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Allometric Growth Patterns of Body and Carcass Components in Ardhi Goat

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Abstract: This study aims to evaluate the developmental trends and the allometric growth values of various body parts and fat depots of the most prevailing indigenous Saudi goat. Thirty male Ardhi kids were serially slaughtered at 10, 15, 20, 25, 30 and 35 kg live weight. As the kids grew, the bones of hind limb grew at slower rates than the bones of the forelimb and within each limb, the cannon bone grew relatively at a slower rate than the upper skeletal bones. The allometric coefficients for the growth of hot and cold carcass, liver, stomach compartments and lean relative to empty body weight were isogonic (b = 1.00), whereas coefficients of all internal fat depots, intermuscular and subcutaneous fat weights were heterogonic with the high growth impetus of b values greater than 1.00 ($p<0.01$). The developmental rates of the intestines and separated bones from cold carcass side were heterogonic with medium growth impetus. These results, showed that the highest growth coefficients were obtained for omental and perirenal fat indicating the late maturing characteristics of these depots, followed in a decreasing order by mesenteric and intermuscular fat, channel fat and finally subcutaneous and pericardial fat, which were the earliest developing depots.

Keywords: Allometric growth, Ardhi kids, carcass partitioning, fat depots

INTRODUCTION

Within the expanding Saudi Arabian meat production enterprises, increasing emphasis is being placed on the importance of goat production in the overall economic viability of agribusiness industries; it provides the markets with 15.5 thousand tons of meat annually representing over 10% of total indigenous red meat production (FAO, 2010). Goat population in Saudi Arabia is exceeding 3.3 million and mostly in the hands of the nomads and small holder farms. Kids are raised by their mothers and slaughtered at 10-15 kg live weight to produce light carcasses (El-Waziry *et al*., 2011). With the desire for lighter and leaner carcasses, goat offers an attractive alternative to other types of red meat. The pattern of developmental growth and distribution of carcass tissues within the goat body has its own vital physiological significance and it is an area demanding extensive investigations. Several studies have shown that the partitioning of body components is influenced by slaughter weight (Bonvillani *et al*., 2010). In addition, McGregor (1985) and Dhanda *et al*. (2003) found a large heterogeneity in results of goat carcass composition between various goat breeds. Therefore, partition and growth of tissues should be determined for each breed. In Saudi Arabia, Ardhi goat is the most widely distributed indigenous breed in the central and northern areas. There is a dearth of published information on carcass composition from Ardhi goat. Therefore, this study attempts to define the development and distribution of carcass and non-carcass components in Ardhi male goat kids slaughtered at different weights.

MATERIALS AND METHODS

Thirty male weaner kids, of average body weight 7.6±0.2 kg and *circa* 45-60 days old, were selected for this study in an attempt to study the developmental changes and the distribution of carcass and non-carcass components in Ardhi goat kids slaughtered at different weights. Kids were purchased from a local farm; upon arrival to the experimental farm, kids were individually weighed, ear tagged, vaccinated, injected against internal and external parasites and vitamin A-D-E injections were given. Kids were randomly allocated to one of six equal groups of a given slaughter weight (10, 15, 20, 25, 30 and 35 kg) and were serially slaughtered when the average body weight of each group reached the target weight. Each experimental group was housed in a 3×3 m yard located under roof in an open-sided barn. Kids were fed *ad libitum* fattening diet; the fattening diet was formed as a pelleted total-mixed ration consisting of (g/kg DM): 250 g alfalfa hay, 574.4 g barley, 75 g wheat bran, 49.4 g soybean meal, 3.8 g

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salt, 17.3 g limestone, 22.5 g molasses, 1.5 g trace minerals and vitamins and 6.1 g buffer and calcium lignosulfate. The chemical composition (DM basis) was 16.5% CP, 1.16% EE, 24.91% NDF, 14.22% ADF, 7.46% ash and 2.78 Mcal ME/kg DM. All yards were supplemented with mineral mixture blocks.

Upon attaining the target slaughter weight, the lengths of right forelimb and hind-limb bones on the live kids were recorded. These were including humerus: the length between the eminent part of shoulder joint and the elbow joint; ulna: the length between the elbow joint and distal end of the carpal joint; metacarpus: the distance between the carpal joint and fetlock joint; femur: the length between the eminent part of the hip joint and the stifle joint; tibia: the length between the stifle joint and the distal end of the tarsal joint; metatarsus: the distance between the tarsal joint and fetlock joint. All lengths were taken by the same person throughout the trial and measured to the nearest 0.1 cm using vernier caliper.

Kids were slaughtered after 18 h without feed by severing the jugular vein and the carotid arteries. During evisceration, the gastrointestinal tract tied off at the esophagus and rectum. The gastrointestinal tract was subsequently removed, weighed full and empty to calculate empty body weight by subtracting digesta weight from the fasted live weight; the gastrointestinal tract was then separated into stomach compartments and intestines. Hot carcass, liver, empty stomach compartments, empty intestines and internal fat; namely, omental fat, mesenteric fat, perirenal fat, pericardial fat and channel fat weights were recorded immediately after dressing. Carcasses were then chilled at 4°C for 24 h and the cold carcass weights were recorded; thereafter, the carcasses were carefully split longitudinally into two equal halves along the dorsal mid line and the right sides were utilized for subsequent measurements.

The right side of each carcass was then fabricated into six wholesale cuts; namely, shoulder, rack, loin, leg, breast and flank according to the commercial jointing procedures outlined by Romans *et al*. (1985) for lambs. The weight of the wholesale cuts was recorded; each wholesale cut was physically separated into dissectible subcutaneous fat, inter muscular fat, lean and bone components. Carcass component weight on each carcass side was then calculated by summing up the weights of dissectible components in fabricated wholesale cuts.

Data for carcass and non-carcass components, bone lengths and wholesale cut weights were statistically analyzed by regression analysis using GLM procedures of SAS (2002); model included linear and quadratic effects of slaughter weight. To determine the differential growth of body components relative to empty body and cold carcass-side, the bivariate allometric formula $Y = \alpha X^b$ was transformed into logarithms:

$$\text{Log } Y = \text{Log}\alpha + b \log X + \varepsilon$$

where,

- Y = The dependant carcass or non-carcass component measurement
- α = The intercept
- b = Relative growth coefficient of Y with respect to the growth of X
- X = The independent empty body weight or cold carcass-side weight
- ε = The residual error

To verify if $b = 1$, the t-test was used; when $b = 1$, growth was denominated isogonic, indicating that growth of both X and Y were similar during the growth period considered. On the other hand, when $b \neq 1$, growth was denominated heterogonic, being negative with precocious development if $b<1$ and positive with late maturation if $b>1$. The heterogonic growth coefficients were classified into the following growth impetus groups (Abouheif, 1990): high, b value greater ($p<0.05$) than 1; medium, b value less ($p<0.05$) than 1 and greater than 0.5; low, b value less than 0.5 and greater than 0.3; and very low, b value less than 0.3.

RESULTS AND DISCUSSION

As the goat kids grew from 10 to 35 kg (Table 1), the weights of empty body, hot and cold carcass, liver, stomach compartments and intestines increased linearly ($p<0.05$) with the increasing slaughter weight, whereas the dressing percentage exhibited quadratic ($p<0.05$) responses. Dressing percent values for those kids weighing 10 to 20 kg of slaughter weight were not significant differences ($p>0.05$) averaging 43.0%, thereafter it increased ($p<0.05$) to 48.6% when animals attained 25 kg and remained constant up to 35 kg of slaughter weight. These results were partially in line with that reported by Yáňez *et al*. (2009) who found that non-carcass components in Saanen goat kids weighing 5-35 kg showed a curve with a little superior accentuated inflection between 16.7 to 28.2 kg of weight, which caused a slight improvement in carcass dressing with higher weight. According to McGregor (1985) the increased in dressing percentage with increasing live weight was due to the relatively greater growth of fat and muscle compared to the rest of the empty body. Ogink (1993) concluded that the late development of carcasses caused an increase of carcass proportion and yield improvement in Saanen goats between 8.3 and 28 kg of live weight. Generally, dressing percentages in this study vary from 42.5 to 48.6% and these values are in close agreement with that 42-49% reported for different breeds and weights of goat kids (Daskiran *et al*., 2006; El-Waziry *et al*., 2011). The percentage of chilling losses exhibited a trend towards quadratic decreases ($p<0.01$) as

Table 1: Mean weights of various carcass and non-carcass components in growing Ardhi goat kids

	Slaughter weight, kg								Coefficients[1]	
Component	10	15	20	25	30	35	SEM[2]	p-value[3]	b	R^2
Slaughter weight, kg	10.1	15.1	19.8	25.9	30.3	35.3	1.23	L**		
Empty weight, kg	8.9	13.4	17.5	23.2	27.6	32.5	1.63	L**		
Hot carcass, kg	4.4	6.5	8.4	12.6	14.4	16.8	1.48	L**	1.003	0.914
Dressing, %	43.5	43.1	42.5	48.6	47.5	47.6	0.86	Q*	0.003^+	0.258
Cold carcass, kg	4.1	6.1	8.1	12.2	13.9	16.2	1.35	L**	1.075	0.896
Chilling loss, %	6.7	6.1	3.5	3.2	3.5	3.6	0.74	L*Q**	-1.102	0.931
Liver, g	200	470	500	520	650	740	37.7	L**	0.911	0.883
Liver, %[4]	2.2	3.5	2.9	2.2	2.4	2.3	0.35	NS	0.120^+	0.239
Stomach compartments, g	310	530	720	750	950	1050	52.4	L**	0.906	0.813
Stomach compartments,%[4]	3.5	4.0	4.1	3.2	3.4	3.2	0.31	NS	0.106^+	0.218
Intestines, g	460	710	740	830	1050	1110	49.1	L**	0.668^+	0.769
Intestines, %[4]	5.2	5.1	4.2	3.6	3.8	3.4	0.55	L*	-0.398^+	0.189

[1]Estimate derived from allometric equation $Y = \alpha X^b$ describing body component (Y) relative to empty body weight (X); R^2 = coefficient of determination; $^+$ $b \neq 1$ for $p<0.01$; [2]Standard error of mean; [3]Probability of either linear (L) or quadratic (Q) effect of slaughter weight; NS = $p>0.05$, *$p<0.05$, **$p<0.01$. [4]Based on empty body weigh

Table 2: Mean bone lengths in growing Ardhi goat kids

	Slaughter weight, kg								Coefficients[1]	
Bone length, cm	10	15	20	25	30	35	SEM[2]	p-value[3]	b	R^2
Metacarpus	12.6	13.0	13.4	13.9	15.8	16.8	0.40	L**	0.188^+	0.864
Ulna	17.2	17.9	18.0	19.5	21.4	22.8	0.47	L**	0.258^+	0.823
Humerus	14.2	17.3	17.9	20.0	21.6	23.0	0.65	L**	0.387^+	0.769
Metatarsus	16.5	17.0	17.4	18.0	19.0	20.8	0.39	L**	0.168^+	0.673
Tibia	21.2	23.3	23.3	24.6	27.6	29.5	0.68	L**	0.226^+	0.773
Femur	18.3	20.0	23.1	24.3	24.4	24.3	0.54	L*Q**	0.309^+	0.756

[1]Estimate derived from allometric equation $Y= \alpha X^b$ describing bone length (Y) relative to empty body weight (X); R^2 = coefficient of determination; $^+$ $b \neq 1$ for $p<0.01$; [2]Standard error of mean; [3]Probability of either linear (L) orquadratic (Q) effect of slaughter weight; *$p<0.05$ and **$p<0.01$

slaughter weight increases. This result is in accordance with that reported by Marichal *et al*. (2003) who stated that refrigerated losses were decreased with increasing slaughter weight. The decreased chilling loss probably attributed to a reduction in the body surface/body weight ratio and to the thicker subcutaneous fatness of the carcasses (Bonvillani *et al*., 2010). The percentages of liver and stomach compartments did not change ($p>0.05$) with increased slaughter weight, while the percentage of intestines decreased ($p<0.05$) linearly. In contrast, Marichal *et al*. (2003) reported a significant increase in the contribution of the gastrointestinal tract as a percentage of the empty body weight.

The allometric coefficients for the growth of hot and cold carcass, liver and stomach compartments relative to empty body weight were isogonic, indicating that the developmental rates of these characters were similar to the empty body weight increased. The developmental rate of intestines relative to empty body weight increased was heterogonic with a medium growth impetus, showing it to be an early maturing organ in comparison with the liver and stomach compartments that were late developing organs. The growth coefficient values of carcass and liver in this study are similar to those reported coefficients of 1.015 and 0.979 for grazing Angora goat, respectively (McGregor, 1992). Similar results were also reported by Yáňez *et al*. (2009) who found that the relative growth of carcass in relation to empty body weight in Saanen goats was isogonic.

The allometric coefficients of bone lengths relative to empty body weight (Table 2) were heterogonic and significantly ($p<0.01$) smaller than 1.00. Generally, bone lengths of the legs of Ardhi goat kids were slow growing measurements, which agreed with the findings of Teixeira *et al*. (1995) who concluded that long bones were earlier developing parts of the body in Serrana kids. Also, Ogink (1993) found that b value in castrated Saanen and West African Dwarf goats was 0.23 for ulna length in both breeds. In an earlier experiment, Notter *et al*. (1983) found that the growth coefficients for metacarpal and metatarsal bones in sheep had a strong negative allometry as body weight increased. In comparing the relative growth, the length of the humerus and femur had a lower growth impetus ($0.30<b<0.50$), whereas metacarpus, ulna, metatarsus and tibia were of very low growth impetus ($b<0.30$). The results also showed that the bones of hind-limb grew relatively at a slower rate than did the bones of the forelimb and within each limb, the cannon bone (metacarpus/metatarsus) grew relatively at a slower rate than the upper skeletal bones, showing it to be the earliest developing bone within each limb. On a functional basis, the early-maturing pattern of legs, which is responsible for the mobility of the goat kids, was not surprising for an element that is so vital to the survival.

Fat weights in perirenal, channel, pericardial, omental and mesenteric depots (Table 3) increased

Table 3: Mean weights and mean weights expressed as percentages of total internal fat weights of various internal fat depots in growing Ardhi goat kids

	Slaughter weight, kg								Coefficients[1]	
Character	10	15	20	25	30	35	SEM[2]	p-value[3]	b	R^2
Internal fat depot, g										
Perirenal	83	164	210	345	564	820	55.54	L**	1.838$^+$	0.873
Channel	14	27	30	44	77	94	5.52	L**	1.376$^+$	0.864
Pericardial	10	22	23	28	52	67	3.69	L**	1.247$^+$	0.914
Omental	96	204	262	466	830	1155	71.92	L**	1.844$^+$	0.871
Mesenteric	64	125	147	242	380	557	28.73	L**	1.438$^+$	0.902
Total internal fat	267	542	672	1125	1903	2693	86.08	L**	1.685$^+$	0.931
Internal fat depot,%										
Perirenal	31.1	30.3	31.3	30.7	29.6	30.4	3.9	NS	0.111$^+$	0.452
Channel	5.2	5.0	4.5	3.9	4.0	3.5	0.9	NS	-0.185$^+$	0.337
Pericardial	3.7	4.1	3.4	2.5	2.7	2.5	1.3	NS	-0.147$^+$	0.419
Omental	36.0	37.5	39.0	41.4	43.6	42.9	4.6	L**	0.424$^+$	0.679
Mesenteric	24.0	23.1	21.8	21.5	20.1	20.7	3.7	NS	-0.203$^+$	0.286

[1]Estimate derived from allometric equation $Y = \alpha X^b$ describing fat depot "Y" relative to empty body weight "X"; R^2 = coefficient of determination; $^+$ $b \neq 1$ for $p<0.01$; [2]Standard error of mean; [3]Probability of Linear (L) effect of slaughter weight; NS = p>0.05, **p<0.01

linearly (p<0.01) with increased in slaughter weight. Growth coefficients of various internal fat weights relative to empty body weight were heterogonic with high growth impetus of b values greater than 1.00 (p<0.01). The present findings agreed with the literature (McGregor, 1992; Mtenga *et al*., 1994; Bonvillani *et al*., 2010) in that most of the internal fat depots increased in weight at a faster rate than body weight. The largest growth coefficients were for omental and perirenal fat, followed in a decreasing order by mesenteric, channel and pericardial fat depots. Similarly, McGregor (1992) found that the fastest growing fat depots in relation to live weight in grazing Angora goat were omental, followed by perirenal and mesenteric fat. Teixeira *et al*. (1995) reported that the allometric growth coefficient for internal fat weights in relation to empty body weight in Serrana kids were higher than 1.00 and the order of fat deposition was: mesenteric fat, kidney knob and channel fat and omental fat. Also, growth coefficients for omental and pericardial fat weight were significantly higher than 1.00, whereas the allometric coefficient for mesenteric fat was isometric (Bonvillani *et al*., 2010). In a conclusion, one common feature observed in this study and the other mentioned trials that the largest growth coefficient was recorded for the omental fat weight; the pattern of growth coefficients for other internal fat depots varied between trials. The fact that these studies utilized a variety of genotypes merits interpretation of the discrepancies, because breed differences have been observed in fat growth rates and distribution in farm animals (Berg and Butterfield, 1976). These results, however, showed that omental and perirenal fat were the latest developing internal fat depots, while mesenteric, channel and pericardial fat were the earlier developing internal fat depots.

The percentage of omental fat increased (p<0.01) with increased slaughter weight. The percentage of perirenal, channel, pericardial and mesenteric fat weights relative to total internal fat weight showed a non-significant (p>0.05) changes with the increased in slaughter weight. This is, however, in agreement with the findings of Shemeis *et al*. (1994) who found no significant difference among age groups in terms of the fat percentage of perirenal depot and around the intestines reflecting a fixed pattern of fat partitioning in response to changes in chronological age.

The dissectible subcutaneous and intramuscular fat, lean and bone weights from the right side of the cold carcasses (Table 4) were linearly increased (p<0.01) with increased in slaughter weight; such effect of slaughter weight on carcass composition has been widely reported (McGregor, 1992; Mtenga *et al*., 1994; Yáňez *et al*., 2009). As the Ardhi goat kids grew, the proportion of dissectible intramuscular fat and lean as a percentage of the cold carcass side weight increased linearly (p<0.01) with the increasing slaughter weight, while the percentage of bone was linearly decreased (p<0.01). On the other hand, differences in dissectible subcutaneous fat percent between slaughter groups were not detectable (p>0.05).Accordingly, Marichal *et al*. (2003) reported no significant differences among Canary goat kids weighing 6 to 25 kg in the percentage contribution of subcutaneous fat in relation to carcass side weight. The present results contrasted sharply with Mtenga *et al*. (1994) in Saanen goats, who found that the proportion of subcutaneous fat increased with the increased in slaughter weight from 9.5 to 36.5 kg. At similar carcass weights in general, similar trends for lean, bone and inter muscular fat were reported by Dhanda *et al*. (1999) and Marichal *et al*. (2003) who found that age and slaughter weight positively influenced the percentages of lean and intermuscular fat and negatively affected the bone percentage. Bone deposition in animal development precedes deposition of muscle and fat, which should be the reason for these bone results (Treacher *et al*., 1987).

The allometric coefficient for the growth of dissectible lean weight was isogonic (b = 1.113; p>0.05), indicating a proportional growth with empty body weight, while the bone weight was the early developing carcass component with a medium growth

Table 4: Mean weights and mean weights expressed as percentages of cold carcass side weight of various carcass components in growing Ardhi goat kids

	Slaughter weight, kg								Coefficients[1]	
Component	10	15	20	25	30	35	SEM[2]	p-value[3]	b	R^2
Carcass composition, g[4]										
Subcutaneous fat	144	203	311	394	433	570	33.9	L**	1.262^+	0.877
Intermuscular fat	84	128	241	368	443	517	34.4	L**	1.477^+	0.831
Lean	1118	1707	2349	3850	4502	5276	302.4	L**	1.113	0.783
Bone	704	962	1219	1488	1571	1737	73.7	L**	0.695^+	0.822
Carcass composition,%										
Subcutaneous fat	7.0	6.8	6.8	6.5	6.2	6.1	0.31	NS	-0.012^+	0.236
Intermuscular fat	4.1	4.3	4.0	6.0	6.4	6.4	0.29	L**Q**	0.403^+	0.560
Lean	54.4	56.9	58.7	63.1	64.8	65.1	0.98	L**	0.139^+	0.474
Bone	34.5	32.0	30.5	24.4	22.6	21.4	1.11	L**	-0.379^+	0.785

[1]Estimate derived from allometric equation $Y= \alpha X^b$ describing carcass component "Y" relative to empty body weight "X"; R^2 = coefficient of determination; $^+$ $b \neq 1$ for $p<0.01$; [2]Standard error of mean; [3]Probability of either linear (L) or quadratic (Q) effect of slaughter weight; NS= $p>0.05$ and $^{**}p<0.01$; [4]dissected from the right side of cold carcass

Table 5: Mean weights and mean weights expressed as percentages of cold carcass side weight of wholesale cuts in growing Ardhi goat kids

	Slaughter weight, kg								Coefficients[1]	
Character	10	15	20	25	30	35	SEM[2]	p-value[3]	B	R^2
Wholesale cut, g[4]										
Shoulder	606	927	1317	1912	2123	2537	134.7	L**	1.013	0.882
Rack	173	272	367	514	638	746	40.5	L**	1.035	0.992
Loin	216	317	389	657	710	941	50.4	L**	1.064	0.854
Leg	674	978	1266	1899	2023	2385	120.8	L**	0.935	0.892
Breast	315	427	579	860	1167	1100	74.4	L**	0.988	0.859
Flank	65	80	82	257	289	390	25.6	L**	1.392^+	0.877
Wholesale cut,%										
Shoulder	29.6	30.9	32.9	31.4	30.8	31.3	0.84	NS	0.013^+	0.437
Rack	8.4	9.1	9.2	8.5	9.2	9.2	0.25	NS	0.035^+	0.351
Loin	10.5	10.6	9.6	10.7	10.2	11.6	0.28	NS	0.064^+	0.449
Leg	32.9	32.6	31.7	31.2	29.2	29.5	0.69	NS	-0.089^+	0.376
Breast	15.4	14.2	14.6	14.0	16.5	13.6	0.47	NS	-0.012^+	0.296
Flank	3.2	2.7	2.1	4.2	4.2	4.8	0.82	NS	0.029^+	0.315

[1]Estimate derived from allometric equation $Y = \alpha X^b$ describing wholesale cut "Y" relative to empty body weight "X"; R^2 = coefficient of determination; $^+$ $b \neq 1$ for $p<0.01$; [2]Standard error of mean; [3]Probability of linear (L) effect of slaughter weight; NS = $p>0.05$; $^{**}p<0.01$; [4]Fabricated from the right side of cold carcass

impetus (b = 0.695; p<0.01), indicating a declining proportion of this component with increasing empty body weight. The intermuscular and subcutaneous fat weight on the other hand, were heterogonic with growth coefficients of greater than 1.00 (p<0.01), demonstrating the late maturing characteristics of these components. The analyses verified that the intermuscular fat (b = 1.477; p<0.01) was later developing tissue than the subcutaneous fat which had an allometric coefficient of 1.262 (p<0.01), indicating earlier developing. The present tissue growth behavior was in close agreement with the pattern reported by Teixeira *et al*. (1995) and Yáñez *et al*. (2009) who found that bone was the most precocious carcass tissue in relation to empty body weight and growth rate of dissectible lean was comparable to the whole body, while carcass fat was deposited more and more during later growth; Inter muscular fat was later developing than subcutaneous fat.

With regard to the allometric coefficients relating the growth of all studied body fats to empty body weight, results presented in Table 3 and 4 showed that in Ardhi goat kids, the highest growth coefficients were obtained for omental and perirenal fat indicating the late maturing characteristics of these depots, followed in a decreasing order by mesenteric and intermuscular fat, channel fat and finally subcutaneous and pericardial fat which were the earliest developing depots. Generally, the present results confirmed the conclusions by Teixeira *et al*. (1995) who reported that most of the internal fat depots grew at higher rates than carcass fat depots.

The differences observed in the proportions of the wholesale cut weights expressed as a percentage of cold carcass side weight (Table 5) at different slaughter weights were not statistically significant (p>0.05), in agreement with Argüello *et al*. (2007) and Bonvillani *et al*. (2010). The relative growth of wholesale cut weights followed the empty body weight development, with the exception of flank cut which showed a positive heterogonic allometric coefficient greater than 1.00 (b = 1.392; p<0.01). These data agreed with that presented by Yáñez *et al*. (2009) who found isogonic growth coefficients for all commercial cuts in Saanen goats, with exception of brisket cut which had a coefficient value greater than 1.00. The isogonic growth of shoulder, rack, loin, leg and breast cuts might be attributed to the low dissectible fat deposition that allowed the cuts to follow the same behavior of dissectible lean tissue, which was its main constituent. On the contrary, flank cut, considered a region with later maturation and it is possible that the later development is caused by higher fat deposition and lower lean proportion in this region when compared to other cuts. This assumption was supported by the data reported by Dhanda *et al*. (2003) who found that the flank cut had the lowest percentage of muscle and the highest percentage of total fat.

CONCLUSION

Based on presented results, it can be concluded that liver, stomach compartments and lean tissue of the Ardhi kids grow proportionally with the increase in empty weight. All fat tissues, however, grow faster related to empty body weight, whereas intestines and bones were heterogonic with medium growth impetus. The highest growth coefficients were obtained for omental and perirenal fat indicating the late maturing characteristics of these depots, followed by mesenteric and intermuscular fat, channel fat, subcutaneous and pericardial fat, lean, liver and stomach compartments and finally bones and intestines which were the earliest developing organs.

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