfield (1976), using 8 breeds of widely different origin, found that external appearances are generally poor indicators of muscle distribution within specie. However, there is wide variation between species in muscle distribution.

Berg and Butterfield (1976) extended the theory of "function response" to account for differences in species muscle distribution. Species with different agilities and mobilities (hence different relative functions) are expected to have different muscle distribution. For example, White tail deer is 20 - 25% higher in distal muscles than cattle. The standard muscle groups which are related to function are described in detail by Berg and Butterfield (1976) who have extensively reviewed studies on muscle distribution of cattle, sheep, pigs and wild animals. However, there has been limited study on muscle distribution of goats and comparison data with other species is even more scanty. The aim of the present study was to compare muscle distribution of goats with that of other species of farm animals.

Materials and Method

Eight male Saanen goats were slaughtered at about 36 kg liveweight and dissected into individual muscles as described by May (1970) for sheep. Weights of individual muscles were then grouped into 8 standard muscle groups as follows:

1. Proximal pelvic limb - agility index;
2. Distal pelvic limb - agility index;
3. Around spinal column - size index;
4. Abdominal wall - diet bulkness index;
5. Proximal thoracic limb - agility index;
5. Distal thoracic limb - agility index;
6-8 Thoracic and neck to thoracic - weight support index;
9. Neck and thorax - neck and cranial index.

The data were then compared with published data for bulls, ram and boars (Berg and Butterfield (1976)). As it was costly to involve and slaughter bulls, rams and boars in the present

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study, data from literature for these animals that had reached the same physiological maturity (50-60%) were used according to the method of Berg and Butterfield (1976). The weight of these animals and those of goats in the present study ranged from 50 - 65% of mature weight. The data were then brought together in indices as described by Mtenga (1979).

Results and Discussion

Table 1 shows the distribution of muscles in Saanen goats into 8 standard muscles. Mean carcass weight was 19.2 kg with dressing percentage of 50.8 of live weight. The carcass contained 61.7, 24.3 and 14.1% muscle, bone and fat, respectively. As a percentage of total muscle weight, the group 1 muscles (proximal pelvic muscles) had highest proportion of muscle followed by neck and thorax to thoracic limb (muscle group 7 and 8) and the muscle around the spinal column. The lowest proportion of muscle is found within muscle group 6 (distal thoracic limb) and muscle group 2 (distal pelvic limb). This order of distribution in goats is similar to muscle distribution in other farm animals (Bryden, 1969; Berg and Butterfield, 1976).

Tables 2, 3 and 4 show the muscle distribution of rams, bulls and boar relative to male goats. In Table 5, a summary of the relative muscle weight distribution of various species is presented. It must be mentioned that comparison with published data has certain limitations and interpretation must therefore be done with caution. It has been well established by Berg and Butterfield (1976) and Mtenga (1979) that relative muscle distribution can be affected by nutritional background, relative maturity of the animal under study, slaughtering techniques and dissecting techniques.

The ranking of indices of standard muscle group III (muscle surrounding the spinal column) was bulls (82), goats (100), rams (114) and boar (114). Rams and boars seem to have similar relative weights of muscle of this group. There seems to be no explanation for species differences in this muscle. If the "size-index" theory advocated by Berg and Butterfield (1976) were applicable, the proportion of muscles surrounding the spinal column in goats should be comparable with that in sheep and to some extent, in pigs.

The "agility" index of Berg and Butterfield (1976) is supported by the present goat study in that the intrinsic distal muscle of thoracic (VII) and hind limbs (II) are a much higher proportion of total muscle than in other species. When the index figures for these two muscle groups are combined, the animals are ranked: pigs (70), bulls (79), rams (94) and goats (100). When a combined index of locomotion (standard muscle groups I, II, V and VI) is considered, the same pattern of ranking emerges, with goats showing the highest index. The present results suggest that the goat is the most mobile

Table 1: Muscle distribution of Saanen goats at 36.0-kg live weight

Standard muscle group	Mean weights (g)	Mean weight (%)
Group I	1374	23.2
Group II	289	4.9
Group III	904	15.3
Group IV	615	10.4
Group V	690	11.7
Group VI	196	3.3
Group VII - VIII	959	16.2
Group IX	881	14.9
Total muscle	5927 (61.7)[1]	100.0

[1] As percentage of carcas weight

Table 2: Muscle distribution of male goats: comparison with rams

Standard muscle group		Weight of muscle group as percentage of total muscle weight			
		male goats[a]	Rams[b]	Rams minus goats	Index[c]
I	Proximal pelvic limb	23.1	26.6	+3.5	115
II	Distal pelvic limb	4.9	4.7	-0.2	96
III	Around spinal column	15.3	17.4	+2.1	114
IV	Abdominal wall	10.4	9.4	-1.0	90
V	Proximal thoracic limb	11.7	11.2	-0.5	96
VI	Distal thoracic limb	3.3	3.0	-0.3	91
VII - VIII	Thorax and neck	16.2	13.6	-2.6	94
IX	Neck and thorax	14.9	11.2	-3.7	75

[a]Present study: Total side muscle weight 5.9kg, n = 8.
[b]Lohse (1973): Total side muscle weight 4.3 kg, n = 12
[c]Index = (Ram value x 100) / (Goat value)

Table 3: Muscle distribution of male goats: comparison with bulls

Standard muscle group		Weight of muscle group as percentage of total muscle weight			
		male goats[a]	Bulls[b]	Bulls minus goats	Index[c]
I	Proximal pelvic limb	23.1	28.4	+5.3	123
II	Distal pelvic limb	4.9	4.3	-0.6	88
III	Around spinal column	15.3	12.5	+2.8	82
IV	Abdominal wall	10.4	9.7	-0.7	93
V	Proximal thoracic limb	11.7	12.5	+0.8	107
VI	Distal thoracic limb	3.3	2.3	-1.0	70
VII - VIII	Thorax and neck to thorcic limb	16.2	16.0	-0.2	99
IX	Neck and thorax	14.9	12.5	-2.4	84

[a]Present study: Total side muscle weight 5.9kg, n = 8
[b]Berg and Buterfield (1976): Bull mean total side muscle weight 77.6 kg, n = 63
[c]Index = (Bull value x 100) / (Goat value)

and agile species when compared with sheep, cattle and pigs.

The "abdominal wall index" applicable to standard muscle group IV gave the following ranking: boars (108), goats (100) bulls (93) and rams (90). The concepts of Hammond (1932) in which he attributed late development to the loin were in fact based largely on the late development of the abdominal wall muscles. Berg and Butterfield (1976) suggested that the improved meat species have heavier abdominal muscles than their wild counterparts. However, it is doubtful if this "selection for meat index" theory is applicable in the present study. This is because the Saanen goat has not been selected for meat characteristics and yet ranks higher than cattle and sheep. Any conclusion should be treated with caution for it has been shown (Berg and Butterfield, 1976) that the weight of abdominal viscera and nature of diet influence the proportion of abdominal wall muscles.

There is no simple explanation for the higher proportion of standard muscle group VII - VIII and IX found in the goats, as the data do not conform to the observation by Berg and Butterfield (1976) that, animals which appear lighter at the cranial end have the lightest muscles in these standard muscle groups. The mus-

Table 4: Muscle distribution of male goats: comparison with boars

Standard muscle group		Weight of muscle group as percentage of total muscle weight			
		male goats[a]	Boars[b]	Boars minus goats	Index[c]
I	Proximal pelvic limb	23.1	28.7	+5.6	124
II	Distal pelvic limb	4.9	3.9	-0.4	80
III	Around spinal column	15.3	17.4	+2.1	114
IV	Abdominal wall	10.4	11.2	+0.8	108
V	Proximal thoracic limb	11.7	11.8	+0.1	101
VI	Distal thoracic limb	3.3	1.9	-1.4	58
VII - VIII	Thorax and neck to thorcic limb	16.2	12.4	-3.8	77
IX	Neck and thorax	14.9	9.7	-5.2	65

[a]Present study: Total side muscle weight 5.9kg, n = 8
[b]Richmond and Berg (1971): Total side muscle weight 17.3 kg, n = 12
[c]Index = (Boars value x 100) / (Goat value)

Table 5: Muscle distribution of several species expressed relative to goats[1]

Standard muscle group		Indices (figures derived from Tables 2, 3 and 4.			
		male goats	Rams	Bulls	Boars
I	Proximal pelvic limb	100	115	123	124
II	Distal pelvic limb	100	96	88	80
III	Around spinal column	100	114	82	114
IV	Abdominal wall	100	90	93	108
V	Proximal thoracic limb	100	96	107	101
VI	Distal thoracic limb	100	91	70	58
VII - VIII	Thorax and neck to thorcic limb	100	84	99	77
IX	Neck and thorax	100	75	84	65
Exensive group[2]	A	100	112	117	116
	B	100	112	104	115
	C	100	109	105	112

[1]Weight of standard muscle groups as percentage of total muscle of each species compared with similar value for goats at 100
[2]A = Muscle groups I and II
B = Muscle groups I, II, and II
C = Muscle groups I, II, III and V

cles have partly a weight supporting function in relation to the head and horns and partly specialised function, for fighting in males. In the present study it was observed that male goats were active in fighting each other and in butting hurdles and walls than male sheep. The high ranking index of goats for standard muscle group VII - VIII and IX possibly indicates the goat to be the most aggressive, followed by the bull, ram and boar.

In another individual muscle study, Mtenga (1979) observed crest development in male goats similar to the present study and the study by Lohse (1973) in sheep and also the dome-like enlargement produced by M. Splenius in *Bos taurus* bulls (Berg and Butterfield, 1976).

The splenius muscle seemed to be well developed in goats in the present study. At 6000 g total side muscle weight, Jury *et al.* (1977) found this muscle to comprise only 0.33% of the total muscle in rams, whereas in the present study it comprised 0.85% at a comparable total side muscle of 5856 g.

Table 4 also shows that the goat is at a potential disadvantage commercially because of the lower proportions of expensive muscle groups in its carcass compared with sheep, cattle and pigs. Ladipo (1973), with lambs and goats of comparable empty body weight and under the same management, also reported lambs to contain significantly higher percentage of leg, loin rack and hind saddle than goats. It must be stated that demand for expensive muscle groups is limited to well developed meat markets and does not apply generally in developing countries.

Conclusion

The present data on goats, compared to other farm animals showed clearly that the goat is the most mobile and it is also the most active species compared to sheep, cattle and pigs. The data also shows that the goat is capable of greatest jumping. These findings have implication on the grazing and feeding management of goats such as mixing of animals of different species in grazing and construction of feeders.

It is however interesting to note that the goat has a relatively large weight of muscle in the abdominal muscle. It is unlikely that this came about by selection for muscle as goats have received less selection than cattle, sheep and pigs. It is most probable that feeding bulky versus non-bulky diets could account for this difference, although more data are needed to verify this contention. The greater abdominal muscle in goats may reflect their greater reticulo-rumen capacity relative to other species.

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