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GROWTH AND CARCASS COMPOSITION OF LOCAL IRAQI BLACK GOATS

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ABSETRACT

The pattern of growth and carcass composition of indigenous Iraqi black goats were assessed through serial slaughter and carcass dissection of 36 kids at six different growth phases. The general linear model procedure and allometric growth equations were used to assess the effects of various factors and differential growth of carcass components, respectively. Results showed that kids growth and carcass composition were significantly (P< 0·05 to P< 0·001) affected by the growth phase and sex of kids. The effects of growth phase clearly showed that slower growth of the body and of carcass components were observed during the third phase (i.e. after weaning). Although there was an effect on fat to lean ratios (P < 0·05), growth phase had no significant effect on dressing out proportion, and lean to bone ratios. A significant influence of sex (P < 0·05) was observed on lean to bone ratios. The log/log regression of weights of dissectible carcass components on hot carcass and empty body weight showed that the differential growth of bone was declining and that of lean was isometric relative to the growth of empty body weight. For carcass fat, the allometric growth coefficients (b) of 1.6 indicated that fat is a late maturing body component. Moreover the growth of carcass fat relative to empty body weight in local goat was slower than that reported for other goat breeds.

INTRODUCTION

The knowledge of goat carcass composition, the quantitative accretion of each carcass component and changes in growth patterns at various stages of growth is important both in nutrition studies (in which nutrient requirements are being determined) and in production system analyses that attempt to optimize profit (1). Proper understanding of the quality and distribution of dissectible body components such as bone, fat and lean throughout the carcass is also required not only to assess the animal as a meat producer, but also to market the meat efficiently (2). To date studies involving carcass evaluation and body composition of meat animals have received considerable attention in many parts of the world. Especially, in developing countries, where goats are used extensively for meat production there is not much information regarding their tissue partitioning and general growth performance (3). Therefore, there is a need to characterize tissue partitioning and carcass composition of goats at different stages of growth and thereby identity phases of body development where strategic interventions could be made. It is also essential for appropriate slaughter points that would consider efficiency of tissue accretion. A good understanding about physiological responses of goats' body tissues and the information derived from such studies is also necessary for detailed evaluation of improvements in nutrition, general management and genetic upgrading of meat animals. The main objective of this study was therefore to define the pattern of growth and assess the carcass composition of indigenous Iraqi local black goat at different growth phases.

MATERIAL AND METHODS

Study area and experimental animals

This study was conducted at Al-Hartha Agricultural Station, College of Agriculture, University of Basrah. Climatic conditions are characterized by very low irregular rainfall, long dry season and high temperatures. In this study, an indigenous Iraqi black goat (30) was used. This type (breed) is well known in the country and is of great economic importance in the areas of their origin (middle and south of Iraq) and the production systems it inhabit. It is also easily distinguishable from each other and from other indigenous goat breeds of the country on the basis of their distinct morphological characteristics (4).

Management

Nannies were mated in single-sire groups of 20 to 25 females to a buck of the same breed. Bucks selected for mating were also checked and underwent breeding soundness tests prior to joining nannies each season. Ten bucks were used at each mating period. All kids were reared on their dams until weaning at 3 months of age. During this time they had no access to food other than what was given to their dams. After weaning, kids were raised mainly on grazing of poor natural pasture except for limited supplementation. Kids received supplemental green alfalfa adlibtum and were offered in groups a limited amount of concentrate at a rate of 50 to 150 g/ head/ day (composed of 20% wheat bran, 30% corn and 50% barley) in the evening. Newborn kids were vaccinated against infectious diseases and therapeutic treatments were given to sick animals. Kids were routinely checked for any health problems and drenched at specific intervals as a protection against endo- and post-parasites. Kids were housed with their dams in half shaded barns.

Experimental design

A total of 36 kids equally divided into two sexes were slaughter at six ages (6 kids each). A group of six kids (3 males and 3 females) at 1, 6, 12, 18, 24, and 30 months of age was slaughtered and dissected to assess variation in the composition of dissectible body components and differential growth of body tissues.

Slaughter and carcass dissection

Kids were slaughtered by severing the jugular vein and the carotid arteries. After weights of skin, head and trotters were taken the abdomen was opened and the gastro-intestinal tract (GIT) tied off at the oesophagus and rectum. The GIT was removed and the whole GIT and its various compartments were weighed full and empty. Empty body weight (EBW) was calculated as a difference between slaughter weight and weight of digesta. During evisceration the weight of all internal organs (viscera) was taken. In addition, weights of all internal fat depots: kidney fat, urogenital fat, and gut fat (omental and mesenteric i.e. the fatty tissue surrounding the alimentary tract) were recorded. Finally, the weight of the hot dressed carcass was taken and stored overnight at 4°C until dissection the following morning. Prior to dissection, each cold carcass was weighed and then halved longitudinally into two equal right and left halves by sawing down along the dorsal mid line and the weight both sides was taken. The left side of the carcass was dissected into components of bone, lean meat, fat (subcutaneous and intermuscular) and sundry trimmings (major blood vessels, ligaments, tendons and thick connective tissue sheets associated with some muscles) and the weight of each dissectible body component was recorded (5).

Statistical analyses

All statistical analyses were made using the Statistical package SPSS (6). The weights of lean, bone, fat and sundry trimmings from each of the slaughtered kids were doubled to get total weight of carcass lean, bone, carcass fat and sundry trimmings of the whole body. Weights of the different fat depots were also summed up to give the total carcass fat (TCF). Individual body fat depots were grouped into two major depot classes as: non- carcass fat (NCF; kidney, urogenital and gut fat) and carcass fat (CF; subcutaneous and intermuscular fat) for the analysis of differential growth and partition of adipose tissue among body depots. Data on empty body weight, dissectible body components and the two classes of body fat depots were analysed by fitting a model that included the effects of sex, growth phase, their interactions and body weight (kg) as a covariate using the GLM procedures of SPSS (6). After several preliminary analyses, the following statistical model was selected and fitted to the data:

$$Yijkl = \mu + Si + Aj + b(Xijk - X) + eijkl$$

Where:

Y= observation on each kid;

μ= overall mean;

Si= fixed effect of the j^{th} sex of the kids (j= male, female);

Aj= fixed effect of the k^{th} growth phase of the kid;

$b(Xijk - x)$= body weight of kids (covariable); and

$eijkl$= error term.

The significance of the differences among means of main effects was tested by Duncan's new multiple-range test. Interactions between main effects were tested and those with no significant effects were deleted from the final model.

The allometric growth equation of Huxley (7) was used to assess the differential growth of dissectible body components relative to hot carcass and empty body using the slaughter and carcass dissection data. The data was first transformed to logarithms (base 10) and log transformed weights of dissectible body components were regressed on hot carcass and empty body weight using the allometric growth equation of the form

$$Y=aX^b$$

. This exponential relationship was converted to a logarithmic form as follows:

$$\log 10Y = \log 10a + b\log 10X$$

Where:

Y= weight of dissectible body component;

X= empty body weight or weight of hot carcass;

a =the value of Y when X= 1; and

b= the growth coefficient describing the proportionate growth of dissectible body components relative to weight of hot carcass or empty body weight.

RESULTS

Factors affecting growth and carcass composition

As animals grow from birth to maturity, the composition of the body change both in terms of its chemical and dissectible body components. The relative growth patterns of dissectible body components obtained from this study through serial slaughter and dissection of kids at different stages of growth is presented in Table 1. Means and standard errors of pre-slaughter weight, EBW, hot and cold carcass weight, dissectible body components, dressing percentage, lean to bone and fat to lean ratios are presented. The results obtained show that sex

of kids had no significant effect on the composition of dissectible body components except on carcass bone (P< 0·01), pre-slaughter and empty body weights (*P*< 0·05). The least-squares analysis showed that females had lighter pre-slaughter, empty body and bone weights as compared with males (Table 1).

Growth phase had a significant effect on the composition of dissectible carcass components. The differences in pre-slaughter (*P*< 0·001), empty body and hot carcass weights (*P*< 0·001) and the composition of carcass lean (P< 0·001), bone (P< 0·001) and dissectible fat content (P< 0·01) at different growth phases were highly significant (Table 1, 2, 3 and Fig 1). Of the six different growth phases, lighter weight and slower growth rate of carcass and dissectible body components was observed during the third growth phase (i.e. after weaning). The growth after this phase was, however, characterized by an improved body condition and faster development of dissectible body components.

Table 1 :Pre-slaughter weight, empty body weight, hot carcass weight, cold carcass weight and dressing (%) of male and female kids at different growth stage (means ± se)

Effects	No. of animals	Pre-slaughter	Empty body	Hot carcass	Cold carcass	Dressing %
		Weights(kg)				
Overall mean	36	13.6 ±2·4	10·9±2·1	4·8±1·3	4·6±1·1	48.4±5.4
Sex		*	*			**
Male	18	13·0±0·3a	10·4±0·2a	5·1±0·2	4·8±0·1	50.1a±0.6
Female	18	12·1±0·3b	9·7±0·3b	4·7±0·2	4·5±0·1	47.5b±0.5

a,b,c,d Within variable groups, means with different superscripts differ significantly (*P* < 0·05).

Table 2 :Pre-slaughter weight, empty body weight, hot carcass weight, cold carcass weight and dressing (%) of kids at different growth stage (means ± se)

Effects	No. of animals	Pre-slaughter	Empty body	Hot carcass	Cold carcass	Dressing %
Growth stage		***	***	***	***	
1	6	6·5±0·5d	5·9±0·4d	3·1±0·2d	2·8±0·2d	47.4±0.8
2	6	10·6±0·5c	8·2±0·4c	4·1±0·2c	3·9±0·2c	47.9±1.0
3	6	11·5±0·5c	8·9±0·4c	4·3±0·3c	4·0±0·2c	48.4±1.0
4	6	15·6±0·5b	12·2±0·4b	5·8±0·2b	5·7±0·2b	48.8±1.0
5	6	18·6±0·4a	14·8±0·4a	7·2±0·2a	6·9±0·2a	48.9±0.9
6	6	20.0±0·5a	15.3±0.5a	8.3±0.3a	7.5±0.3a	50.4±1.0

a,b,c,d Within variable groups, means with different superscripts differ significantly (*P* < 0·05).

Dressing proportion

Dressing proportion is the proportion of body weight (g/kg) considered to be edible and is affected by breed, age and castration (8; 9; 10). Sex of kids showed significant effect (P< 0·01). Male kids had a relatively higher DP (50.1%) as compared with those of females (47.5%). The effect of growth phase on DP was not significant, but an increase was observed in the DP of kids as growth phases preceding which could be due to an increase in fat deposition.

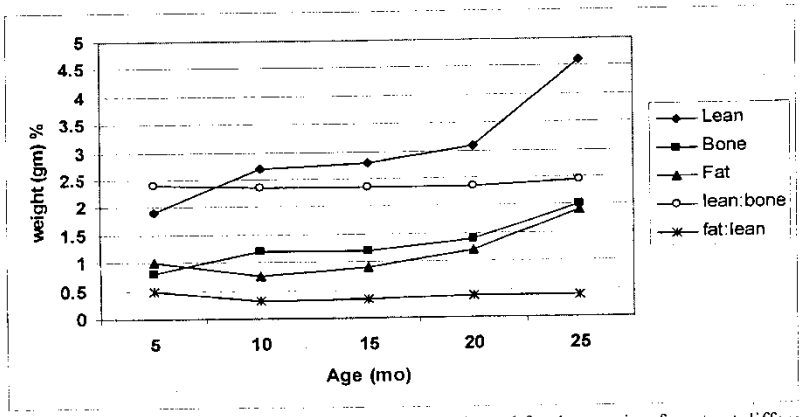

Fig (1) :Distribution of lean, bone, fat, lean: bone ratio and fat: lean ratio of goats at different ages.

Fat: lean and lean: bone ratios

In this study, except for growth phase (P< 0·05) there were no significant effects on the fat to lean ratio. However, the least-square means in Table 3 show a slightly higher fat to lean ratio for females compared with male lambs (0·36 *vs.* 0·31). Although no clear increasing or decreasing trend was observed, the fat to lean ratio was lower during the third and fourth growth phases.

Unlike the fat to lean ratio, the lean to bone ratio was significantly affected sex (P< 0·05). Females had a lean to bone ratio of about 2·4 as compared with the 2·3 for males indicating that the skeleton of females is slightly more developed than that of the males. This could also be indicative of the potential and suitability of female for future improvements in meat production in the region. A strong relationship was also observed between sex and the lean to bone ratio of kids. However, as the number of experimental kids used was relatively small it is suggested that this needs to be further verified on a larger number of experimental kids and with more carcass measurements before firm conclusions are made.

Table 3: Dissectible body components (kg), lean to bone and fat to lean ratios of Iraqi local black goats (means ± standard errors)

Effects	No. of animals	Dissectible components			Lean: bone	Fat: lean
		Lean	Bone	Fat		
Overall mean	36	3·1±0·8	1·3±0·3	1·1±0·3	2·3±0·4	0·34±0·1
Sex						*
Male	18	3·2±0·1	1·4±0·1	1·1±0·1	2·3±0·1	0·31±0·1
Female	18	3·1±0·1	1·3±0·1	1·2±0·1	2·4±0·1	0·36±0·1
Growth stage		*	*	*	*	*
1	6	1·9±0·2d	0·8±0·1de	1·0±0·2b	2·4±0·1	0·44±0·1a
2	6	2·6±0·2c	1·1±0·1d	0·7±0·2b	2·3±0·1	0·34±0·1b
3	6	2·7±0·2c	1·1±0·1d	0·9±0·2b	2·3±0·1	0·33±0·1b
4	6	3·1±0·8 b	1·3±0·3 c	1·1±0·3b	2·3±0·4	0·34±0·1b
5	6	3·9±0·2b	1·6±0·1b	1·2±0·2b	2·5±0·1	0·39±0·1a
6	6	4·6±0·2a	2·0±0·1a	1·9±0·2a	2·4±0·1	0·40±0·1a

a,b,c,d Within variable groups, means with different superscripts differ significantly ($P < 0·05$).

Relative growth of dissectible body components

The allometric growth coefficients were calculated from the log/log regression of weights of dissectible body components on hot carcass and empty body weights (7) to obtain comparative information on relative growth patterns. The results presented in Table 3 show that bone has a growth coefficient (b) of less than one indicating a declining proportion of this component with increasing carcass and empty body weight. On the other hand, the growth of lean body relative to EBW (but not to hot carcass weight) is proportional (i.e. isometric), with a growth coefficient almost equal to 1. This is, however, contrary to the growth of dissectible body fat which, with an allometric growth coefficient of greater than 1, grows relatively faster than the growth of hot carcass and EBW. Overall, results of the allometric growth coefficients in this study show that bone is an early maturing tissue followed by lean and fat. Of all the tissues, fat is late maturing with a growth coefficient of well above 1.

Table 4: Allometric growth equations describing the relationship between dissectible body components (Y), hot carcass or empty body weight (X)

Body component (y)	A	B	s.e.b	R^2 %	MSE
Relative to hot carcass					
Lean	–0·1144	0·8724	0·0667	68.4	0·013
Bone	–0·4425	0·7849	0·0511	74.9	0·007
Fat	–0·9618	1·2683	0·1865	36.9	0·104
Relative to empty body weight					
Lean	–0·6168	1·1063	0·0431	89.3	0·004
Bone	–0·8773	0·9772	0·0271	94.2	0·001
Fat	–0·5445	1·4529	0·2030	39.3	0·100

DISCUSSION

Factors affecting growth and carcass composition

With regard to the effect of sex, Moore *et al.* (11) reported the tendency of female kids to have smaller carcasses and deposit more fat in the body than male kids. Taher et al (10) also confirmed a significant effect of sex in Iraqi local goats in which castrated kids had more carcass fat ($P< 0·001$) and slightly less muscle and bone ($P< 0·05$) than male kids. Whereas Thonney *et al.* (12) reported that sex significantly affected the weight of the carcass and its component parts, mainly in so far as the males were heavier than the females. Growth phase is one of the most important factors that affect the composition of dissectible body components. In this regard, Tahir *et al.* (13) reported that dissected body components, carcass weight, dressing percentage, percentages of soft organs and dissectible fat contents in Iraqi local goats male kids slaughtered in different age groups were significantly greater at 12 and 15 months of age than at 4 and 6 months. Such an effect of stage of growth on carcass composition has been widely reported (14; 15). The results obtained in the present study, in which an increase with age was observed in almost all dissectible body components, pre-slaughter and EBWs are in accordance with the results reported by Warmington and Kirton (16).

Dressing proportion (DP)

A trend for DP to increase with age has been reported by Owen and Norman (8). Studies by McDowell and Bove (17) and Devendra and Burns (9) also indicated that DP or the edible proportion of a meat animal is within the range 35% to 60% and this differs from country to country. That in the present study the mean DP equaled 48.4% is in line with literature reports (18; 19). However, in view of the isometric growth pattern of internal organs relative to the growth of EBW, the increase with age in dressing-out percentage reported by Ruvuna *et al.*(20) is contrary to the results obtained in the present study.

In this study, no significant difference was observed between the DP of male and female kids. However, Almedia *et al* (21) reported a significant difference among the different sexes of Boer goat. In the case of Colomer-Rocher *et al.* (22), the tendency towards a higher dressing-out proportion in the females was explained by their tendency to deposit more fat in the carcass.

Fat: lean and lean: bone ratios

Muscle is the most and bone is the least valuable tissue in the carcass. Factors affecting their growth and the ratio between these tissues are therefore critical to the value of the carcass

and in the selection of potential meat animals. The results obtained with regard to lean to bone ratios show that males appear to have slightly heavier skeleton than that of females giving a lean to bone ratio of 2·3 and 2·4 for males and females, respectively. Such an effect of sex on the lean to bone ratio has also been reported by Taher *et al.* (13) working on a same breed of goat in a study which also indicated that males had a higher proportion of muscle and a lower proportion of total fat than the females. In the present study, the difference observed in the lean: bone ratios at different stages of growth was not statistically significant although a tendency to increase with an increase in the age and weight of lambs was noticed. The reason for this could be the decline in the growth of bone (the growth coefficient of bone relative to the carcass is less than one, Table 4) relative to the growth of lean body tissue and hence an increased lean : bone ratio with the increase in carcass weight and stage of growth.

Relative growth of dissectible body components

Regarding the relative growth of dissectible body components, Afonso and Thompson (23) reported that among carcass tissues of sheep (total fat, carcass lean, bone and viscera) fat is late maturing, while both carcass lean and bone weights are early maturing tissues relative to empty body weight. This pattern of relative development of major carcass tissues is in accordance with the findings of Fourie *et al.* (24) in sheep and Mukhoty and Berg (25) and Berg and Butterfield (26) in cattle and is in line with the results of the present study. Differences in the allometric growth coefficients of different body components have been widely reported (e.g. 27). The results, in general, suggest that the rate of deposition of fat in the carcasses of local goats is slower than in some other tropical goat breeds.

In conclusion, this study shows that among others, factors like growth phase and season of birth had a significant effect on the growth and carcass composition of local Iraqi goat. The effects of growth phase have indicated that the third growth phase is the critical phase of development where strategic nutritional/ management interventions should be made to ensure optimum body growth and carcass composition. In addition, the effect of season of birth of kids on growth and carcass composition revealed an obvious advantage of planned seasonal breeding.

نمو وتركيب ذبائح المعز العراقي المحلي الأسود

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الخلاصة

حلل نمط نمو وتركيب ذبائح الماعز المحلي العراقي الاسود من خلال سلسة من الذبح وتشريح ذبائح ٣٦ جديا عند ٦ مراحل نمو. استخدم نموذج الخطي العام و معادلة النمو الاعتادية لتحديد اثر عوامل مختلفة على النمو ومكونات الذبائح على التوالي. اظهرت النتائج ان كل من نمو الجديان و مكونات الذبائح تاثرت معنويا($p<0.001$, $p<0.05$) بمرحلة النمو والجنس وقد بينت مرحلة النمو بوضوح بطيء في نمو الجسم ومكونات الذبائح في المرحلة الثالثة من النمو (بعد الفطام). وعلى الرغم من وجود تاثير معنوي ($p<0.05$) لمرحلة النمو في نسبة الدهن: اللحم، ولكنه لم يكن له تاثير معنوي في نسبة التصافي ونسبة اللحم:العظم. واظهر انحدار لوغاريتم/لوغاريتم لوزن مكونات الذبائح على وزن الذبيحة الحار ووزن الجسم الفارغ، وان نمو العظام تناقص مع تزايد في نمو اللحم نسبة الى نمو وزن الجسم الفارغ. وان معامل نمو الدهن (١,٠٦) يوضح بان الدهن متاخر النمو. إضافة الى ذلك ان دهن الذبيحة نسبة الى وزن الجسم الفارغ للماعز المحلي اقل من تلك لسلالات الماعز الاخرى.

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