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VALUE OF CONFORMATION AS AN INDICATOR OF MUSCLE CONTENTS AND DEGREE OF MUSCLING OF THE HIND LEG IN LAMBS

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ABSTRACT

A total of 85 male and female lambs of different breeds and commercial crossbreeds, representing animals of good and poor body conformation, were used to study the value of conformation as an indicator of muscle weight of the different subregions and degree of muscling of the hind leg in sheep. Body conformation was determined objectively by the length of the hind leg of each carcass and degree of muscling of the hind leg was expressed by the ratio between its muscle and bone weights.

The values of correlation coefficients indicated that conformation is associated negatively (P<0.001) with both muscle weight of the subregions of the thigh and the degree of muscling of the hind leg (r = -0.596). Breed and carcass weight showed highly significant effect (P<0.001) on muscle weight of the different subregions and degree of muscling of the hind leg. Sex and hind leg length, representing the conformation type, had also highly significant effect on the degree of muscling of the hind leg, however their effect on the hind leg muscle content was less important. Generally, after the adjustment for the differences due to carcass weight and hind leg length, lambs having poor conformation showed higher values for both weights of the subregions muscles of the thigh and degree of muscling of the hind leg. Conformation, expressed by the hind leg length, with the weight of the carcass were found to be good predictors for muscle contents of the hind leg and its degree of muscling (R^2 = 0.59-0.86).

Keywords: Muscle weight, Body conformation, Degree of muscling, Sheep.

INTRODUCTION

Shape or conformation of the meat animal or its carcass has long received attention from breeders and meat traders. In many meat markets, lambs with good visual conformation are valued more highly and receive better prices than those with average or poor conformation. Generally, carcasses with better conformation are expected to have advantages in terms of lean meat contents and proportion of higher priced cuts (Kempster *et al.*, 1982).

In sheep, a few studies have been undertaken to evaluate the relationship between objectively assessed conformation and meat yield (Spurlock *et al.*, 1966; Cunningham *et al.*, 1967; Hopkins *et al.*, 1997; Abdullah *et al.*, 1998; Tatum *et al.*, 1998). Like subjective conformation, objective conformation is an attempt to describe complex 3- dimensional shape with a simple index. However, unlike visual conformation, it is based on precisely defined and standardized measurements (De Boer *et al.*, 1974), which leads to easier comparison and interpretation of results from experiments and other sources.

On the other hand, the hind leg is the joint which contains much of the valuable muscles of the carcass and relatively small amount of subcutaneous fat, so allowing assessment of carcass shape precisely either subjectively or objectively. Anatomically, it consists of seven subregions muscles of different weight and importance. Therefore, the present study was carried out to evaluate the value of objective conformation as an indicator of muscle contents and degree of muscling of the hind leg in sheep.

MATERIAL AND METHODS

Animals

This study was carried out on 49 ram lambs and 36 ewe lambs carcasses of different breeds and commercial crossbreeds, bought by the "Laboratoire de Recherches sur la Viande", INRA, Jouy-en-Josas, France and slaughtered at a similar stage of body development (i.e. slaughter weight was proportionately about 40% of the mature weight of the breed). The number of carcasses per breed, sex and conformation type is shown in Table 1a. However, table (1b) shows the characteristics of animals used in the study.

Table 1a. Number of carcasses of lambs per breed, sex and conformation type.

Breeds	Number of lambs		Conformation types
	Males	Females	
Charmois	3	-	Good
Charolais	3	3	Good
Ile-de-France	3	3	Good
Rava	3	3	Poor
Romanov	3	3	Poor
Solognot	3	3	Poor
Southdown	3	3	Good
Suffolk	3	3	Good
Tarasconnais	3	3	Poor
Texel	3	3	Good
Crossbreeds	8	2	Good
Crossbreeds	11	7	Poor
Total	49	36	-

Lambs were grouped according to the breed and their hind leg conformation into lambs having "good" (N=43), LGC, and "poor" (N=42); LPC, conformation (Table 1a). The conformation was determined objectively by the length of the hind leg (i.e. the value "F") measured similarly to that described by Pálsson (1939), from the tarsal-metatarsal joint to the anterior edge of the symphysis pubis. As suggested by Anous and El-Sayed (2000), lambs of good and poor conformation are those having hind leg length of <25 and >28 cm, respectively.

Hind leg dissection and traits considered

After maintaining the carcasses for 24h in a cold room at 2°C, they were weighed and quartered and the right hind legs were weighed (in grams) and their lengths (i.e. "F" values) were measured (in cm). The right hind legs were then dissected into individual muscles (n=27), bones, fat and other components and their weights were recorded (in grams). The individual muscles were then grouped into seven anatomical subregions according to Anous (1991) and the weights of the following subregions were recorded: gluteal muscles (GLU), intrinsic pelvic muscles (INP), cranial thigh muscles (CRT), caudal thigh muscles (CAT), medial thigh muscles (MET), cranial lower leg muscles (CRL) and caudal lower leg muscles (CAL). The sum of both individual muscles weights and individual bones weights was designated as total muscle weight and total bone weight of the hind leg, respectively. The degree of muscling of the hind leg was then determined by calculating the ratio (g/g) between total muscle weight and total bone weight of the hind leg (MBR).

Statistical Analysis

The data were analyzed using the least squares procedure of the General Linear Models program of SAS (1990), with the use of hind leg length and carcass weight as covariates, according to the following model:

Where:

Y_{ijk}	is the considered trait (i.e.GLU,INP,CRT,CAT,MET,CRL,CAL or MBR)of the k^{th} animal in the i^{th} breed and j^{th} sex adjusted for hind leg length and carcass weight;
μ	is the overall mean;
B_i	is the fixed effect of the i^{th} breed (i = 1,...,11);
S_i	is the fixed effect of the j^{th} sex (j = 1,2);
b_1	is the partial regression coefficient of the considered trait on hind leg length;
X_{1ijk}	is the hind leg length of the k^{th} animal in the i^{th} breed and j^{th} sex;
$\bar{X}_1$	is the average of the hind leg length;
B_2	is the partial regression coefficient of the considered trait on carcass weight;
X_{2ijk}	is the carcass weight of the k^{th} animal in the i^{th} breed and j^{th} sex;
$\bar{X}_2$	is the average of the carcass weight;
E_{ijk}	is the random error associated with each observation.

Note.: Breed * Sex interaction was not significant (P>0.05), therefore it was excluded from the model.

RESULTS AND DISCUSSION

Relationship Between Conformation and Muscle Contents

Table (2) shows the relationship between conformation type, expressed objectively by the length of the hind leg (i.e. the value "F"), and both muscle weight of the different subregions and degree of muscling of the hind leg of lambs. The values of correlation coefficients (calculated irrespective of the effect of breed and sex) indicated that conformation is associated negatively with all the examined subregions muscles as well as the hind leg muscle weight to bone weight ratio except the INP muscles. However, it shows highly negative significant association (P<0.001) with both the muscle weights of the subregions of the thigh; CAT and MET, and the degree of muscling of the hind leg. Thus, lambs with short hind leg, which represent generally lambs having good conformation, tended to have more muscle weight in the caudal and medial thigh subregions and higher muscle to bone ratio (MBR) compared to lambs with long hind leg, which represent generally lambs having poor conformation. This suggests that the muscle contents and degree of muscling of the sheep can be changed through selection for the hind leg length. This is already indicated from experiences in selection for body type (Thorgeirsson, 1983; Waldron *et al.*, 1992). As a result, exterme length of the hind leg was offset by decreases in muscle contents and degree of muscling of the hind leg, confirming the previous results of Thorgeirsson (1983) and Anous (1986).

Table 2. Correlation coefficients[1] between hind leg length (in cm) and weights of the hind leg subregions muscles[2] (in g) and the hind leg muscle weight to bone weight ratio (g/g) in lambs.

Traits	GLU	INP	CRT	CAT	MET	CRL	CAL	MBR
Hind leg length	-0.235^{*}	0.113^{NS}	-0.219^{NS}	-0.512^{***}	-0.643^{***}	-0.234^{*}	-0.212^{NS}	-0.596^{***}

[1] ***: Significant at P<0.001; *: Significant at P<0.05; NS: Not significant at P>0.05.
[2] GLU = gluteal muscles; INP = intrinsic pelvic muscles; CRT = cranial thigh muscles; CAT = caudal thigh muscles;
MET = medial thigh muscles; CRL = cranial lower leg muscles; CAL = caudal lower leg muscles; MBR = muscle weight to bone weight ratio.

Differences Among Means

Table (3) showed that both breed and carcass weight had highly significant effect (P<0.001) on all the traits considered. Sex and hind leg length had also highly significant effect (P<0.001) on the degree of muscling of the hind leg expressed by the ratio MBR, however their effect on the weight of the hind leg subregions muscles is less important, compared with the effect of breed and carcass weight. On the other hand, sex showed more influence on the weights of the subregions muscles of both the pelvic (i.e. GLU and INP) and leg (i.e. CRL and CAL) regions of the hind leg, while hind leg length, representing the conformation type of the carcass, found to affect mainly the weights of the subregions muscles of the thigh region (especially CAT and MET). The latter region represents the high-priced cuts of the carcass. Generally, lambs having poor conformation (Table 3) representing by the following breeds: Solognot, Rava, Romanov and Tarasconnais showed higher values compared with lambs having good conformation for both weights of the muscles of CAT (656 g vs 609 g), MET (225 g vs 188 g) and CRL (54 g vs 50 g) subregions and degree of muscling of the hind leg (5.96 vs 4.36) after the adjustment for the differences due to both carcass

Table 3. Analysis of variance (in the upper part), least squares means (LSM) with their standered arrors (± S.E.) and coefficients of variation; C.V.% (in the lower part) of weights of the hind leg subregions muscles[1] (in g) and the hind leg muscle weight to bone weight ratio (g/g) in lambs.

Sources of variation	Degrees of freedom	Mean squares2							
		GLU	INP	CRT	CAT	MET	CRL	CAL	MBR
Breed	10	1255.93358***	71.28269***	6177.80741***	13254.43020***	1973.00465***	119.42548***	1934.85337***	0.90148***
Sex	1	1708.98982*	94.56356**	4888.72210*	4121.50730^{NS}	1657.54225*	334.65528**	5751.18766***	1.99487***
Carcass weight	1	27833.59686**	262.63889***	86460.17615***	270286.43020***	24919.75097***	1279.31400***	12921.30941***	2.52134***
Hind leg length	1	1537.35636*	14.01978^{NS}	3266.65713^{NS}	52210.20280***	16417.19295***	127.40443*	1446.86822^{NS}	4.25318***
Remainder	71	370.43130	15.26293	908.50310	2067.98730	327.38127	30.93863	434.46778	0.10888
	Number of animals	LSM±S.E.							
		GLU	INP	CRT	CAT	MET	CRL	CAL	MBR
Overall	85	222	36	424	627	205	52	215	4.45
Breed:									
Charmois	3	217±13.29	32±2.70	361±20.82	547±31.41	149±12.50	42±3.84	196±14.40	4.59±0.23
Charolais	6	249±7.88	39±1.60	467±12.35	684±18.63	218±7.41	59±2.28	243±8.54	4.35±0.13
Ile-de-France	6	225±8.38	32±1.70	423±13.12	691±19.80	230±8.88	52±2.42	232±9.08	4.91±0.14
Rava	6	220±9.06	34±1.84	450±14.18	684±21.40	219±8.51	56±2.62	220±9.81	4.48±0.15
Romanov	6	237±8.65	42±1.75	458±13.54	612±20.43	,223±8.13	52±2.50	200±9.36	4.99±0.15
Solognot	6	219±10.40	36±2.11	437±16.28	642±24.57	221±9.77	55±3.00	204±11.26	4.71±0.18
Southdown	6	215±10.23	36±2.07	420±16.02	552±24.16	172±9.61	47±2.96	216±11.08	4.41±0.17
Suffolk	6	203±11.55	34±2.34	350±18.08	519±27.27	150±10.86	45±3.34	209±12.51	3.26±0.20
Tarasconnois	6	227±10.12	37±2.05	465±15.85	686±23.91	236±9.51	54±2.92	220±10.96	4.97±0.17
Texel	6	240±9.23	41±1.87	448±14.46	660±21.81	207±8.68	58±2.67	245±10.00	4.65±0.16
Crossbreed	28	212±3.90	34±0.79	406±6.10	613±9.21	201±3.66	50±1.13	201±4.22	4.35±0.07
Sex:									
Male	49	a 229±3.17	a 37±0.64	a 434±4.97	a 634±7.50	a 207±2.98	a 54±0.92	a 226±3.44	B 4.35±0.05
Female	36	b 219±3.51	b 35±0.71	b 417±5.49	b 619±8.28	b 197±3.30	b 50±1.01	b 208±3.80	A 4.69±0.06
C.V. %	-	8.67	10.85	7.10	7.25	8.84	10.68	9.69	7.42

[1]: See abbreviations in Table 2.
[2]***: Significant at P<0.001; **: Significant at P<0.01; *: Significant at P<0.05; ^{NS}: Not significant at P>0.05; Means with the same letter are not significantly different.

weight and hind leg length. This means that the elimination of the effect of fatness which is influenced by the weight of the carcass and to some extent the effect of the hind leg length which is affected the conformation of the carcass inversed the expected superiority of lambs having good conformation especially for the weight of the subregions muscles of the thigh region and the degree of muscling of the hind leg for the favour of lambs having poor conformation. This confirmed the importance of fatness as a major factor influencing muscle contents and degree of muscling of the carcasses of sheep (Kempster *et al.*, 1981 and 1987; Purchas and Wilkin, 1995). The results suggested also the limited role of conformation alone (measured objectively in the present study by the length of the hind leg) compared with carcass weight and consequently its fatness, on weights of the hind leg muscle subregions and its degree of muscling.

Prediction Equations of Muscle Contents and Degree of Muscling

Table (4) showed the possibility of estimating the muscle contents and the degree of muscling of the hind leg of sheep carcasses from objective measurements such as hind leg length and carcass weight (calculated irrespective of the effect of breed and sex). It was found that hind leg length with the weight of the carcass were good predictors of muscle weight of the different subregions of the hind leg cut especially those of the thigh region and its degree of muscling (R^2 values ranging from 0.59 to 0.86). This finding agrees with that from other sheep studies (Kempster et al., 1981 and Purchas and Wilkin, 1995). As an application of these results in the meat trade, one can, by using carcass weight and hind leg length, determine, at least roughly, the flesh amongst the different subregions of the hind leg cut in lambs. A butcher could claim that his profit depends, at least to some extent, upon his ability to do so.

Table 4. Estimates[1] of prediction equations of weights of the hind leg subregions muscles[2] and the hind leg muscle weight to bone weight ratio in lambs with their standard errors (S.E.).

Traits	Intercept ± S.E.	b_1 ± S.E.	b_2 ± S.E.	R^2
GLU	95.86±35.66	-2.71±1.33	9.94±1.15	0.80
INP	6.20±7.24	0.26±0.27	0.96±0.23	0.59
CRT	125.32±55.84	-3.95±2.08	17.52±1.79	0.81
CAT	368.71±84.25	-15.78±3.14	30.98±2.71	0.86
MET	198.62±33.52	-8.85±1.25	9.40±1.08	0.81
CRL	20.35±10.30	-0.78±0.38	2.13±0.33	0.69
CAL	127.95±38.62	-2.63±1.44	6.77±1.24	0.75
MBR	6.72±0.61	0.14±0.02	0.09±0.02	0.74

1 b_1 is the regression coefficient of the considered trait on hind leg length; b_2 is the regression coefficient of the considered trait on carcass weight.
2 See abbreviations in Table 2.

CONCLUSION

This study indicated that selection for the hind leg length can change the muscle contents and degree of muscling. Also, it could be concluded that fatness is a major factor influencing muscle contents and degree of muscling of the carcass of sheep.

This study also indicated that, carcass weight and hind leg length could be used to determine (at least roughly), the flesh amongst the different subregions of the hind leg cut in lambs.

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REFERENCES

Abdullah A.Y., R.W. Purchas and A.S. Davies (1998). Patterns of change with growth for muscularity and other composition characteristics of Southdown rams selected for high and low backfat depth. N.Z.J. Agric. Res., 41: 367-376.

Anous M.R. (1986). Interrelations entre principaux composants anatomiques, conformation et longeur des os du gigot des ovins. Ann. Zootech., 35: 185-200.

Anous M.R. (1991). A comparative study of muscle-bone relationships in the hind limb of goats and sheep. Anim. Prod., 53: 81-87.

Anous M.R. and M.M. El-Sayed (2000). The relationship between hind limb conformation and muscle weight distribution in sheep. 8th Conf. Agric. Dev. Res., Fac. Agric., Ain Shams Univ., Cairo, November 20-22,2000. Annals Agric. Sci., Sp. Issue2, 595-604, 2000.

Conningham N.L., Z.L. Carpenter, G.T. King, O.D. Butler and J.M. Shelton (1967). Relationship of linear measurements and certain carcass quality and tenderness of ewe, whether and ram lambs. Anim. Sci., 26: 683-687.

De Boer H., B.L. Dumont, R.W. Pomeroy and J.H. Weniger (1974). Manual on E.A.A.P. reference methods for the assessment of carcass characteristics in cattle. Livest. Prod. Sci., 1: 151-164.

Hopkins D.L., N.M. Fogarty and D.J. Menzies (1997). Differences in composition, muscularity, muscle: bone ratio and cut dimensions between six lamb genotypes. Meat Sci., 45: 439-450.

Kempster A.J., D. Croston and D.W. Jones (1981). Value of conformation as an indicator of sheep carcass composition within and between breeds. Anim. Prod., 33: 39-49.

Kempster A.J., A. Cuthbertson and G. Harrington (1982). The relationship between conformation and the yield and distribution of lean meat in the carcasses of British pigs, cattle and sheep: a review. Meat Sci., 6: 37-53.

Kempster A.J., D. Croston, D.R. Guy and D.W. Jones (1987). Growth and carcass characteristics of crossbred lambs by ten sire breeds, compared at the same estimated carcass subcutaneous fat proportion. Anim. Prod., 44: 83-98.

Pálsson H., 1939. Meat qualities in the sheep with special reference to Scottish breeds and crosses. Part I. Carcass measurements and «sample joints» as indicies of quality and composition. J. Agric. Sci. (camb), 24: 544-574.

Purchas R.W. and G.H. Wilkin (1995). Characteristics of lamb carcasses of contrasting subjective muscularity. Meat. Sci., 41: 357-368.

SAS, 1990. Statistical Analysis System. SAS User's Guide: Statistics. SAS Institute Inc. Editors, Cary, NC.

Spurlock G.M., G.E. Bradford and J.D. Wheat (1966). Live animal and carcass measurements for the prediction of carcass traits in lambs. Anim. Sci., 25: 454-459.

Tatum J.D., J.A. Samber, B.R. Gillmore, S.B. Le Valley and F.L.Williams (1998). Relationship of visual assessments of feeder lamb muscularity to differences in carcass yield traits. Anim. Sci., 76: 774-780.

Thorgeirsson S. (1983). The influence of conformation on carcass composition and muscle distribution in Icelandic sheep. 34th Annual Meeting of the Study Commissions EAAP, Madrid, 3-6 October, 1983.

Waldron D.F., J.N. Clarke, A.L. Rae and E.G. Woods (1992). Selected response in carcass composition to selection for muscularity in sheep. Proc. N.Z. Soc. Anim. Prod., 52: 29-31.

قيمة التكوين الجسماني كدليل لكل من المحتوي العضلي ودرجة الامتلاء العضلي للقائمة الخلفية في الأغنام

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استخدم إجمالي عدد ٨٥ من الحملان الذكور و الإناث التابعة لسلالات وخلطان تجارية مختلفة تمثل كل من الأغنام ذات التكوين الجسماني الجيد والأغنام ذات التكوين الجسماني الفقير بهدف دراسة قيمة التكوين الجسماني الخارجي للحيوان كدليل لكل من وزن العضلات في المناطق التشريحية المختلفة ودرجة الامتلاء العضلي للقائمة الخلفية في الأغنام . وقد تم تحديد التكوين الجسماني للحيوان كميا بالاعتماد علي مقياس طول القائمة الخلفية للذبيحة كما تم التعبير عن درجة الامتلاء العضلي للقائمة الخلفية بحساب النسبة بين إجمالي وزن العضلات وإجمالي وزن العظام بها .

وقد أوضحت قيم معاملات الارتباط أن التكوين الجسماني للحيوان يرتبط سلبيا بكل من وزن العضلات في المناطق التشريحية المختلفة المكونة للقائمة الخلفية ودرجة الامتلاء العضلي لها . وقد كان لكل من السلالة ووزن الذبيحة تأثيرا معنويا علي كل من وزن العضلات في المناطق التشريحية المختلفة للقائمة الخلفية ودرجة الامتلاء العضلي لها . كما كان لكل من الجنس وطول القائمة الخلفية(الذي يمثل التكوين الجسماني للحيوان) تأثيرا معنويا علي درجة الامتلاء العضلي للقائمة الخلفية بينما كان تأثيرها علي أوزان العضلات في المناطق التشريحية المختلفة أقل في الأهمية.

وقد أظهرت الحملان ذات التكوين الجسماني الفقير ، وذلك بعد التصحيح للاختلافات الراجعة إلي كل من وزن الذبيحة وطول القائمة الخلفية ، قيما أعلي لكل من أوزان المناطق التشريحية المكونة لمنطقة الفخذ ودرجة الامتلاء العضلي للقائمة الخلفية ككل وذلك مقارنة بالحملان ذات التكوين الجسماني الجيد. كما وجد أن التكوين الخارجي معبرا عنه بطول القائمة الخلفية وأيضا وزن الذبيحة يمكن استخدامها معا في التنبؤ بالمحتوي العضلي للمناطق التشريحية المختلفة ودرجة الامتلاء العضلي للقائمة الخلفية.