Estimating the live weight using some body measurements in Saanen goats

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SUMMARY

This research was carried out to investigate the estimation of the live weight in Saanen Goats by statistical methods. Seventy Saanen Goats were used as the study material. The goats were divided into two groups. The first group included 2-2.5 years aged goats at first lactation period while the second group included the goats ready to be inseminated for the first time. The average live weight, heart girth, shank circumference, withers height, body length and chest depth values were calculated as 55.37 kg, 91.57, 9.32, 66.94, 109.75 and 32.55 cm respectively for the first group whereas the same parameters were calculated as 41.03 kg, 84.00, 8.86, 62.07, 101.55 and 30.27 cm respectively for the second group. Live weight (LW) was found to be highly correlated with heart girth (HG), shank circumference (SC), withers height (WH), body length (BL) and chest depth (CD) in the first group, whereas live weight was highly correlated with heart girth and body length in the second group. The regression equation for the first group was established as LW = -151,295 + 1,067*HG + 3,262*BL + 0,167*SC + 0,604*WH + 0,254*CD and it was LW = -64,753 + 0,863*HG + 0,717*BL – 0,029*SC + 0,207*WH + 0,254*CD for the second group. It is concluded that live weight could be predicted by statistical methods using several body measurements in Saanen goats.

Keywords: live weight, correlation, regression, Saanen goat, body measurements

INTRODUCTION

The biometric measurements are used to assess several characteristic of animals. These measurements provide important evidences for the growth of the breed and the properties that change with environmental effects and feeding factors. In addition, body measurements are important data sources in terms of reflecting the breed standards (Riva et al., 2002) and are also important in giving information about the morphological structure and development ability

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of the animals. Body measurements differ according to the factors such as breed, gender, yield type and age. The most common parameters used for body measurements in sheep are; head length, head depth, frontal with, ear length, body length, withers height, rump height, body depth, heart girth, width at withers, shank circumference, tail length and width. Body weight estimations are done using body measurements by different statistical analysis (Gurcan, 2000).

Live weight plays an important role in determining several characteristics of the farm animals especially the ones having economical importance. Birth weight, early growth, feed conversion ratio as well as feeding requirements could be predicted by knowing the live weights of several stages of the lambs (Eker and Yavuz, 1960). Estimating the live weight using body measurements is practical, faster, easier, and cheaper in the rural areas where the sources are insufficient for the breeder (Nsoso et al., 2003). However, a scale can not be recommended for each family to determine the weights of the animals (Eker and Yavuz, 1960). Several charts that show the estimated weights according to the body measurements are established in the countries where animal industry is developed. The variation of the body measurements is used as criteria in classification of the goats. The estimated values of the quantitative characteristics are useful in developing appropriate selection criteria (Mohammed and Amin, 1996). The yields and the parameters that affect them are desired to be determined easily and inexpensive in animal breeding. If the data regarding the yield properties are obtained with difficult and expensive methods, then using indirect measurements could be an alternative way to be followed (Boztepe and Dag, 1995).

The relationship between live weight and economically important yields is well known in farm animals and live weight estimations using the body measurements is a matter of concern for sheep industry. In general the correlation between heart girth and live weight is found to be higher in sheep and goats. Therefore live weight can be predicted via morphometric measurements in pasture (Atta and El khidir, 2004; Hassan and Ciroma, 1990; Koyuncu and Tuncel, 1992; Mohammed and Amin, 1996; Ozturk et al., 1994; Şengonca and Gucuk, 1991). Another important point is the environmental effects, particularly from "sustainability of the breed standards" point of view for imported animals. The question of sustaining high yields and standards in different conditions is an essential concern for breeders. Therefore the results of the studies regarding the breed standards of the imported animals reared in their regions attract their attention.

Saanen goat is one of the most popular milk type goat breeds with 50 kg average live weight in females and 65 kg in males. Since, it is well adapted to different conditions; it can successfully be reared in different regions of the world. However optimum yields can be obtained under good handling and feeding conditions. Growing is fast in this breed and it could reach to puberty rapidly. Lactation period is 260-280 days and average milk yield is 700 kg.

Milk yield can be over than 1000 kg in elite flocks. This breed has a high reproductive yield. Multiparturition is often seen (Ertuğrul, 1996). The milk is generally used in making cheese and ice-cream (Uğur et al., 2002).

The aim of this study was to examine the relationships between body measurements and live weight as well as investigate the prediction of live weight using some body measurement in Saanen goats reared in Bolu conditions.

MATERIAL AND METHODS

The material of the study was provided from a private farm where purebred Saanen goats were reared. The data were collected from 70 female Saanen goats. Heart girth, withers height, body depth, shank circumference and body length parameters were recorded after 8 hours of feed restriction. Linear body measurements were taken by a tape measure and body weight was taken using a digital scale, while the animals were motionless:

- Withers height (WH) was measured as the distance from the surface of a platform to the withers.
- Body length (BL) was measured as distance from the occipital joint to the first caudal vertebra.
- Heart girth (HG) was measured just behind the scapula by a tape measure.
- Chest depth (CD) was measured as vertical distance from sternum to withers.
- Shank circumference (SC) was measured from the left mid metacarpus.

The goats were divided into two groups. The first group involved 48 heads, 2-2.5 aged lactating goats while the second group was formed by 22 yearling goats. The goats were fed ad libitum grass, alfalfa, common vetch, trefoil, oats, maize, mixed leguminous. The concentrated feed provided for the lactating goats was gradually increased from 0.65 to 1.5 kg. The goats having an average of 2.5 l daily milk yield consumed 1 kg concentrated feed, 1 kg maize, silage and 1 kg grass per day. The animals were located indoors providing 2 m^2 floor space per goat; 40 cm feeder width and an automatic water supplier per 40 goats.

SPSS – 11.0 program designed for Windows was used for the statistical analyses. Relationships between the several body measurements were calculated by Pearson correlations and regression equations were established.

RESULTS AND DISCUSSION

The results including the means and the standard errors related to the body measurements for both groups are shown in Table 1. The average live weight of Saanen goats was calculated as 55.37 kg for the first group and 41.05 kg for the

second group in this study. The results seem in accordance with the previous reports (Akman et al., 2001; Yalcın, 1986).

Table 1 Linear body measurements of the lactating and yearling Saanen Goats

	Group	n	Average (x) ¯	Standard error (Sx)
Live weight	1	48	55.37	1.93
	2	22	41.03	1.01
Heart girth	1	48	91.57	1.08
	2	22	84.00	.76
Shank circumference	1	48	9.32	.09
	2	22	8.86	.01
Withers height	1	48	66.94	.50
	2	22	62.07	.55
Body length	1	48	109.75	.89
	2	22	101.55	1.15
Chest depth	1	48	32.54	.44
	2	22	30.27	.40

The correlation coefficients between the live weight and body measurements were ranged as heart girth, body length, shank circumference, chest depth and withers height with the values of 0.95, 0.86, 0.78, 0.77 and 0.55 respectively for the first group, whereas the same parameters were ranged as heart girth, body length, chest depth, shank circumference and withers height with the values of 0.84, 0.73, 0.42, 0.35 and 0.23 respectively for the second group in Saanen goats (Table 2, Table 3).

Table 2 Correlation coefficients between body measurements and live weight of lactating Saanen goats

	LW	HG	SC	WH	BL	CD
LW	1	0.945**	0.782**	0.549**	0.861**	0 .769**
HG		1	0.745**	0.467**	0.767**	0.772**
SC			1	0.287*	0.624**	0.500**
WH				1	0.649**	0.576**
BL					1	0.729**
CD						1

**P < 0.01; *P < 0.05

Several researchers (Boztepe and Dag, 1995; Ozturk et al., 1994; Şengonca and Gucuk, 1991) stated that live weight could be estimated accurately using the heart girth parameter in sheep and goats. In addition the method was described to be handier comparing to other parameters since a tape measure is

sufficient. Our results are in accordance with these claims in terms of the high correlation coefficients (P< 0.01) between live weight and heart girth.

Table 3 Correlation coefficients between body measurements and live weights of yearling Saanen goats

	LW	HG	SC	WH	BL	CD
LW	1	0.843**	0.348	0.225	0.726**	0.421*
HG		1	0.200	0.246	0.622**	0.353
SC			1	-0.070	.630**	-0.023
WH				1	0.155	0.486*
BL					1	0.423*
CD						1

**P < 0.01; *P < 0.05

According to the results of this study, the highest correlation was determined between live weight and heart girth in both groups. The regression equation for the first group was established as;

$LW = -100.084 + 1.698*HG$, $R^2 = 0.89$

When heart girth and body length were considered together the coefficient of determination increased to 93.9 % and the equation is change into

$LW = -137.118 + 1.242*HG + 0.718*BL$; $R^2 = 0.94$

When shank circumference was included in the equation the coefficient of determined increased to 94.7%;

$LW = - 146.313 + 1.081*HG + 0.679*BL + 3.013*SC$; $R^2 = 0.95$

When five different body measurements are used the equation is established as;

$LW = - 151,295 + 1,067*HG + 3,262*BL + 0,167*SC + 0,604*WH + 0,034*CD$; $R^2 = 0.95$

For the second group the regression equation is established as;

$LW = - 53.061 + 1.120*HG$; $R^2 = 0.71$

When heart girth and body length were used together the equation was established as;

$LW = -59.363 + 0.848*HG + 0.287*BL$; $R^2 = 0.78$

When five different body measurements are used the equation is established as;

LW = - 64.753 + 0.863*HG + 0.717*BL - 0.029*SC + 0.207*WH + 0.254*CD; R^2 = 0.78

The most appropriate parameters were determined to be heart girth and body length to predict the live weight in the established regression equations. In case of using three body measurements, body length, heart girth and shank circumference could be used in a regression equation with 94.7 % estimation accuracy. In this study, five of the examined body measurements were used while establishing the equations. Nevertheless, heart girth parameter is the easiest way to use for live weight prediction in field conditions.

Many researchers (Atta and El Khidir, 2004; Hassan and Ciroma, 1990; Koyuncu and Tuncel, 1992; Mohammed et al., 1996; Ozturk et al., 1994; Tuncel, 1982; Valdez et al., 1982; Yarkın et al., 1961) reported heart girth as the most appropriate and confident parameter in live weight estimations for sheep and goats. The average values for live weight, withers height and hearth girth parameters were reported to be 42 kg, 67.2, 67.2 and 81.3 cm respectively for Anatolian Black Goats in Mudurnu and Gerede province (Yarkın and Eker, 1961). The correlation coefficients between live weight withers height, body length, body depth and heart girth were found as 0.69, 0.65, 0.45 and 0.86 respectively ($p<0.01$) in Anatolian Black goats those were reared in village conditions (Koyuncu and Tuncel, 1992). On the other hand, Tuncel (1982) stated the live weight, withers height, body length, body depth and hearth girth measurements for mature Kilis goats as 36.6 kg, 65.6, 30.1, 79.4 cm respectively. The phenotypic correlations between live weight and withers height, body length, body depth and heart girth were determined as 0.36, 0.56, 0.38 and 0.64 respectively while the correlations between withers height and body length, body depth, hearth girth were found as 0.38, 0.48 and 0.40 ($P<0.01$). Hassan and Ciroma (1990) examined the relationships between live weight and body measurements in Nigerian Sokota goats. They used 201 goats by dividing them into 3 groups (1-2, 3-4, 5- over aged groups). The average live weights were measured as 16.41, 22.94, 30.02 kg respectively; average measures for body length were determined as 79.15, 87.33 and 96.57 cm; for withers height 57.49, 62.77, 67.39 cm; for heart girth 61.78, 67.86 and 75.77 cm respectively. Our results regarding body length, withers height and heart girth were 109.75, 66.94, 91.57 cm. for the first group and 101.55, 62.07 and 84.00 for the second group. They also found high correlations between live weight and body length, withers height and heart girth considering these correlations they concluded that live weight could be estimated using body length and withers height parameters. The results seem to be similar to our findings. Atta and El Khidir (2004) carried out two experiments to predict the live weight of 36 male and 48 female Nilotic lambs from parturition to adult age period using body measurements. In both sexes high correlation coefficients were calculated between heart girth and live weight parameters (R^2= 0.98 and R^2= 0.96, for males and females, respectively). Likewise withers height and body length

exhibited high relationships. Live weight estimation for male was done using $y = 0.0001668*X^{2.867}$ regression equation, while $y = 0{,}0010674*X^{2.407}$ equation was used for females. Mohammed and Amin (1996) reported the correlation coefficient between the live weight and heart girth as 0.96 for male goats; 0.83 for nonpregnant females and 0.71 for pregnant females. They stated that heart girth parameter could be used as a reliable tool in predicting the live weight in Sahel goats. Similar to their findings we determined correlation coefficient between the live weight and heart girth as 0.95 for the first group and 0.84 for the second group. Ozturk et al. (1994) stated that heart girth was the most appropriate parameter in predicting the live weight using only one parameter in Konya Merino. In case of using two parameters body length and heart girth were found to be most convenient parameters. In the event of using three parameters body length, heart girth and body depth were found to be more appropriate. If it is necessary to increase the parameters in estimating the live weight, chest width, shank circumference could be added. However using many body measurements to predict the live weight is not a simple and easy process. Therefore the least parameters are used, the easiest practice is done.

It is obvious that using many body measurements to predict the live weight is not handy in goat breeding. Therefore the less body parameters are used, the easier results are obtained. Among all the parameters the most reliable body parameter is the heart girth measurement which has the highest correlation with live weight ($r = 0.945$, $r = 0.843$).

Representing the output of the study in brief, live weight values corresponding to heart girth measures are demonstrated in Table 4 and 5; while comparison of measured and calculated live weight values are shown in Tables 6 and 7.

Table 4 Live weight values corresponding to heart girth measures for lactating Saanen Goats

Heart girth (cm)	Live weight (kg)	Heart Girth (cm)	Live weight (kg)
82	39.15	100	69.72
83	40.85	101	71.42
84	42.55	102	73.12
85	44.25	103	74.82
86	45.95	104	76.52
87	47.64	105	78.22
88	49.34	106	79.92
89	51.04	107	81.62
90	52.74	108	83.32
91	54.43	109	85.02
92	56.13	110	86.72
93	57.83	111	88.42
94	59.53	112	90.12
95	60.38	113	91.82
96	62.92	114	93.52

97	64.65	115	95.22
98	66.32	116	96.92
99	68.02	117	98.62

Table 5 Live weight values corresponding to heart girth measures for yearling Saanen Goats

Heart Girth (cm)	Live weight (kg)	Heart Girth (cm)	Live weight (kg)
77	33.18	84	41.02
78	34.30	85	42.14
79	35.42	86	43.26
80	36.54	87	44.38
81	37.66	88	45.50
82	38.30	89	46.62
83	39.90	90	47.74

Table 6 Comparison of measured and calculated live weight values for lactating Saanen Goats

Measured live weights (kg)	Corresponding results based on regression equations for live weights (kg)			
	HG	HG + BL	HG + BL + SC	HG+SC+WH + BL+CD
66.50	67.17	66.35	64.01	64.03
61.30	65.47	68.70	67.83	67.90
101.50	98.58	100.10	100.22	100.88
75.10	68.02	70.56	70.96	71.24
81.00	76.51	78.21	77.72	77.60
71.30	66.32	70.76	71.24	71.08
75.00	62.92	66.84	69.22	70.04
63.10	62.92	62.53	60.63	60.67
61.20	62.92	61.09	59.27	59.13
93.20	93.49	90.63	91.54	91.82
51.60	56.13	56.13	54.95	54.08
65.00	73.11	67.11	64.40	64.31
45.00	44.25	41.69	41.95	42.21
41.20	42.55	46.19	43.29	43.48
49.10	44.25	46.71	46.70	45.84
50.30	54.43	54.88	52.36	52.48
50.80	54.43	54.17	54.69	54.49
45.50	51.04	48.09	47.63	47.33
60.00	60.38	61.39	61.19	61.22
52.50	52.74	53.64	52.78	52.84
63.00	59.53	65.79	63.90	64.27
57.70	57.83	55.93	57.68	57.13
43.80	42.55	44.04	44.26	44.09
58.50	59.53	58.61	58.61	58.93

57.50	57.83	60.96	62.44	63.26
55.00	54.43	49.14	49.94	50.58
53.80	47.64	48.48	48.18	48.13
58.40	56.13	56.13	56.45	56.02
66.80	68.02	70.56	70.96	70.89
49.90	54.43	51.29	51.98	51.32
42.30	40.85	41.36	41.82	42.02
42.30	44.25	43.84	42.48	43.43
48.70	49.34	47.57	47.23	47.81
54.50	52.74	53.64	55.80	55.14
41.70	44.25	39.53	39.91	40.70
43.30	40.85	42.08	42.50	42.51
44.50	44.25	41.69	41.95	41.97
42.50	47.64	44.17	42.60	43.30
53.60	49.34	50.44	51.45	51.90
45.70	44.25	45.28	45.34	45.16
46.30	56.13	52.54	53.06	53.59
48.30	59.53	52.87	54.69	54.55
51.00	47.64	47.76	47.50	48.48
42.30	40.85	43.51	43.86	44.22
42.50	47.64	47.76	47.50	47.93
58.60	54.43	58.47	58.77	58.66
44.00	39.15	41.55	42.10	42.46
41.00	40.85	39.20	38.28	38.06
55.36	**55.40**	**55.41**	**55.28**	**55.39**

Table 7 Comparison of measured and calculated live weight values for lactating Saanen Goats

Measured live weights (kg)	Corresponding results on regression equations for live weights (kg)		
	HG	HG+BL	HG + SC+ WH+ BL+CD
42.20	39.90	41.44	41.45
35.40	39.90	38.86	38.23
49.50	44.38	45.98	46.15
45.00	41.02	40.00	40.55
44.00	43.26	45.14	45.04
37.50	39.90	38.86	39.23
43.50	43.26	42.27	41.85
35.50	35.42	34.03	33.52
42.50	43.26	43.70	44.00
37.50	35.42	35.76	35.95
40.00	37.66	39.46	38.96
43.50	47.74	44.80	44.69

38.00	36.54	36.89	36.66
42.20	44.38	44.84	44.96
48.80	45.50	44.54	44.62
41.50	42.14	42.85	42.97
41.00	43.26	43.99	43.46
30.00	33.18	31.76	32.07
34.80	35.42	35.47	35.64
47.30	46.62	46.82	46.40
40.50	41.02	41.14	41.15
42.50	43.26	43.70	44.53
41.03	**41.02**	**41.01**	**41.00**

CONCLUSIONS

According to the results of this study, it could be concluded that live weight can be predicted using some body measurements considering the correlation coefficients in Saanen goats reared in Bolu conditions. Thus the similarity of the breed standards could be easily evaluated whether they could be sustained in different conditions with a very feasible method.

ACKNOWLEDGEMENTS

This study was conducted as a Master thesis with the reference number 2005-003 at Afyon Kocatepe University. We thank to Bolu Bolca Hindi Company for their support in providing us the research materials.

REFERENCES

Akman, N., Emiroğlu, M., Tavmen, A. (2001) Sheep Breeding. 1st Edition. Çamlıca Culture and Fraternal Association Publications İstanbul, 4: 45-62 (in Turkish)

Atta M., El Khidir O. A. (2004) Use of Heart Girth Wither Height and Scapulaischial Length for Prediction of Live Weight of Nilotic Sheep. Small Ruminant Research, 55 (1-3) 233-237

Boztepe S., Dağ B. (1995) Relationships between body measurements and yield characteristics in Awassi sheep. Seçuk Univ. J Agri Fac, 6(8), 173-180 (in Turkish, English abstract)

Eker M., Yavuz O. (1960) Estimation of live weight and breeding time for Kilis Milk Type Goats using heart girth measures. Ank. Univ. Agri. Fac. Annual Fascicule, 3: 295-300 (in Turkish, English abstract)

Ertuğrul M. (1996) Small ruminant management practices. 2nd Edition, Ank. Üniv. Agri. Fac. Publications, 1446, Ankara, 18-20 (in Turkish)

Gürcan İ. S. (2000) Estimation of live weight by statistical methods using body measurements in Merino sheep. Ank.Üniv. Health sci Inst. PhD Thesis, Ankara (in Turkish, English abstract)

Hassan A., Ciroma A. (1990) Bodyweight Measurements Relationship Nigerian Red Sokoto Goats, Department of Animal Science, Usmanu Danfodiyo University, P.M.B. 2346

Koyuncu M., Tuncel E. (1992) The relationships between hair characteristics, live weight and body measurements in Anatolian Black Goats. Uludağ. Univ. Sci. Inst. Publications, 20

Mohammed I. D., Amin J. D. (1996) Estimating Body Weight From Morphometric Measurement of Sahel (Borno White) Goats, Small Ruminant Research, 24, 1-5

Nsoso S. J., Aganga A. A., Moganetsi B.P., Tshwenyane S.O. (2003) Body Weight, Body Condition Score and Hearth Girth in İndigenous Tswana Goats During The Dry and Wet Seasons in Southeast Bostwana, Livestock Res. for Rural Development 15 (4) 25-31

Öztürk A., Kayış S. A., Parlat S. S., Gürkan M. (1994) The possibilities of estimating the live weight using some body measurements in Konya Merino. J Anim. Res. 4 (1), 23-25

Riva J., Rizzi R., Marelli S., Cavalchini G. (2002) Body Measurements in Bergamasca Sheep, Small Ruminant Research, 221-227

Şengonca M., Gücük, T. (1991) The possibilities of estimating the live weight using some body measurements in native Merino. Uludağ Univ. J Agric. Fac., 8, 1-8

Şengonca M., Taşkın T., Koşum N. (2003) Simultaneous Comparison of Various Production Traits of Saanen x Hair Crossbred and Pure Hair Goats. Turk J Vet Anim Sci., 27, 1319-25

Tuncel E. (1982) Some hair characteristics and the relationships between live weight and hair characteristics in Kilis Goats. Ank. Univ. Agric. Fac. Publications, 831

Uğur F., Savaş T., Dosay M., Ataşoğlu C. (2002) Growth and Behavioral Traits of Turkish Saanen Kids Weaned at 45 and 60 Days, Department of Animal Science, Faculty of Agriculture, 179-184

Valdez C. A., Fagan D.V., Vicera I.B. (1982) The Correlation of Body Weight to External Body Measurements in Goats, Dairy Goat Journal Publishing Co., Scottsdale, AZ (EUA), 3. International Conference on Goat Production and Disease. Tuscon, AZ (EUA)

Yalcin, B.C. (1986) Sheep and goats in Turkey. FAO Animal Production and Health Paper 60, Rome. ISBN 92-5-102449-9

Yarkın I., Eker M. (1961) Studies on Some Breeding Characteristics of Kilis Milk Goats. Yearbook of the Fac. Agric. 43-152