Developmental Changes of Fat Depots in Male Saanen Goats

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Abstract

Thirty-four male British Saanen goats were reared on milk substitutes from birth to weaning at 35 days and then given barley-based concentrate diet ad libitum. They were slaughtered serially at birth (3.5 kg), weaning (9.5 kg), 24.5, 36.5, 48.5 and 72.5 kg live weights. Weights of fat depots were recorded. With the exception of channel fat, all fat depots increased significantly (P< 0.001) with increasing slaughter weight. Fat growth coefficients were greater than 1 (P<0.001) and was highest for subcutaneous fat (1.887), followed by gut fat (1.802), dissected fat (1.687), inter-muscular fat (1.619) and lowest for channel fat (1.127). Relative to total fat, the greatest change in proportion of fat occurred between birth and 24.5 kg of live weight. There were little consistent changes in proportion of subcutaneous fat relative to change in total body fat.

Key words: *Growth, fat depots, Saanen goats*

Introduction

Fat growth and development in farm animals is of importance from several points of view. Firstly, as a reserve of energy, fat can determine the survival of the animal in periods of food scarcity. Secondly, as a major carcass tissue, it may affect the complex industry of meat production, including feeding, decision on the optimum slaughter weight, grading of the carcass and meat quality. In the latter context, some fat depots are more valuable than others e.g. subcutaneous and inter-muscular fat are more desirable than kidney and gut fats. Within fat depots in the carcass, provided it is not in excess, fat in the expensive joints is more valuable than fat in less expensive joints (Berg *et al.*, 1978). Thirdly, the statement that fat is a passive organ has been discounted (Adler and Wertherimer, 1968). The authors also pointed out that lipogenesis mainly occurs in the adipose tissues. Fourthly, the rigid relationship between body weight, muscle and bone, demonstrated by Lawrence and Fowler (1997), implies that the use of genetic and environmental factors in manipulating body composition is likely to have greater effects on the proportion of fat than on other carcass tissues. Defining the pattern of fat growth in breeds of goats is therefore essential to an understanding of body and carcass composition problems associated with production and marketing. Goat carcass value is influenced markedly by both amount and distribution of fatty tissue depots (Ladipo, 1973). In cattle, several studies have shown that the partitioning of fat among the depots is influenced by slaughter weights (Berg *et al.*, 1978). Growth and partition of fat depots in goat carcasses has not been thoroughly studied and results from controlled experiments are particularly scarce. The present study attempts to define growth and distribution of fat depots in male British Saanen goats slaughtered at different weights.

Materials and methods

A total of 34 male Saanen goats were purchased at birth and serially slaughtered at birth (3.5 kg), weaning (9.5 kg), 24.5, 36.5, 49.5 and 72.5 kg live weights at Reading University Farm. The animals were artificially reared on Denkavit Lamb ewe milk replacer until weaning at 35 days of age. The milk

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replacer contained (g/kg DM) 245 crude protein, 200 oil, 2.5 fibre, 30 000 1U vitamin A, 14 000 1U vitamin D_3 and 30 1U vitamin E. After weaning, they were fed *ad libitum* fattening barley-based concentrate diet consisting of (g/kg DM) 750 barley, 50 flaked maize, 100 soybean meal, 50 fish meal, 30 molasses, 15 limestone, 4 salt and 1 mineral supplements. The diet contained 228 g/kg DM crude protein and 17.4 MJ gross energy/kg DM.

The animals were slaughtered and kidney fat, gut fat and channel fat (fat found around pelvis bones) from the whole animal were separated and weighed. Subcutaneous and inter-muscular fat were obtained by dissecting both the right and left sides of the carcass. Dissected fat weight was obtained by summing up weights of subcutaneous and intra-muscular fat. Mean weights of the various fat depots were expressed as a percentage of empty body weight (EBW = live weight – gut fill weight) and analysed following a one way analysis of variance as described by Snedecor and Cochran (1989). Fat depots were also expressed as a percentage of total fat weight. Data for each fat depot were transformed to logarithms to establish part and whole allometric growth relationships of the type

$$Y = ax^b$$

Where Y is the fat depot weight, x is EBW, and b is the growth coefficient describing proportionate growth of fat in a depot relative to EBW.

Results

Mean live weights of various fat depots at six grouped slaughter weights are shown in Table 1 while the mean weights of the same depots but expressed as percentages of empty body weights are presented in Table 2. With the exception of channel fat, weight at slaughter had a significant ($P<0.001$) effect on the proportion of all fat depots. Both the absolute weight and the proportions of these fat depots increased with increase in slaughter weight. However, the increase in proportions was small during the live weight range 24.5 to 49.5 kg.

In the allometric equations for growth of fat depots relative to empty body weight (Table 3), the growth coefficients were significantly greater than 1.00, indicating that, as empty body weight increased, the proportion of these fat depots increased, confirming the results by direct comparison of percentages in Table 2.

More of the variation in fat depot weights could be accounted for by variation in empty body weight using allometric equations. The largest growth coefficient was for subcutaneous fat, showing it to be the latest developing depot, while kidney and channel fat were the earlier developing depots.

Table 1. Mean weights (g) of various fat depots at six live weights

Component	Slaughter stage					
	Birth	Weaning	24.5 kg	36.5 kg	49.5 kg	72.5 kg
No. Of animals	4	4	8	8	8	2
Gut fat	27	157	901	1680	2695	6268
Total channel fat	8	22	69	116	138	256
Total kidney fat	27	99	289	705	1039	2651
Subcutaneous fat	6	133	433	796	953	3157
Inter-muscular fat	27	163	657	1138	1758	3623
Dissected fat[1]	33	296	1090	1934	2711	6780

[1]Dissected fat = Subcutaneous fat + Inter-muscular fat

Table 2. Mean weights expressed as percentages of EBW of various fat depots at six live weights[1,2]

Component	Slaughter stage						
	Birth	Weaning	24.5 kg	36.5 kg	49.5 kg	72.5 kg	SE_d
No. Of animals	4	4	8	8	8	2	
Gut fat	0.82	1.75	4.36	5.24	6.28	9.47	0.40***
Total channel fat	0.26	0.25	0.33	0.36	0.32	0.39	0.04
Total kidney fat	0.82	1.11	1.40	2.19	2.43	3.99	0.06***
Subcutaneous fat	0.21	1.49	2.11	2.49	2.22	4.78	0.37***
Inter-muscular fat	0.82	1.81	3.20	3.55	4.11	5.47	0.27***
Dissected fat[3]	1.03	3.30	5.31	6.03	6.33	10.25	0.50***

[1]For ease of tabulation, standard deviations and coefficients of variation are excluded
[2] SE_d = Average standard error of difference
[3]Dissected fat = Subcutaneous fat + Inter-muscular fat
***** = significant at P< 0.001**

The relationship between the various fat depots was also studied by expressing weights of fat as a percentage of total body fat (Table 4). Total body fat proportion progressively increased with increasing empty body weight. The proportion of inter-muscular fat relative to body fat showed little consistent changes with increase in total fat weight. At birth, most of the fat was accumulated in three major depots: gut, kidney and inter-muscular (Tables 1 and 2). With increase in total body fat, the most notable change was the increase in proportion of subcutaneous fat (Table 4). The increase was accompanied by a decrease in the proportion of kidney fat. Table 4 also indicates that the major changes in proportions of fat depots occurred early in life, i.e. before total body fat exceeded 2.4 kg (corresponding to 24.5-kg live weight).

Table 3. Allometric regression equations showing growth of fat depots relative to empty body weight[1].

Component	b log x + a	SE_b	R
Gut fat	1.802x*** - 11.262	0.036	98.77
Total channel fat	1.127x* - 7.044	0.057	92.32
Total kidney fat	1.455x*** - 8.813	0.055	95.61
Subcutaneous fat	1.887x*** - 12.956	0.103	91.26
Inter-muscular fat	1.619x*** - 9.734	0.039	98.14
Dissected fat	1.687x*** - 9.930	0.053	96.93

[1] *, **, *** indicate that the b - value is significantly different from 1.00 at P<0.05, P<0.01, or P<0.001 respectively.

Discussion

The present findings agree with the literature on pattern of growth of fat in goats (Ladipo, 1973; Colomer-Rocher *et al.*, 1992), sheep (Hammond, 1932; Gaili, 1976), Cattle (Berg *et al.* 1978; Lawrence and Fowler 1997) and pigs (Richmond and Berg, 1972) in that most of the fat depots increase in weight at a faster rate than body weight. The results in the present study indicate that subcutaneous fat grows faster in post - natal life than all other fat depots, a finding similar to that of Gaili (1976) and Teixera *et al.* (1995) using lambs. Kirton *et al.* (1972) also noted that, apart from omental fat, subcutaneous fat was the last fat depot to mature. Whilst the order of fat depot development was similar to that of cattle (Williams, 1978), it was slightly different from that given by Palsson and Verges (1952), who described gut fat as slower growing than inter-muscular fat. Kirton *et al.* (1972) also found channel and inter-muscular fat in male lambs to be early maturing.

The present result also contrast sharply with those reported by Ladipo (1973), using a mixture of male dairy goats breeds slaughtered between 22 and 54 kg live weight. He reported fat depots to increase in the following order of increasing rate: sub-cutaneous, gut (caul and mesenteric) fat, inter-muscular fat, and finally visceral fat (kidney, channel and heart fat). Per unit of empty body weight, the growth rates of inter-muscular and visceral fat depots in Ladipo's study were twice that of subcutaneous fat. The fact that Ladipo (1973) used a mixture of breeds merits interpretation of the results with caution, because breed differences have been observed in fat growth rates and distribution in farm animals (Berg and Butterfield, 1976).

Relative to total body fat, gut fat was the largest contributor to the total fat reaching a peak at about 2.4 kg total body fat, corresponding to 24.5 kg live weight. This fat depot, together with that of the kidney and channel fat, is usually trimmed off the carcass in lambs and cattle and sold as cooking fat. The ratio of dissected carcass fat (subcutaneous plus inter-muscular fat) to other fat depots of the body may, therefore, be more important criterion in determining meat quality in goats. This was 1.87, 1.06, 0.87, 0.77 and 0.74 at birth (3.5 kg), weaning (9.5 kg), 24.5, 36.5, 49.5 and 72.5 kg live weight, respectively. Table 4 demonstrates that the greatest change in proportions of the various fat depots occurred between birth and 24.5 kg live weight in male Saanen goats. This period may, therefore, be critical in the study of genetic and environmental factors affecting fat depots' growth and distribution. Subcutaneous fat made the least contribution at birth, but rose sharply to its mature proportion at weaning. The conclusion by Ladipo (1973) that proportions of inter-muscular fat decreased, with increase in carcass fat, can be interpreted to correspond to the 24.5 to 72.5 kg live weight interval in the present study.

Table 4. Partition of body fat depots in male goats slaughtered at six live weights

Slaughter weight group	Number of animals	Total body fat (g)	Total body fat as % of EBW	Fat depots as % of total body fat				
				Inter-muscular	Subcutaneous	Kidney	Channel	Gut
Birth (3.5 kg)	4	95	2.93	27.65	7.00	28.33	8.87	27.99
Weaning (9.5 kg)	4	575	6.41	28.24	23.24	17.32	2.90	28.30
24.5 kg	8	2350	11.40	27.98	18.51	12.28	2.98	38.25
36.5 kg	8	4435	13.82	25.67	17.95	15.85	2.61	37.92
49.5 kg	8	6583	15.35	26.71	14.46	15.83	2.08	40.91
72.5 kg	2	15955	24.10	22.70	19.83	16.56	1.62	39.29

Conclusion

The present study shows that the various fat depots in goats grow faster relative to empty body weight. They also grow at different rates relative to each other. There is however need for further studies taking into account breed and nutrition influences in fat growth and distribution.

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