*Livestock Studies 62(1), 21-30*
*https://doi.org/10.46897/livestockstudies.1120052*

RESEARCH PAPER

LIVESTOCK STUDIES

# The First Identification and Some Carcass Characteristics of the 7 Lumbar Vertebrae in Sheep in Turkey

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**Article History**
Received: 30 September 2021
Accepted: 23 February 2022
First Online: 23 May 2022

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**Keywords**
Lamb
Lumbar vertebrae number
Slaughter traits
Carcass traits

## Abstract

The purpose of this study was to draw attention to the number of the lumbar vertebrae in BA B1 crosses (Bafra×F1 (Bafra×Akkaraman)) lambs (75% Bafra and 25% Akkaraman), and the effect of 7 lumbar vertebrae on some carcass traits. Even though some studies reported that the number of the lumbar vertebrae might be considerably different dependent on the sheep genotype, this has not been reported for Turkish breeds. While a study on the BA B1 lambs has been performed, seven lumbar vertebrae have been identified in four of the eighteen lambs. The means of the carcass length (80.800±0.583 and 84.375±1.375 cm) ($P$ = 0.036), leg weight (5.942±0.079 and 6.209±0.052kg) ($P$ = 0.032), loin weight (1.560±0.096 and 1.849±0.060 kg) ($P$ = 0.048), and loin's lean weight (0.875±0.059 and 1.058±0.032 kg) (P=0.040) were statistically different between the groups of lambs (6 and 7 lumbar vertebrae, respectively). In conclusion, the number of lumbar vertebrae has economically affected important parts of the carcass.

## Introduction

The mammalian vertebral column, also known as the spinal column or spin, consists of a sequence and repeating bones called vertebrae and is divided into five morphologically different and functionally distinct spinal regions (cervical, thoracic, lumbar, sacral and caudal vertebrae) (Donaldson *et al*., 2013; Zhang *et al*., 2019). The vertebrae number of the each region gives the vertebral pattern, and this pattern is generally C7T13L6(7)S4Ca(Cy)16-18 in the sheep breeds (Akers and Denbow, 2013). This pattern varies across the mammalian species, but the cervical vertebrae number is conserved at a total of seven in the mammalian species except for a few species (Lambe *et al*., 2014; Lee *et al*., 2011). Moreover, the vertebral number of the post-cervical region shows differences between and within the breeds. For instance, Arabian horses have one less lumbar vertebra than the all other common horse breeds, and European commercial pig breeds (n=21–23) have more thoracolumbar vertebrae than the Asian breeds (n=19-20) (Borchers *et al*., 2004; Reese, 2019; Zhang *et al*., 2017). In the sheep, European breeds (n=17-21) and Chinese indigenous breeds (n=19-21) may reveal the range of variation in terms of the thoracolumbar vertebrae number (Zhang *et al*., 2017, 2019). It is reported that lumbar vertebrae numbers of the Texel, Scottish Blackface, and Mongolia sheep have shown a variation between 4 and 7; 6 and 8; 6 and 7, respectively (Donaldson *et al*., 2013; Zhang *et al*., 1998;).

The length of the thoracolumbar region affects the production traits, so the variation of the thoracolumbar vertebra number within the breeds can be used to increase the production yields per animal. For example, Arabian horses have five lumbar vertebrae, and this trait provides them a better endurance ability than other horse breeds. On the other hand, long thoracolumbar region in the livestock affects the body length, carcass traits and the amount of quality meat in the carcass because this region is the most valuable section of the carcass. In addition, long body length can affect the fertility and milking traits since the long lumbar region provides larger area for genital organs (Akçapınar and Özbeyaz, 1999; Akçapınar, 2000).

It is known that vertebral number was highly heritable in the pigs (Borchers *et al*., 2004; King and Roberts, 1960), and the selection of pig broods with longer back trait caused more thoracolumbar vertebras in the commercial pig breeds having 21 to 23 thoracolumbar vertebras than their ancestors having 19 thoracolumbar vertebras (Donaldson *et al*., 2013; Fredeen and Newman, 1962; Yang *et al*., 2009). King and Roberts (1960) reported that each extra vertebra caused an increase of about 1.5 cm in the carcass length, and on the other hand Tohara (1967) stated this variation in the pig breeds could cause totally 85 mm extension in the carcass length.

As already mentioned, the trochal and lumbar vertebrae numbers in the sheep show a variation between and within the breed. Higher thoracolumbar vertebrae number is a desirable trait; therefore, this is expected to increase in the sheep populations. Zhang and Siqin (1998) indicated this rate increase in the Mongolian sheep between 1982 and 1996 years. The heritability of the vertebra number in the sheep is different for separate vertebral regions. While this trait in the Texel sheep is high for the trochal region ($h^2$=0.99; SE=0.42), it is relatively low for the lumbar region ($h2$=0.08; SE=0.12) (Donaldson, 2015).

Genetic control of the vertebral morphology was determined to be done by the Hox gene family (Wellik, 2007). Previous studies showed that Vertin (VRTN) gene affects the thoracic vertebrae number in sheep and pigs, and NR6A1 gene affects the lumbar vertebrae number in pigs (Li *et al*., 2019; Yang *et al*., 2016).

The objective of this current study was to evaluate the effect of 6 and 7 lumbar vertebrae numbers (Figure 1) on the slaughter and carcass traits in the BA B1 genotype.

## Materials and Methods

### Materials

This study was performed using 9 BA B1 lambs (5 lambs having 6 lumbar vertebrae and 4 lambs having 7 lumbar vertebrae). BA B1 lamb is a crossbreed genotype, obtained via the crossbreeding of Bafra (75%) and Akkaraman (25%) breeds at the Gozlu state farm (38° 29' N and 32° 27' E, 1020 m of altitude) in the central Anatolia region of Turkey. Bafra rams mated with Akkaraman ewes, and F1 ewes were then backcrossed with Bafra rams to produce the second cross (B1) lambs.

Lambs were separated from dams at an average 90 days of age (weaning) and fattened during 84 days with ad-libitum concentrate fed (15% crude protein and 2,800 kcal/kg ME) and 300 g alfalfa hay per animal/day after 10 days dietary adaptation period. Finally, lambs having 6 and 7 lumbar vertebrae were slaughtered at a mean weight of 42.950±0.877 and 42.175±0.893 kg, respectively.

### Methods

Lambs' weights were determined 12 hours before slaughter, and then when fasting just before slaughter. Head, skin, feet, heart, lungs, liver, spleen, testicles, full digestive tract, empty rumen, empty intestine, trachea-


**Figure 1.** Some carcass photos for the carcasses having 6 and 7 lumbar vertebrae.

esophagus, omental fat, and mesenteric fat were removed and weighted after bleeding. Then, the carcass measurements were taken.

The length of the carcass (between the caput humeri and tuber ischia), the back (between the distal cranial points of the shoulder and the tail), the leg internal (between the cranial edge of symphysis pubis and the tarsal–metatarsal joint), the leg external (between the articulatio coxae and the tarsal–metatarsal joint), the rump (between the tuber coxae and tuber ischia) and the neck (between the distal cranial point of the shoulder and cranial point of the neck) were measured on the carcasses. Similarly, the width of the leg (distance between the two gigots at the junction point alignment of the legs), the chest (distance between the left and right of the extremitas proximalis scapulas) and the rump (distance between the articulationes coxae) were obtained on the carcasses. Then, leg circumference (over the articulationes coxae on the carcass), chest girth (over the caudal points of the scapulas), rump girth (over the articulationes coxae), chest depth (distance between the sternum and the withers) were taken. Carcass compactness and leg compactness indexes were calculated by the formulae: cold carcass weight/length (kg/m) and leg weight/length (kg/m), respectively (Santos *et al*., 2007).

Gastrointestinal tracts were weighed both full and empty to identify gastro-intestinal contents weights, and empty body weight was calculated using these values. Consequently, dressing percentages were calculated based on slaughter weight and empty body weight. The carcass body (including perinephric–pelvic fat and kidneys) was chilled at 4 °C for 24 h and weighed. To measure the eye muscle (MLD: musculus longissimus dorsi) area (cm2), it was drawn onto the transparency sheet at the level of the 12th and 13th rib 24 h after the slaughter, and this figure area was calculated using th e AutoCAD software (version 2019). At the same time, the fat depth was measured from subcutaneous fat using a caliper in this region.

After this period, tail, perinephric–pelvic fat and kidneys were separated from the carcasses, and the carcasses were symmetrically divided through the columna vertebralis. Left and right side of the carcass were weighed, and left side was cut into six sections (leg, foreleg, back, loin, neck and breast+flank) according to the Akçapınar (1981). These individual cuts were grouped by first quality (leg, back, and loin), second quality (foreleg), and third quality (neck and breast+flank) according to the Díaz *et al*. (2006). Each individual cut piece was dissected and weighed as the lean, bone, fat, and remainder.

**Statistical Analysis**

In this study, SPSS software package (SPSS Software, 2005) was used for the t-test analysis to determine the influence of having 6 and 7 lumbar vertebrae lambs within the genotype on the slaughter and carcass characteristics.

## Results and Discussion

Generally, lamb meat production is the primary function of the world and Turkey sheep industry. The profit increase in this industry can be achieved in a number of ways; and especially development of the carcass quality traits is one of those ways. The detection of the easy identification methods, determination of the gene effects on the carcass characteristics and using those in the animal breeding programs can provide an increase in the amount of muscle and saleable meat for specific body regions or cuts. For instance, the increase in the trochal and/or lumbar vertebrae numbers (i.e., larger carcass length and lumbar vertebrae number) is significant in terms of sheep meat production.

**Table 1.** Means (±SE) of slaughter characteristics.

| Trait | Means | | | Minimum | Maximum |
|---|---|---|---|---|---|
| | L6 (n:5) | L7 (n:4) | Sig. | L6 - L7 | L6 - L7 |
| Final weight (kg) | 44.020±0.905 | 44.088±0.915 | 0.960 | 42.450-42.750 | 46.700-46.750 |
| Slaughter weight (kg) | 42.950±0.877 | 42.175±0.893 | 0.560 | 41.350-41.200 | 45.450-44.850 |
| Empty body weight (kg) | 40.663±0.755 | 40.636±0.861 | 0.981 | 39.179-39.197 | 43.042-43.071 |
| Hot carcass weight (kg) | 20.452±0.590 | 20.211±0.529 | 0.776 | 18.982-19.395 | 22.589-21.766 |
| Carcass weight (kg) | 19.720±0.524 | 19.650±0.403 | 0.922 | 18.400-19.000 | 21.600-21.800 |
| Hot dressing[a] (%) | 47.627±1.062 | 47.909±0.304 | 0.810 | 44.853-47.075 | 50.535-48.531 |
| Hot dressing[b] (%) | 50.270±0.738 | 49.730±0.531 | 0.591 | 48.449-48.763 | 52.481-50.756 |
| Chilled dressing[a] (%) | 45.940±1.081 | 46.960±0.312 | 0.587 | 42.684-46.116 | 48.322-47.515 |
| Chilled dressing[b] (%) | 48.485±0.724 | 48.360±0.231 | 0.880 | 46.455-47.868 | 50.183-48.983 |

L6 and L7: No. of lumbar vertebrae
[a] Based-on slaughter weight
[b] Based-on empty body weight

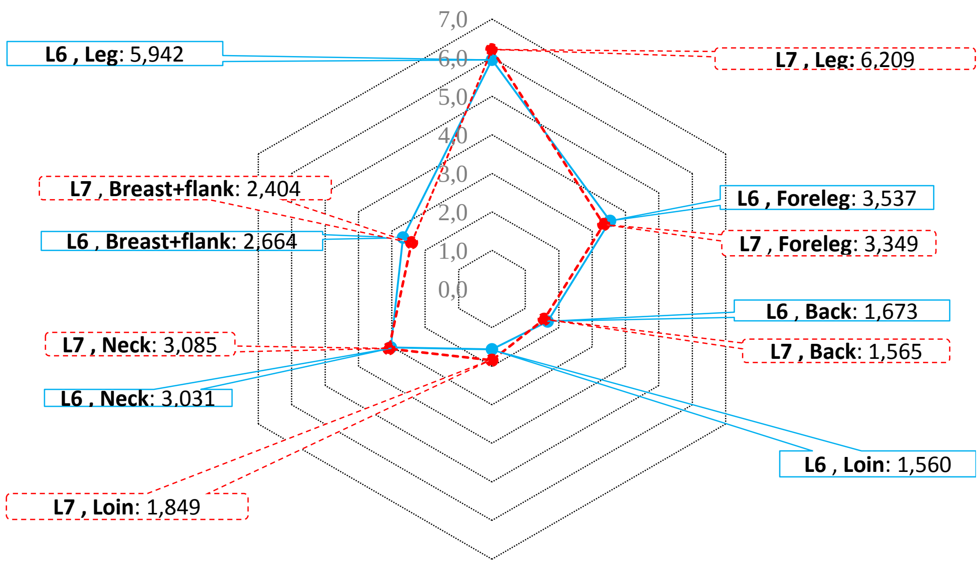



**Figure 2.** Means for individual cuts in the carcass (kg).

As a result of this information, it is known that larger lumbar vertebrae number will affect the quality meat ratio in the carcass. Therefore, the evaluation of the vertebral number in the sheep breed can improve the profit of the producer per animal.

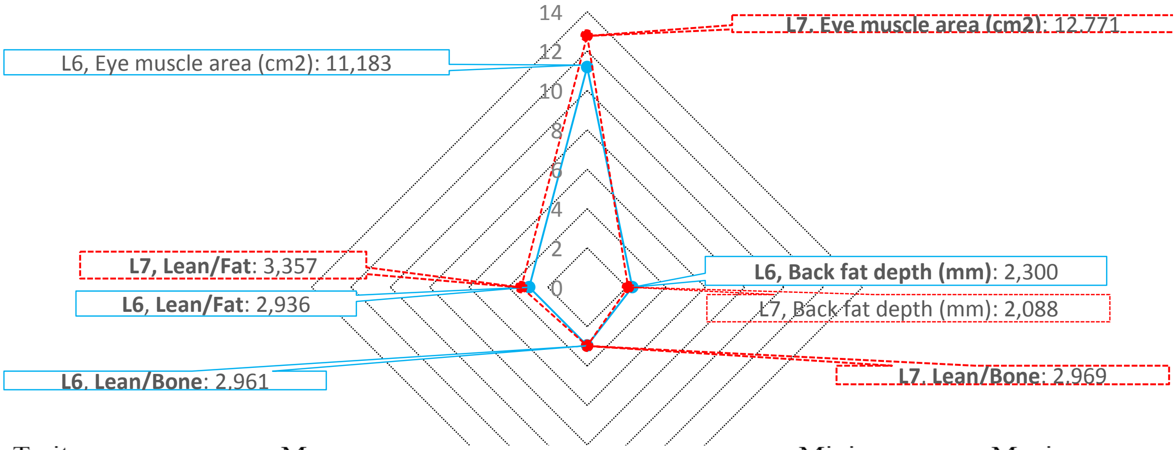
The values of the slaughter characteristics were presented in Table 1. The differences in the slaughter characteristics between L6 and L7 lamb groups were not significant. This result can be considered to be normal since the final and slaughter weights of two groups are very close.

There were not any significant differences between the non-carcass components of two groups (Table 2). It, however, draws attention to the weight of skin, head, and omental fat which are higher for the lambs having 6 lumbar vertebrae.

The traits of carcass measurements were shown in Table 3. As expected, carcass length of the lambs having 7 lumbar vertebrae was significantly ($P$ = 0.036) longer than the lambs having 6 lumbar vertebrae. There were significant differences between two groups for rump width ($P$ = 0.048). Besides, leg external length and neck length were numerically better for the lambs having 7 vertebrae.

The means, minimum-maximum values and ratios for individual cuts and compositions of carcasses were given in Table 4. Weight of leg ($P$ = 0.032) and loin ($P$ = 0.048) values between two groups were found to be statistically important. The highest leg and loin weights were obtained for the lambs having 7 lumbar vertebrae (Figure2).

Eye muscle area, back fat depth, lean/bone and lean/fat values were reported in Figure3. There were no statistical differences between two groups in terms of these values. Eye muscle area and lean/ fat values of the lambs having 7 lumbar vertebrae, however, are




| Trait | Means | | | Minimum | Maximum |
|---|---|---|---|---|---|
| | L6 (n:5) | L7 (n:4) | Sig. | L6 - L7 | L6 - L7 |
| Lean/Fat | 2.936±0.246 | 3.357±0.417 | 0.392 | 2.026-2.479 | 3.379-4.330 |
| Lean/Bone | 2.961±0.120 | 2.969±0.096 | 0.958 | 2.659-2.793 | 3.254-3.200 |
| Eye muscle area (cm²) | 11.183±0.622 | 12.771±0.455 | 0.091 | 9.465-13.255 | 11.480-13.599 |
| Back fat depth (mm) | 2.300±0.413 | 2.088±0.262 | 0.245 | 1.570-1.660 | 3.850-2.850 |

**Figure 3.** Means (±SE) and minimum-maximum values for some carcass traits.

**Table 2.** Means (±SE), minimum-maximum values and ratios (±SE) for non-carcass components.

| Trait | Means (kg) | | | Minimum | Maximum | Ratio (as % of slaughter weight) | | |
|---|---|---|---|---|---|---|---|---|
| | L6 (n:5) | L7 (n:4) | Sig. | L6 - L7 | L6 - L7 | L6 | L7 | Sig. |
| Skin | 5.785±0.401 | 5.043±0.289 | 0.197 | 4.650-4.476 | 7.017-5.820 | 13.428±0.722 | 11.935±0.466 | 0.147 |
| Head | 2.201±0.031 | 2.098±0.072 | 0.199 | 2.143-1.881 | 2.316-2.185 | 5.132±0.068 | 4.980±0.173 | 0.460 |
| Feet | 0.978±0.035 | 0.990±0.035 | 0.822 | 0.875-0.886 | 1.079-1.041 | 2.286±0.111 | 2.348±0.074 | 0.678 |
| Heart | 0.175±0.007 | 0.184±0.005 | 0.322 | 0.159-0.169 | 0.191-0.192 | 0.410±0.023 | 0.438±0.011 | 0.322 |
| Lungs | 0.723±0.040 | 0.640±0.034 | 0.170 | 0.617-0.588 | 0.819-0.734 | 1.680±0.071 | 1.523±0.097 | 0.222 |
| Liver | 0.937±0.033 | 0.951±0.041 | 0.787 | 0.831-0.899 | 1.029-1.074 | 2.180±0.064 | 2.250±0.049 | 0.433 |
| Kidneys | 0.148±0.007 | 0.146±0.004 | 0.844 | 0.135-0.140 | 0.175-0.155 | 0.346±0.021 | 0.3475±0.005 | 0.953 |
| Spleen | 0.117±0.018 | 0.103±0.013 | 0.571 | 0.073-0.078 | 0.180-0.139 | 0.274±0.044 | 0.245±0.033 | 0.631 |
| Testicles | 0.308±0.015 | 0.317±0.004 | 0.609 | 0.270-0.309 | 0.360-0.325 | 0.716±0.023 | 0.755±0.014 | 0.223 |
| Trachea- Esophagus | 0.094±0.009 | 0.092±0.006 | 0.816 | 0.074-0.077 | 0.124-0.106 | 0.220±0.017 | 0.220±0.020 | 1.000 |
| Full digestive tract | 7.329±0.451 | 7.367±0.293 | 0.949 | 6.334-6.692 | 8.918-7.992 | 17.048±0.884 | 17.458±0.499 | 0.719 |
| Empty rumen | 1.250±0.044 | 1.226±0.073 | 0.779 | 1.160-1.118 | 1.405-1.439 | 2.912±0.090 | 2.915±0.190 | 0.988 |
| Empty intestine | 1.713±0.032 | 1.835±0.081 | 0.174 | 1.645-1.653 | 1.833-2.018 | 4.000±0.142 | 4.348±0.145 | 0.134 |
| Omental fat | 0.548±0.056 | 0.431±0.067 | 0.217 | 0.429-0.309 | 0.686-0.585 | 1.276±0.131 | 1.018±0.141 | 0.224 |
| Mesenteric fat | 0.461±0.033 | 0.423±0.052 | 0.536 | 0.330-0.273 | 0.510-0.510 | 1.074±0.073 | 0.998±0.114 | 0.575 |

L6 and L7: No. of lumbar vertebrae

**Table 3.** Means (±SE) and minimum-maximum values for carcass measurements.

| Trait | Means (cm) | | | Minimum | Maximum |
|---|---|---|---|---|---|
| | L6 (n:5) | L7 (n:4) | Sig. | L6 - L7 | L6 - L7 |
| Carcass length | 80.800±0.583 | 84.375±1.375 | 0.036 | 79.000-80.500 | 82.000-87.000 |
| Back length | 61.600±1.208 | 63.875±0.747 | 0.178 | 57.000-62.000 | 64.000-65.500 |
| Leg internal length | 28.000±0.652 | 27.375±0.747 | 0.547 | 26.500-26.000 | 30.000-29.500 |
| Leg external length | 41.000±0.474 | 42.000±0.677 | 0.252 | 39.500-41.000 | 42.000-44.000 |
| Rump length | 7.400±0.510 | 7.625±0.554 | 0.775 | 6.000-6.500 | 9.000-9.000 |
| Neck length | 14.700±0.700 | 15.750±0.433 | 0.272 | 13.000-14.500 | 17.000-16.500 |
| Leg circumference | 48.900±0.510 | 48.875±0.657 | 0.976 | 47.500-47.000 | 50.000-50.000 |
| Chest girth | 75.800±0.735 | 75.750±1.250 | 0.972 | 74.000-73.000 | 78.000-79.000 |
| Rump girth | 58.900±1.308 | 58.625±0.800 | 0.872 | 54.500-57.000 | 62.000-60.000 |
| Leg width | 16.900±0.245 | 16.750±0.323 | 0.717 | 16.000-16.000 | 17.500-17.500 |
| Chest width | 17.900±0.332 | 17.250±0.433 | 0.264 | 17.000-16.000 | 19.000-18.000 |
| Rump width | 17.700±0.122 | 17.250±0.144 | 0.048 | 17.500-17.000 | 18.000-17.500 |
| Chest depth | 27.700±0.300 | 28.625±0.625 | 0.195 | 27.000-27.000 | 28.500-30.000 |

L6 and L7: No. of lumbar vertebrae

larger than those of the lambs having 6 lumbar vertebrae. In addition, the back fat depth of the lambs having 7 lumbar vertebrae was lower than that of the lambs having 6 lumbar vertebrae.

Table 5 illustrated the results measured and calculated for the composition of the individual cuts in the carcass. As expected, the lean weight in the loin cuts of the group having 7 lumbar vertebrae was significantly ($P$ = 0.040) higher than that of the other group having 6 lumbar vertebrae (Figure 4).

Comparison of lumbar vertebrae numbers of BA $B_1$ genotype showed that the lambs having 7 lumbar vertebrae had better quality meat ratio because of the leg and loin weights, lean value in the loin section, and long carcass length (Tables 1, 3, 4, and Figures 2 and 4).

The leg and loin weights and lean meat content in the loin for the carcass having 7 lumbar vertebrae will affect the quality meat ratio in the lamb carcass, and these desirable traits are commercially valuable because of their sale at higher prices. The similar studies in the pig breeds were performed with the variation of vertebral numbers, and their outcome on the carcass traits. The results of those also revealed that the increasing in the lumbar vertebrae numbers affect the quality meat ratio in carcass (Borchers *et al.,* 2004; Tohara, 1967).

The back length means of the lambs having 7 lumbar vertebrae was 2.275 cm longer than that of the lambs having 6 lumbar vertebrae. It can be inferred from this result that one extra lumbar vertebra causes 2.275 cm in length. This finding is similar with Li *et al.*'s (2017)

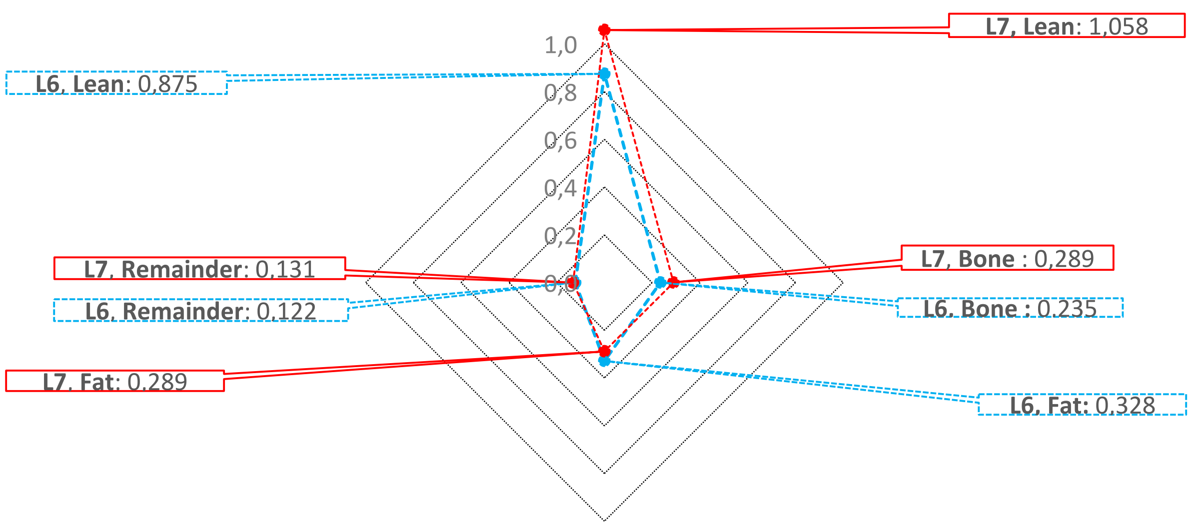



**Figure 4.** Means for composition of the loin (kg).

**Table 4.** Means (±SE), minimum-maximum values and ratios (±SE) for individual cuts and composition of carcasses.

| Trait | Means (kg) | | | Minimum | Maximum | Ratio (as % of carcass weight) | | |
|---|---|---|---|---|---|---|---|---|
| | L6 (n:5) | L7 (n:4) | Sig. | L6 - L7 | L6 - L7 | L6 (n: 5) | L7 (n: 4) | Sig. |
| *Individual cuts in the carcass* | | | | | | | | |
| Leg | 5.942±0.079 | 6.209±0.052 | 0.032 | 5.713-6.073 | 6.095-6.321 | 30.187±0.621 | 31.636±0.658 | 0.156 |
| Foreleg | 3.537±0.191 | 3.349±0.141 | 0.475 | 3.048-3.057 | 4.229-3.646 | 17.950±0.923 | 17.034±0.552 | 0.453 |
| Back | 1.673±0.111 | 1.565±0.061 | 0.453 | 1.272-1.422 | 1.882-1.713 | 8.502±0.597 | 7.991±0.459 | 0.537 |
| Loin | 1.560±0.096 | 1.849±0.060 | 0.048 | 1.345-1.712 | 1.851-2.000 | 7.967±0.653 | 9.435±0.470 | 0.127 |
| Neck | 3.031±0.266 | 3.085±0.212 | 0.883 | 2.512-2.711 | 4.044-3.695 | 15.392±1.378 | 15.668±0.806 | 0.877 |
| Breast+flank | 2.664±0.310 | 2.404±0.165 | 0.516 | 2.095-2.123 | 3.860-2.834 | 13.404±1.186 | 12.210±0.641 | 0.440 |
| Tail | 0.848±0.154 | 0.813±0.128 | 0.869 | 0.570-0.480 | 1.340-1.075 | 4.248±0.677 | 4.120±0.622 | 0.896 |
| Perinefral and pelvic fat | 0.465±0.037 | 0.376±0.036 | 0.133 | 0.380-0.315 | 0.560-0.480 | 2.350±0.145 | 1.906±0.140 | 0.068 |
| *Category* | | | | | | | | |
| First quality | 9.175±0.226 | 9.623±0.102 | 0.144 | 8.331-9.332 | 9.560-9.786 | 46.656±1.714 | 49.062±1.481 | 0.338 |
| Second quality | 3.537±0.191 | 3.349±0.141 | 0.475 | 3.048-3.057 | 4.229-3.646 | 17.950±0.923 | 17.034±0.552 | 0.453 |
| Third quality | 5.695±0.359 | 5.490±0.367 | 0.704 | 4.872-4.881 | 6.873-6.528 | 28.796±1.204 | 27.878±1.378 | 0.630 |
| *Composition of the carcass* | | | | | | | | |
| Lean | 9.984±0.186 | 10.132±0.227 | 0.627 | 9.466-9.666 | 10.553-10.640 | 50.707±1.024 | 51.669±1.983 | 0.660 |
| Bone | 3.388±0.112 | 3.423±0.140 | 0.849 | 3.128-3.076 | 3.756-3.759 | 17.264±0.895 | 17.477±0.994 | 0.878 |
| Fat | 3.529±0.391 | 3.140±0.333 | 0.488 | 2.845-2.458 | 5.025-3.970 | 17.752±1.454 | 15.906±1.382 | 0.397 |
| Remainder | 1.505±0.064 | 1.766±0.252 | 0.299 | 1.333-1.372 | 1.634-2.496 | 7.679±0.488 | 8.921±1.064 | 0.290 |

L6 and L7: No. of lumbar vertebrae

**Table 5.** Means (±SE), minimum-maximum values and ratios (±SE) for composition of individual cuts of carcasses.

| Trait | Means (kg) | | | Minimum | Maximum | Ratio (as % of individual cuts) | | |
|---|---|---|---|---|---|---|---|---|
| | L6 (n:5) | L7 (n:4) | Sig. | L6 - L7 | L6 - L7 | L6 (n: 5) | L7 (n: 4) | Sig. |
| *Leg* | | | | | | | | |
| Lean | 3.500±0.051 | 3.691±0.119 | 0.153 | 3.334-3.464 | 3.601-3.994 | 58.955±1.319 | 59.451±1.835 | 0.828 |
| Bone | 1.087±0.033 | 1.160±0.035 | 0.174 | 1.022-1.067 | 1.216-1.232 | 18.294±0.526 | 18.673±0.443 | 0.611 |
| Fat | 0.941±0.105 | 0.935±0.093 | 0.968 | 0.584-0.701 | 1.136-1.141 | 15.754±1.591 | 15.070±1.532 | 0.770 |
| Remainder | 0.415±0.035 | 0.423±0.026 | 0.858 | 0.281-0.349 | 0.478-0.466 | 6.997±0.647 | 6.806±0.371 | 0.819 |
| *Foreleg* | | | | | | | | |
| Lean | 2.065±0.132 | 2.014±0.035 | 0.746 | 1.736-1.951 | 2.537-2.093 | 58.289±0.808 | 60.338±1.647 | 0.270 |
| Bone | 0.719±0.055 | 0.655±0.031 | 0.379 | 0.599-0.569 | 0.886-0.718 | 20.385±1.389 | 19.558±0.478 | 0.627 |
| Fat | 0.431±0.067 | 0.404±0.054 | 0.772 | 0.268-0.283 | 0.613-0.527 | 12.125±1.632 | 11.938±1.178 | 0.932 |
| Remainder | 0.322±0.027 | 0.276±0.036 | 0.334 | 0.251-0.180 | 0.396-0.348 | 9.200±0.882 | 8.167±0.791 | 0.424 |
| *Back* | | | | | | | | |
| Lean | 0.787±0.024 | 0.780±0.029 | 0.847 | 0.703-0.724 | 0.847-0.851 | 47.651±2.350 | 49.875±0.980 | 0.453 |
| Bone | 0.377±0.054 | 0.339±0.050 | 0.626 | 0.264-0.240 | 0.519-0.431 | 22.415±2.469 | 21.404±2.451 | 0.726 |
| Fat | 0.407±0.072 | 0.333±0.026 | 0.413 | 0.220-0.274 | 0.659-0.390 | 23.774±3.112 | 21.500±2.268 | 0.592 |
| Remainder | 0.102±0.014 | 0.113±0.015 | 0.614 | 0.071-0.080 | 0.153-0.148 | 6.160±0.726 | 7.221±0.884 | 0.380 |
| *Loin* | | | | | | | | |
| Lean | 0.875±0.059 | 1.058±0.032 | 0.040 | 0.684-0.995 | 1.037-1.118 | 56.219±2.631 | 57.328±1.806 | 0.752 |
| Bone | 0.235±0.041 | 0.289±0.029 | 0.344 | 0.128-0.210 | 0.325-0.343 | 14.722±1.906 | 15.557±1.258 | 0.726 |
| Fat | 0.328±0.047 | 0.371±0.037 | 0.516 | 0.226-0.264 | 0.505-0.431 | 21.367±3.632 | 20.067±2.004 | 0.780 |
| Remainder | 0.122±0.019 | 0.131±0.017 | 0.734 | 0.073-0.080 | 0.167-0.152 | 7.693±0.867 | 7.048±0.828 | 0.614 |
| *Neck* | | | | | | | | |
| Lean | 1.511±0.044 | 1.534±0.059 | 0.760 | 1.383-1.398 | 1.625-1.670 | 51.225±4.134 | 50.341±3.558 | 0.880 |
| Bone | 0.602±0.023 | 0.615±0.065 | 0.840 | 0.543-0.441 | 0.645-0.722 | 20.526±1.992 | 20.472±2.896 | 0.988 |
| Fat | 0.633±0.290 | 0.311±0.028 | 0.362 | 0.211-0.242 | 1.771-0.370 | 18.632±6.505 | 10.103±0.691 | 0.287 |
| Remainder | 0.286±0.018 | 0.625±0.260 | 0.282 | 0.224-0.335 | 0.331-1.402 | 9.617±0.818 | 19.085±6.364 | 0.234 |
| *Breast+flank* | | | | | | | | |
| Lean | 1.246±0.078 | 1.055±0.049 | 0.094 | 1.098-0.953 | 1.536-1.189 | 47.829±.638 | 44.267±2.581 | 0.374 |
| Bone | 0.368±0.029 | 0.366±0.045 | 0.961 | 0.320-0.307 | 0.455-0.498 | 14.139±1.032 | 15.252±1.650 | 0.569 |
| Fat | 0.791±0.249 | 0.787±0.155 | 0.991 | 0.339-0.554 | 1.732-1.232 | 27.434±5.140 | 32.188±4.460 | 0.520 |
| Remainder | 0.259±0.038 | 0.197±0.018 | 0.219 | 0.138-0.148 | 0.366-0.236 | 10.597±2.115 | 8.293±0.983 | 0.396 |

L6 and L7: No. of lumbar vertebrae

(lumbar vertebrae length=2.22 cm) and Zhang *et al.*'s (2017) (lumbar vertebrae length=1.30 cm) in China, and Donaldson's (2015) results (lumbar vertebrae length=2.91 cm) in the United Kingdom. In addition to those, same condition was reported in the pig breeds (King and Roberts, 1960; Tohara, 1967).

The back fat depth of the lambs having 7 lumbar vertebrae group was lower than that of the lambs having 6 lumbar vertebrae groups, which was in accordance with total fat value in the carcass. Therewithal, these findings were also consistent with Borchers *et al.*'s (2004) results in the pig. The back fat depth and rump width values of the lambs having 6 lumbar vertebrae were higher than those of another group. In addition, the lambs having 6 lumbar vertebrae have higher skin and omental fat weight than the lambs having 7 lumbar vertebrae. When these data were assessed, it can be said that the lambs having 7 lumbar vertebrae were still developing stage than the lambs having 6 lumbar vertebrae in this slaughter weight. Some researchers reported that the piglets having 7 lumbar vertebrae had a tendency toward a higher age at slaughter (Meyer and Lindfeld, 1969).

The eye muscle area in the 7 lumbar vertebrae group had larger than another group. Although this difference was not very vital, the value was close to the significance level ($P$=0.091). This result was in accordance with Borchers *et al.*'s (2004) findings at which they reported that more lumbar vertebrae in pigs were significantly affected by the eye muscle area value. In addition, eye muscle area is a significant indicator of lean meat quantity and body muscling (especially hind-leg muscles) in the sheep (Cloete *et al.,* 2004; Hopkins *et al.,* 1992). In this study, it was identified that the lambs with 7 lumbar vertebrae have a larger eye muscle area with a heavier leg and loin, and also higher lean weight in the leg and loin than the lambs with 6 lumbar vertebrae. These results were correlated with other studies with these aspects (Cloete *et al.,* 2004; Hopkins *et al.,* 1992).

## Conclusion

It was concluded that the lambs having 7 lumbar vertebrae had significantly higher carcass length, leg weight, loin weights and loin's lean weight. The evaluation of the vertebral number and using this information in the animal breeding programs will affect the profit per sheep in the world. As a result of this work, we can say that identification of the variation of the vertebrae number for Turkey sheep breeds by the ultrasound or genetic testing can be used as the selection criteria for the sheep breeding.

## Author Contributions

O.F., Gungor, C. Ozbeyaz and N. Unal conceived and designed research. OF Gungor and N Unal conducted experiments. O.F., Gungor analyzed the data and wrote the manuscript. C. Ozbeyaz and N. Unal reviewed and supervised, and C. Ozbeyaz edited the manuscript. All authors read and approved the manuscript.

## Acknowledgments

This project was supported by Ankara University Scientific Research Projects Coordination Unit (64299502-604.01.02-E.84290). The authors gratefully acknowledge the contribution of esteemed senior Prof. Dr. Halil Akcapinar, who was retired from Ankara University.

## Ethical Statement

All animal procedures were conducted under the protocol approved by the Ankara University Animal Experiments Local Ethics Committee (File no. 2018-34, Decision no. 2018-4-36).

## Conflict of interest

The authors declare no conflict of interest.

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