

Some aspects of post-natal growth of Arabi sheep: Live weight and body organs

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ABSTRACT

Twelve age groups of 8 Arabi sheep (4 male and 4 female) each, viz. at birth, 1, 2, 3, 4, 5, 6, 9, 12, 15, and 18 months old, and of mature age were selected and slaughtered to find out the growth of live body weight and the growth and maturity coefficients of the following parts or organs head, pelt, feet, liver, heart, lungs and trachea, kidneys, spleen, testes, alimentary canal including oesophagus, stomach and small and large intestines. Males were heavier than females at all ages and the differences increased with age. However, the percentages of head, pelt and feet decreased with age and had growth coefficient values significantly < 1 , while their maturity coefficient values were significantly > 1 , indicating that these parts were low impetus and early maturing. While the spleen and testes were high impetus and early maturing. The growth patterns of the alimentary canal, oesophagus and stomach percentages were increased up to the age of 6 months and gradually decreased up to the maturity. The b values for alimentary canal, esophagus and trachea, stomach and large intestine were significantly > 1 , and were high impetus, while the small intestine showed low impetus.

Alimentary canal, esophagus and small and large intestine were early maturing while stomach was late maturing. Sex had no significant effect on all growth and maturing coefficients of all traits studied.

Key words : Arabi sheep, Carcass, Post-natal growth

This investigation was conducted to study the growth and maturity patterns of non-carcass parts including edible and in-edible organs and parts in Arabi sheep.

MATERIALS AND METHODS

Experimental flock and management

The present study was conducted at the Animal Farm, Agriculture College, University of Basrah. The main flock consisted of 110 ewes (1.5-2.0 years of age) and 6 rams (3.0-3.5 years of age) of Arabi sheep during 2 breeding seasons 1994-1995. Male and female lambs born in the flock were used to study the growth and development of their edible and in-edible organs or parts. During pre-weaning period, lambs were suckling their dams and small amount of green alfalfa and barley *ad lib.* were given up to weaning (90 days). During post-weaning period lambs were fed on barley 2% of their body weight and 0.5 kg of green alfalfa / lamb / day was given. Besides lambs were allowed to graze for about 6 hr/day on natural pasture, while their dams besides were fed 350g barley /ewe / day and 0.5 kg of green alfalfa, besides

they were allowed to graze on natural pasture for about 6 hr/day. Lambs and their dams were given routine vaccination and internal and external parasites treatments.

Selection of animals for slaughter

Male (4) and female (4) Arabi sheep of each of the 12 age groups, viz. at birth, 1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 15, 18 months old and mature age were selected for slaughter, as closely as possible to the average weight for lambs in each group of different sexes. The mature rams and ewes were selected from the main flock equal to the average weights of mature Arabi sheep (Bhat 1985, Al-Saigh and Al-Khauzai 1993).

Slaughter procedure and carcass dissection

Animals selected were fasted for 18 hr prior to slaughter, carcasses were chilled for 24 hr at 4°C. The selected organs or parts dissected were out during the dressing process after, trimming, cleaning and weighing. The organs or parts were head including horns and skin, pelt without fragments of head and feet, 4 feet, liver after the bile was removed, heart, lungs and trachea as one unit, kidney stripped of their capsules, spleen, testes and alimentary canal cleaned from fat and glands and separated up to oesophagus extending from pharynx, stomach (including rumen, reticulum, omasum and abomasum as one unit), small intestine and large intestine (including caecum and rectum).

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Statistical procedures

The statistical model used to describe all traits was as follows :

$$Y_{ijk} = U + A_i + S_{ij} + e_{ijk}$$

where U was overall mean,

A_i = effect of *i*th age (*i* = 1-12)

S_{ij} = effect of *j*th sex of *i*th age (*i* = 1-12)

e_{ijk} = the random error associated with each observation having zero mean and $1 \sigma^2$.

To examine the relative growth of organs or parts, allometric growth coefficients equation (Huxley 1932) was used. This equation is equivalent to $\log Y = a + b \log X$

where Y is the weight of any organ or part,

X is the starved body weight, and

the symbol b is the growth coefficient.

However, b significantly > 1 = the organ or part grew faster than the body as a whole; b significantly < 1 = the organ or part grew slower than the body; b not significantly different than 1 = the organ or part grew similar to the body as a whole. Testing of homogeneity of growth coefficients between males and females was applied.

To describe the maturing patterns of organs and parts were calculated using the statistical procedure obtained by Butterfield *et al.* (1983a and b) using quadratic equation as follows:

$$Y = p + qX + rX^2$$

where Y = I / Im organ or part weight / mature organ or part weight

X = T / Tm live weight / mature live weight.

which was constrained to pass through the origin (0, 0) and (1, 1) and fitted in the form $Y' = qX'$, where $Y' = (Y - X^2)$ and $X' = (X - X^2)$. q significantly > 1 = an early maturing organ or part; q significantly < 1 = a late maturing organ or part, when q not significantly different from 1 an average matur-

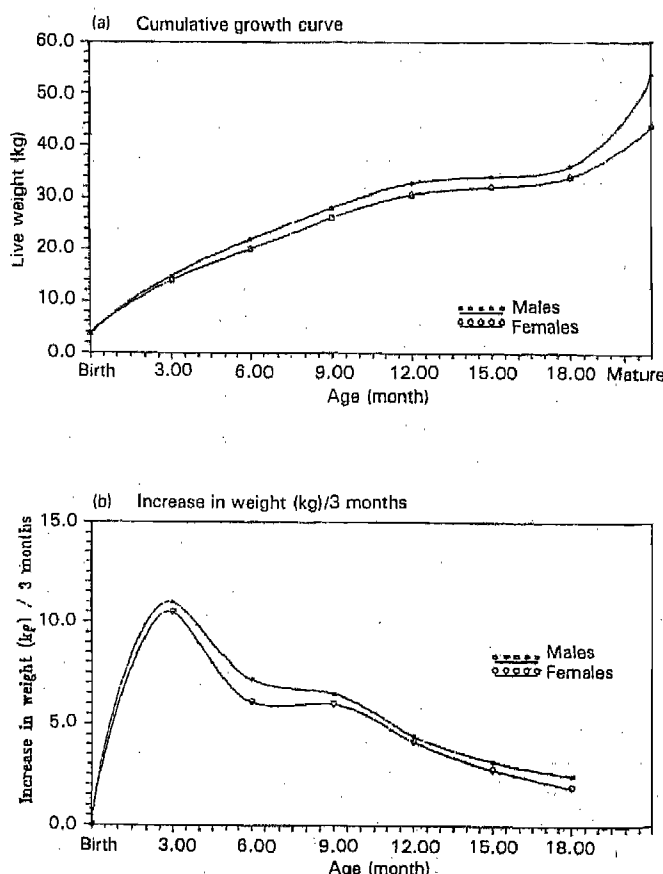


Fig. 1. Growth curve of Arabi sheep (a, b)

ing organ or part relative to the maturing of starved live body weight.

RESULTS AND DISCUSSION

Live weight

The growth in live weight (Fig. 1) showed a sigmoid curve.

Table 1. Starved body weight (kg) and the mean of inedible organs ±SE of Arabi sheep

Slaughter age groups/months	Starved body wt kg		Head %		Pelt %		Feet %	
	Males	Females	Males	Females	Males	Females	Males	Females
At birth	3.87 ^m ±0.23	3.55 ^m ±0.08	18.19±0.60	12.19±0.20	13.45±0.19	13.38±0.14	7.71±0.25	7.52±0.22
1	7.68 ^k ±0.50	7.68 ^k ±0.50	9.16 ^b ±0.59	9.11 ^b ±0.51	12.50 ^b ±0.26	12.00±0.27	4.96 ^b ±0.25	4.63 ^b ±0.27
2	11.40±0.44	10.70 ^c ±0.51	9.03 ^b ±0.60	9.00 ^b ±0.30	12.11±0.10	12.18±0.08	4.39±0.18	4.20 ^c ±0.11
3	14.80±0.61	14.00 ^c ±0.61	8.13±0.30	8.03 ^c ±0.23	12.00±0.14	12.17±0.08	4.14±0.09	4.06 ^d ±0.14
4	17.40 ^h ±0.84	16.30 ^h ±0.67	7.80±0.22	7.69±0.23	11.87±0.16	11.70±0.20	3.60±0.14	3.41±0.11
5	19.65±0.62	18.30 ^h ±1.03	7.38±0.24	7.02±0.27	11.18±0.14	11.12±0.16	3.35±0.16	3.10 ^h ±0.13
6	22.00 ^f ±0.40	20.10 ^h ±0.40	7.27±0.20	6.96 ^d ±0.30	10.73±0.17	10.68±0.10	3.16±0.13	2.97±0.13
9	28.50 ^e ±0.40	26.10 ^g ±0.40	7.05±0.22	6.57 ^e ±0.24	9.96±0.15	9.72±0.20	2.69±0.09	2.63±0.07
12	32.80 ^d ±0.50	30.60 ^d ±0.60	6.47±0.25	6.29 ^e ±0.21	9.85±0.17	9.75±0.20	2.43±0.09	2.40±0.06
15	34.00 ^c ±0.50	32.00 ^g ±0.40	6.46±0.20	6.10 ^g ±0.29	9.88±0.15	9.70±0.27	2.43±0.12	2.42±0.07
18	36.50 ^b ±0.8b0	38.90 ^b ±1.10	6.30±0.18	5.94±0.28	9.38±0.11	9.29±0.16	2.40±0.15	2.35±0.11
Mature	54.50 ^a ±2.30	44.00 ^a ±0.90	5.30±0.30	5.09 ^h ±0.30	9.35±0.22	9.31±0.14	2.26±0.16	2.20±0.15

Different small letters in one column shows significant differences at 5% level; different capital letters in one horizontal line shows significant.

Table 2. Growth and maturity coefficients of inedible and edible organs or parts and the components of the alimentary canal

Organ or part	Growth coefficients (b)		Maturity coefficient (q)
	Male	Female	
Head	0.585 ^b	0.590 ^b	1.582 ^a
Pelt	0.916 ^b	0.876 ^b	1.283 ^a
Feet	0.581 ^b	0.519 ^b	1.628 ^a
Liver	0.740 ^b	0.719 ^b	1.408 ^a
Heart	0.798 ^b	0.742 ^b	1.126 ^a
Spleen	1.131 ^a	1.102 ^a	1.120 ^a
Lungs and trachca	0.666 ^b	0.629 ^b	1.231 ^a
Kidneys	0.681 ^b	0.642 ^b	1.036 ^a
Testes	1.410 ^a	-	1.230 ^a
Alimentary canal	1.038 ^a	1.031 ^a	1.778 ^a
Oesophagus	1.052 ^a	1.042 ^a	1.382 ^a
Stomach	1.158 ^a	1.139 ^a	0.819 ^b
Small intestine	0.810 ^b	0.829 ^b	2.116 ^a
Large intestine	1.110 ^a	1.095 ^a	1.930 ^a

a: (b) or (q) values significantly >1 b: (b) or (q) values significantly <1.

The mean weight of males; at birth, 1, 2, 3, 4, 5, 6, 9, 12, 15, 18 months and maturing were 3.87, 7.68, 11.40, 14.60, 17.40, 19.65, 22.00, 28.50, 32.82, 34.00, 36.50 and 54.50 kg respectively, while those for females live weights were 3.55,

7.50, 10.70, 14.00, 16.30, 18.30, 20.10, 26.10, 30.60, 32.00, 33.90, and 44.00 kg respectively (Table 1). Males tended to be heavier than females, but the significant differences appeared from age of 6 months and gradually increased up to the maturity. Aziz (1977) and Bhadula and Bhat (1980) reported that males have heavier weights than females and the differences increased with age. These differences could be associated with sex hormones (Yeates *et al.* 1975), Aziz (1977) however, pointed out the heavier weaning weight of males which affected the later weights with advancement of age in sheep.

Inedible organs or parts

The percentages of head, pelt and feet from the live body weight decreased as animals grew from birth up to maturity (Table 1). Hammond *et al.* (1971) reported that the proportion of head and feet were greater at birth and then decreased at maturity and those organs developed early. Gaili *et al.* (1972) found that the percentage of pelt was 9.6% in young Sudan desert sheep and decreased to 8.9% at mature age, while Tahir *et al.* (1985) stated that the percentages of head and feet decreased as animals grew older but the little increase in the percentage of pelt probably was because of an increase in the thickness of pelt and the growth of wool.

The growth (b) and maturity (q) coefficients for body organs or parts were shown in Table 2. Head, pelt and feet had growth coefficients significantly <1, while their maturity (q)

Table 3. Mean percentage of edible organs \pm SE of Arabi sheep

Slaughter age groups/months	Liver %		Heart%		Spleen %		Lungs and Trachea		Kidney		Testes %
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males
At birth	2.30 ^a	2.25 ^a	0.79 ^a	0.77 ^a	0.17 ^c	0.15 ^c	2.36 ^a	2.28 ^a	0.78 ^a	0.73 ^a	0.51 ^f
	± 0.20	± 0.10	± 0.01	± 0.10	± 0.02	± 0.01	± 0.03	± 0.03	± 0.06	± 0.06	± 0.20
1	1.83 ^b	1.82 ^b	0.69 ^b	0.54 ^b	0.20 ^c	0.19 ^{cd}	1.97 ^b	1.91 ^b	0.39 ^b	0.40 ^b	0.039 ^f
	± 0.13	± 0.09	± 0.01	± 0.01	± 0.01	± 0.01	± 0.02	± 0.03	± 0.02	± 0.04	± 0.003
2	1.83 ^b	1.82 ^b	0.53 ^c	0.52 ^{bc}	0.22 ^c	0.18 ^d	1.65 ^c	1.71 ^c	0.32 ^c	0.29 ^c	0.030 ^f
	$\pm 0.0.5$	± 0.10	± 0.02	± 0.04	± 0.02	± 0.02	± 0.03	± 0.05	± 0.02	± 0.02	± 0.001
3	1.73 ^c	1.73 ^c	0.53 ^c	0.52 ^{bc}	0.27 ^a	0.23 ^a	1.60 ^c	1.59 ^d	0.31 ^{cd}	0.29 ^c	0.060 ^f
	± 0.04	± 0.03	± 0.03	± 0.03	± 0.01	± 0.01	± 0.03	± 0.03	± 0.02	± 0.03	± 0.007
4	1.64 ^d	1.64 ^d	0.50 ^{cd}	0.52 ^{bc}	0.24 ^b	0.21 ^b	1.58 ^c	1.56 ^d	0.30 ^{cd}	0.29 ^c	0.114 ^e
	± 0.06	± 0.07	± 0.02	± 0.01	± 0.02	± 0.03	± 0.03	± 0.04	± 0.01	± 0.01	± 0.010
5	1.58 ^{de}	1.56 ^c	0.46 ^{de}	0.49 ^{cd}	0.23 ^{bc}	0.23 ^a	1.42 ^d	1.46 ^{de}	0.30 ^{cd}	0.28 ^c	0.220 ^d
	± 0.03	± 0.03	± 0.06	± 0.03	± 0.01	± 0.02	± 0.02	± 0.04	± 0.01	± 0.01	± 0.009
6	1.52 ^e	1.51 ^c	0.43 ^e	0.48 ^d	0.23 ^{bc}	0.22 ^a	1.30 ^e	1.35 ^e	0.29 ^{cd}	0.28 ^c	0.258 ^d
	± 0.44	± 0.06	± 0.02	± 0.01	± 0.01	± 0.03	± 0.06	± 0.06	± 0.01	± 0.01	± 0.003
9	1.38 ^f	1.39 ^f	0.43 ^e	0.44 ^a	0.22 ^c	0.20 ^{bc}	1.12 ^f	1.07 ^f	0.28 ^{de}	0.28 ^c	0.452 ^e
	± 0.08	± 0.06	± 0.03	± 0.02	± 0.01	± 0.02	± 0.09	± 0.03	± 0.01	± 0.02	± 0.005
12	1.23 ^f	1.20 ^f	0.44 ^a	0.43 ^c	0.20 ^d	0.19 ^{cd}	1.03 ^f	1.03 ^f	0.27 ^e	0.27 ^c	0.468 ^e
	± 0.07	± 0.05	± 0.02	± 0.02	± 0.40	± 0.03	± 0.09	± 0.03	± 0.02	± 0.02	± 0.010
15	1.26 ^g	1.20 ^g	0.42 ^a	0.43 ^a	0.20 ^d	0.19 ^{cd}	1.04 ^f	1.03 ^f	0.27 ^e	0.27 ^c	0.647 ^b
	± 0.10	± 0.05	± 0.04	± 0.03	± 0.01	± 0.01	± 0.03	± 0.01	± 0.01	± 0.01	± 0.006
18	1.25 ^g	1.20 ^g	0.42 ^a	0.43 ^c	0.19 ^d	0.19 ^{cd}	1.09 ^f	1.03 ^f	0.27 ^e	0.27 ^c	0.683 ^b
	± 0.40	± 0.07	± 0.02	± 0.02	± 0.02	± 0.01	± 0.01	± 0.01	± 0.01	± 0.01	± 0.013
Mature	1.21 ^g	1.14 ^g	0.42 ^a	0.45 ^c	0.19 ^d	0.18 ^d	1.09 ^f	1.05 ^f	0.27 ^e	0.27 ^c	0.791 ^a
	± 0.50	± 0.03	± 0.01	± 0.02	± 0.01	± 0.01	± 0.01	± 0.01	± 0.01	± 0.01	± 0.080

Different small letters in one column shows significant differences at 5% level.

Table 4. Mean percentage of edible organs \pm SE of Arabi sheep

Slaughter age groups/months	Alimentary canal		Oesophagus %		Stomach%		Small intestine		Large intestine %	
	Males	Memales	Males	Females	Males	Females	Males	Females	Males	Females
At birth	4.33 ^e	4.46 ^f	0.115 ^d	0.112 ^a	1.15 ^a	1.17 ^e	2.52 ^c	2.53 ^d	0.665 ^a	0.639 ^f
	± 0.13	± 0.11	± 0.006	± 0.005	± 0.05	± 0.01	± 0.05	± 0.02	± 0.010	± 0.020
1	5.28 ^d	5.15 ^e	0.121 ^d	0.114 ^e	1.61 ^f	1.62 ^d	2.87 ^{ab}	2.75 ^e	0.674 ^c	0.662 ^f
	± 0.37	± 0.29	± 0.005	± 0.004	± 0.04	± 0.05	± 0.29	± 0.23	± 0.02	± 0.02
2	6.41 ^b	6.61 ^a	0.131 ^e	0.140 ^e	2.42 ^d	2.50 ^{bc}	2.88 ^a	2.00 ^b	0.964 ^{bc}	0.992 ^b
	$\pm 0.2^s$	± 0.23	± 0.007	± 0.010	± 0.07	± 0.06	± 0.22	± 0.14	± 0.04	± 0.05
3	6.63 ^{ab}	6.72 ^a	0.131 ^e	0.136 ^e	2.51 ^e	2.62 ^b	3.01 ^a	3.27 ^a	0.979 ^b	0.972 ^{cd}
	± 0.27	± 0.31	± 0.007	± 0.008	± 0.09	± 0.12	± 0.15	± 0.27	± 0.080	± 0.040
4	6.84 ^a	6.63 ^a	0.154 ^a	0.149 ^b	2.59 ^b	2.60 ^b	3.01 ^a	3.27 ^b	0.979 ^a	0.972 ^{ab}
	± 0.22	± 0.26	± 0.006	± 0.008	± 0.11	± 0.08	± 0.27	± 0.21	± 0.060	± 0.070
5	6.77 ^a	6.63 ^a	0.162 ^a	0.168 ^a	2.63 ^b	2.74 ^a	2.67 ^{bc}	2.65 ^{cd}	1.110 ^a	1.070 ^a
	± 0.17	± 0.24	± 0.004	± 0.008	± 0.07	± 0.08	± 0.17	± 0.18	± 0.040	± 0.050
6	6.81 ^a	6.62 ^a	0.159 ^a	0.164 ^a	2.97 ^a	2.83 ^a	2.62 ^c	2.17 ^c	1.023 ^a	1.045 ^{ab}
	± 0.51	± 0.20	± 0.007	± 0.006	± 0.07	± 0.16	± 0.12	± 0.10	± 0.020	± 0.030
9	5.89 ^c	6.23 ^b	0.131 ^e	0.149 ^b	2.66 ^b	2.79 ^a	2.25 ^d	2.05 ^c	0.907 ^c	0.938 ^d
	± 0.81	± 0.17	± 0.008	± 0.005	± 0.08	± 0.08	± 0.03	± 0.04	± 0.030	± 0.020
12	5.53 ^d	5.62 ^e	0.140 ^b	0.140 ^e	2.48 ^c	2.51 ^{bc}	2.05 ^{de}	2.12 ^c	0.852 ^a	0.858 ^a
	± 0.12	± 0.10	± 0.004	± 0.005	± 0.16	± 0.07	± 0.02	± 0.02	± 0.02	± 0.020
15	5.47 ^d	5.66 ^e	0.142 ^b	0.136 ^e	2.38 ^c	2.50 ^{bc}	2.06 ^{de}	2.13 ^c	0.882 ^a	0.878 ^c
	± 0.11	± 0.10	± 0.006	± 0.005	± 0.07	± 0.06	± 0.05	± 0.03	± 0.40	± 0.020
18	5.27 ^d	5.48 ^{cd}	0.136 ^b	0.140 ^e	2.32 ^c	2.41 ^c	1.94 ^c	2.06 ^c	0.866 ^d	0.882 ^c
	± 0.10	± 0.11	± 0.006	± 0.003	± 0.07	± 0.06	± 0.03	± 0.06	± 0.030	± 0.040
Mature	5.11 ^d	5.30 ^{cd}	0.113 ^a	0.131 ^d	2.58 ^e	2.52 ^{bc}	1.44 ^f	1.65 ^f	0.963 ^{bc}	0.953 ^d
	± 0.13	± 0.14	± 0.004	± 0.003	± 0.14	± 0.11	± 0.02	± 0.03	± 0.20	± 0.020

Different small letters in one column shows significant differences at 5% level.

coefficient values were significantly >1 , indicating these parts were low impetus and early maturing relative to the body weight as a whole. However, the values of the growth coefficients for head (0.737-0.830) and pelt (0.518-0.833) in South down, Romney and their crosses were significantly lower than 1.0 and were low impetus (Kirton *et al.* 1972), whereas the maturity coefficients q values for head, pelt and feet were 1.34, 1.15 and 1.68, respectively, for Merino sheep, indicating they were early maturing (Butterfield *et al.* 1983c). Also the q values in this study were in agreement with the trend of those found by Butterfield *et al.* (1984) and Thonney *et al.* (1987). No significant differences between (b) values of males and females for head, pelt and feet were detected (Table 2).

Edible organs and parts

The percentages of liver, heart, lungs and trachea and kidneys decreased (Table 3) with advancing age and had similar patterns to those of inedible parts and organs, while spleen and testes had different patterns, the percentage of spleen increased up to the age of 3 months thereafter declined, whereas the percentage of the testes gradually increased up to maturity. The trend of these results were similar to those reported by Tahir *et al.* (1985) and Thonney *et al.* (1987). The difference in patterns of percentages of such organs or parts might

be because of the maximum growth rate happened at different periods.

The growth coefficients (b) for liver, heart, lungs and trachea and kidneys were significantly <1 , indicating they were low impetus (Table 2) while b values of spleen and testes were significantly >1 indicating they were high impetus. However, the maturity coefficients q values of liver (1.408), heart (1.126), lungs and trachea (1.231), kidneys (1.063), spleen (1.120) and testes (1.230), were significantly >1 , indicating that these organs were early maturing and had vital function in the beginning of animals life. The trend of the growth coefficients b of the present study was mainly in agreement with those of Kirton *et al.* (1972). Butterfield *et al.* (1983c and 1984) reported that the q values of those organs or parts ranged from 1.30 to 2.51. However, Thonney *et al.* (1987) pointed out that the q values of the internal organs were significantly higher than 1.0. However, sex had no significant differences in growth coefficients of these organs or parts.

Alimentary canal

The least average percentage of empty alimentary canal was found at birth, while the highest percentage was reached at the age of 6 months (Table 4) then gradually decreased and reached to 5.20% at maturity. The oesophagus and stom-

ach had similar percentages trends at birth and the age of 6 months and then decreased at maturity. However, the average percentage of the small intestine was 2.52% at birth and reached the highest value of 3.28% at the age of 3 month. Whereas, the average percentage of the large intestine was 0.652% at birth and increased to reach the highest percentage of 1.09% at the age of 5 months, then decreased to 0.958% at maturity. The small intestine matured early and reached to the maximum values at an early age of 3 months may be because the lambs in pre-weaning period have simple stomach and their feed mainly depended on the milk of their dams, and the small intestine well developed at an early stage for higher absorption of milk nutrients.

The empty alimentary canal and its components oesophagus, stomach and large intestine had growth coefficients values significantly greater than 1.0 (Table 2) and were hence high impetus. The small intestine had b value significantly <1 and was low impetus. These results were in agreement with that of Kirton *et al.* (1972), but was not in agreement with that of Kirton *et al.* (1974) in b value of the stomach 0.917 over 5 breeds of sheep. These differences in b values of the stomach might be because of the type of ration which animals were fed.

The empty alimentary canal had maturity coefficient value of 1.778 which was significantly >1, while Butterfield *et al.* (1983c) calculated 3.20 for Merino sheep and Butterfield *et al.* (1984) found 2.11 for weather and 3.47 for Dorset horn rams. However, the average maturity coefficient value of Thonney *et al.* (1987) was 2.12 for many breeds of sheep. The high q values (ie early maturing) for the components of the alimentary canal were associated with small intestine, large intestine then the oesophagus were significantly higher than 1.0 being an early maturing compared to the starved live body weight as a whole, while stomach had q value 0.819 significantly <1 and was late maturing. No significant differences between b values of males and females for the alimentary canal and its components were found (Table 2).

It could be concluded that heart, pelt and feet were low impetus and early mature. Spleen and testes were high impetus and early mature. Oesophagus, small and large intestine were early mature, while stomach was late mature. Sex had no effect on growth coefficient.

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