EFFECT OF BODY CONDITION SCORE ON SOME BLOOD PARAMETERS FOR ANEMIA LEVEL IN GOATS

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Abstract: The objective of this study was to determine the effect of body condition on some blood parameters for anemia. For this purpose, the relationship between BCS groups and the level of anemia by FAMACHA© Chart scores were examined in one intensive and two semi intensive farm conditions. BCS results were compared to volumes of RBC, HGB, HCT, MCV, MCH and MCHC. Effect of BCS on live weight was found statistically significant. A negative and high correlation (-0,559) between BCS and FAMACHA© Chart score was also found statistically significant. Effect of BCS on some blood parameters; (RBC, HGB, HCT) was found statistically significant ($P<0.001$ and $P<0.05$). The more BCS increased the more RBC, HGP, HCT increased. It could be said that goats kept under better care and feeding conditions could have good BCS scores, and could be more resistant to anemia factors.

Keywords: BCS, anemia, FAMACHA Chart scores, goats.

Introduction

Efficiency, profitable production and minimal animal loss in sheep and goat breeding could be made possible by some practical and simple applications during the year. Recently, a lot of studies have been carried out on practical, easy and economical applications in herd management in breeding of small ruminants. Some methods have been developed for this subject and, especially some of the scoring methods which have been developed for animal fields, feeding animal welfare and health are emphasized to make herd management easier (Russel et al. 1969; Cross and Parker, 1981; Welsh et al., 1993; Malan et al., 2001; Ware, 2005).

Emphasis is placed on practical applications aimed to minimize the negative effects caused by environmental factors. Body condition score (BCS) is a better predictor of body fat than live weight (Russel et al., 1969; Sanson et al., 1993). Ewes with low BCS have been associated with higher prenatal (West et al., 1989) and neonatal mortality (Nordby et al., 1986) and lower lamb livability (Thompson, Meyer, 2004). In order to maintain a maximum reproduction rate, sheep and goat must have an optimum BCS value (Yilmaz et al., 2011; Yilmaz et al., 2011a). The usage of body weights and condition scores in the determination of health and/or nutritional status of livestock has been reviewed by several authors (Oulun, 2005; Sakkinen et al., 2001; Ndlovu et al., 2007). It was know that parasites acquire resistance against drugs after a period (Zajac and Gipson, 2000; Kaplan, 2004; Eguale, et al., 2009). Gastrointestinal nematodes (GIN) of ruminants (cattle, sheep and goats) are ubiquitous and can cause severe injuries and infections on animals and significant losses in farming revenues. The commerce and the use of modern anthelmintic drugs with a broad spectrum of activity have been a solid tool for nearly 40 years. However, the continuous use of these drugs has led to the selection of populations of drug-resistant parasites worldwide (Molento et al., 2011). More practical methods need to be found in the determination of the animals which are, or are not anemic due to either parasites or other reasons. The fundamental objective is to be able to achieve a practical selection of the strongest and most resistant animals. It is, therefore, imperative to devise easy methods for the determination of anemia in goats. One such option is the FAMACHA© system which was developed in South Africa to classify sheep into categories based on different levels of anemia (Bath et al., 2001; Kaplan et al., 2004).

The FAMACHA© Chart method is a diagnostic on-farm system, which provides farmers a facility to identify individual animals that need an anthelmintic treatment through comparing the color of the ocular mucous membranes with a defined color chart (Scheuerle, et al.,2010). The FAMACHA© Chart is a simple system to categorise the anemic status of small ruminants based on the conjunctiva mucosa color on a scale from 1 (optimal eye color, red) to 5 (pale eye color, white). The FAMACHA© Chart method is a relatively simple and low-priced test that has been developed by scientists of the Onderstepoort Veterinary Institute in South Africa especially for small, resource-poor farms (Malan et al., 2001; Van Wyk and Bath, 2002), The system has been successfully tested in different geographic areas (Mors and Gauly, 2009; Molento et al., 2009; Di Loria et al., 2009; Scheuerle, et al., 2010; Reynecke et al., 2011). Especially when animals are predominantly infected by Haemonchus contortus, the FAMACHA© Chart system seems to be a suitable method to detect parasite infections

(Malan et al., 2001; Van Wyk and Bath, 2002). Some studies in Europe, i.e. Italy, show that using FAMACHA© Chart can have a positive influence on milk production, but that this method still needs further evaluation (Cringoli et al., 2009). This system could be easily used to control herd health and management by farmers.

Resistance to diseases and parasites should be taken as a criterion in breeding selection, and the weak animals should be departed from the herd as far as possible. Especially practical and economic application, which could be used for the management and health of sheep and goat herds, should be developed. Some practical applications which are BCS, FAMACHA© Chart, wool, tail, and lameness scores could be used to develop more healthy herds as well as to select animals in farm and in breeding programs. Early proper diagnosis of diseases and poor nutrition is a pre-requisite to reduce losses in communal areas (Tibbo et al., 2004). Methods that can be employed in determining health and nutritional status of goats include body weights and condition changes, worm burdens, packed cell volume, the FAMACHA© technique and use of nutritionally-related blood metabolites.

Body condition scoring (BCS) which is a simple, easily applied clinical scoring by touching the tissue over the lumbar vertebrae, appears to be promising for this purpose, since, in sheep, high genetic correlation with FAMACHA© scores, haematocrit values, and fecal egg counts (FECs) was recorded on a sheep farm in South Africa (Bath et al, 2005).

The aim of this study was to determine the effect of body condition score on some blood parameters and correlation between scores of Body Condition and FAMACHA© Chart in goats reared in intensive and semi-intensive farm conditions.

Material and methods

The study was conducted in August, 2011, on three Saanen goat farms. Animal material of the study was 67 goats (3-4 years old) from the three farms. Goats mating periods in the area are generally in September and October , and the animal should have good BCS a month before this period.

The first farm was an intensive farm, in Adnan Menderes University, which is 52 m above sea level and is 37°45′03.31″ N and 27°45′27.16 ″E. The other farms (the second and the third one) were two semi intensive farms in two different areas in Aydin-Turkey. The second farm is 57 m above the sea level and is 37°35′52.73″ N and 27°59′34.33″ E in the district of Cine-Aydin, Turkey. The third farm is 42 m above the sea level and is 37°25′09.24″ N and 27°22′23.41″ E in the district of Didim, which is a seaside area in Aydin, Turkey.

Goats were not grazed during the year and given feed ad libitum in the first farm, but in the second and the third farms, goats were pastured every day, in addition of the pasturing the goats were given supplementary feeding. Parasitical drug was given twice a year (spring and autumn) against internal parasites in three farms. Live body weights were taken by digital weighbridge.

In the study, BCS of each goat was accepted as the average value of the BCS estimates taken by three researchers. In this study, BCS were used which was developed by Russel et al., (1969) and in which the scores range from from 1 (very poor condition) to 5 (very good condition) with half-unit increments.

5 ml sterile EDTA-blood was collected from the jugular vein of each goat and transferred to laboratory. Red Blood Cells (RBC)= 8-18 10^6/µl, Hemoglobin (HGB)= 8-12 g/dl, Hematocrit (HCT)= 22.0-38.0%, Mean Corpuscular Volume (MCV)= 16-25 fl, Mean Corpuscular Hemoglobin (MCH)= 5,2-8.0 pg and Mean Corpuscular Hemoglobin Concentration (MCHC)= 30.0-36.0 % values were taken as the standard values for the determination of anemia for goats (Stacey and Kramer, 2010), and blood samples were analyzed by automated blood count device (Abacus Junior Vet 5®) in the central laboratory of Adnan Menderes University Faculty of Veterinary Medicine. The colors of the conjunctivae of goats were scored by FAMACHA© Chart by the same experienced person on a 1–5 scale using the FAMACHA© Chart. Color of ocular mucous membranes of each animal was classified into five categories according to the FAMACHA© Chart; 1 = red, non-anemic; 2 = red-pink, non-anemic; 3 = pink, mildly anemic; 4 = pink-white, anemic; 5 = white, severely anemic (Bath et al., 2001; Malan et al. 2001; Van Wyk and Bath, 2002). BCS with some blood values and BCS with FAMACHA© Chart scores were compared to anemia levels for goats.

The averages estimated by the least square means, the effect of body condition groups and farm were determined by the Generalized Linear Model (GLM). Statistical analysis of the differences between groups was performed using Analyze of Variance (ANOVA) and the significance of the differences was determined using Duncan's test. The differences were considered statistically significant at $P<0.05$. All values are presented as Mean± Standard Error of Mean (SEM). The correlations between age, BCS and the FAMACHA© Chart scores were found with basic correlation analysis. The statistical analysis of data was done using the GLM procedure of SPSS 17.0.

The mathematical model was:

$$Y_{ijk} = \mu + a_i + b_j + e_{ijk}$$

In the model;

$Y_{ijk,}$: The effects as follows; i. Body Condition Score, j. Farm

μ : Overall mean,

a_i: the effect of Body Condition Score Groups (i= 1, 2, 3, 4; ≤2.50, 2.51-3.00, 3.01-3.50, ≥3.51 scores),

b_j: the effect of Farms (j= 1, 2, 3; 1st Farm, 2nd Farm and 3rd Farm)

e_{ijk} : Random error term.

Results

The live weight means ranged between 39.77 kg and 54.11 kg and the overall mean of live weight was 45.33

kg according to BCS groups. The BCS 3.1-3.5 and ≥3.51 groups were found statistically significantly (P<0.001) heavier than the BCS groups 2.5 ≤ and 2.51-3.0. The relationship between groups of BCS and some blood parameters (RBC, HGB, HCT) was found statistically significant (P<0.001and P<0.01). As long as BCS was increasing, RBC, HGB, HCT were increasing. RBC, HCT and HGB parameters were found statistically significantly higher in the BCS group ≥3.51 and were found lower in the BCS group ≤2.5 (P<0.001). It was shown that values of HGB, HCT in all groups were lower than the standard values for goat except BCS group ≥3.51. The overall mean of HGB and HCT were found 6.70 g/dl and 17.21%. The overall mean of value of RBC was 11.45 and it was found within the normal values (Table 1).

Table 1. **Least squares means and standard errors for the effect of body condition score on live weight and some blood parameters in general** (Mean±SEM)

BCS groups	n	Live weight	n	RBC 10^6/µl	HGB g/dl	HCT %	MCV fl	MCH pg	MCHC %
2.5 ≤	18	39.77±1.97^{b}	28	10.18±2.90^{c}	5.71±0.28^{c}	14.87±0.71^{c}	14.79±0.38	5.70±0.15	38.69±1.06
2.51-3.0	19	43.64±1.75^{b}	19	11.73±1.81^{bc}	6.95±0.18^{b}	17.50±0.54^{bc}	15.00±0.30	6.02±0.20	41.67±2.28
3.10-3.50	11	51.76±1.33^{a}	14	12.55±1.75^{ab}	7.46±0.30^{b}	19.48±0.82^{b}	15.50±0.44	5.97±0.17	38.39±0.45
≥3.51	7	54.11±1.56^{a}	6	13.98±1.35^{a}	8.78±0.56^{a}	22.87±1.48^{a}	16.33±0.33	6.27±0.19	38.58±0.47
		***		**	***	***	N.S.	N.S.	N.S.
Overall mean	55	45.33±1.18	67	11.45±2.57	6.70±0.19	17.21±0.49	15.13±0.21	5.89±0.09	39.46±0.79
** P<0.01, *** P<0.001, N.S.: Non-significant; a, b, c: Means with no common superscript in a column for a parameter differ (P<0.05)									

The highest overall mean RBC and HCT of goats was found on the first, third and second farms respectively but the overall mean of HGB, MCH and MCHC of goats on the third farm was higher than on first and second farms. RBC, MCH, MCHC values were within the range of normal normal values yet HCT and HGB values were lower than the normal values for goats. Although the animals in the first farm were not grazed in pasture area during the year, these values were found lower than the normal values in the animals (Table 2).

Table 2. **Some blood parameters according to farms** (Mean±SEM)

Farms	n	RBC 10^6/µl	HGB g/dl	HCT %	MCV fl	MCH pg	MCHC g/dl
1st farm	22	13.02±0.36	7.42±0.30	19.02±0.84	14.59±0.31	5.69±0.13	38.96±0.74
2nd farm	23	8.94±0.47	5.20±0.25	14.13±0.69	15.86±0.33	5.89±0.18	37.10±1.02
3rd farm	22	12.35±0.33	7.46±0.16	18.50±0.62	14.96±0.40	6.10±0.17	42.20±1.87

The statistically significant (P<0.01) negative and high correlation (-0.559) was found between BCS and FAMACHA© Chart score. There was no significant correlation between age and BCS and age and FAMACHA© Chart score (Table 3).

Table 3. **Correlations between age, BCS and the FAMACHA© Chart scores**

	BCS	FAMACHA© Chart Score
Age	-0.075	0.124
BCS		-0.559**
** P<0.01		

The mean BCS's according to the FAMACHA© Chart scores are given in Table 4. Means of BCS corresponding to FAMACHA© Chart score were lower. The means of BCS corresponding to scores one and two which are not considered anemic according to FAMACHA© Chart were found 3.17 and 2.34 respectively.

Table 4. **BCS's according to the FAMACHA© Chart Scores** (Mean±SEM)

Eyes scores	BCS
1	3.17±0.84^{a}
2	2.34±0.20^{b}
3	1.82±0.09^{b}
4	1.62±0.12^{bc}
5	0.96±0.09^{c}
	***
*** P<0.001; a, b, c: Means with no common superscript in a column for a parameter differ (P<0.05)	

Discussions

BCS of 1.0 is an extremely thin goat with no fat reserves and a BCS of 5.0 is a very over-conditioned (obese) goat. In most cases, healthy goats should have BCS of 2.5 to 4.0. BCS of 1.0, 1.5, or 2.0 indicate a management or health problem BCS of 4.5 or 5 is almost never observed in goats under normal management conditions (Villaquiran et al., 2004). Yilmaz, et al. (2011a) found that BCS for the highest fecundity and

litter size was determined ≥ 2.01 and lowest rates for these traits were ≤ 1.50. The fertility of BCS 3 does was better than BCS 2 (Widayati et al. 2011). According to this study, the highest live weight and high or normal blood parameters were found in the groups of BCS 3.5 and, the lowest rates of all blood parameters were in the BCS groups' ≤2.5. BCS and live weights for goats might diminish owing to various reasons, anemia could be observed in these animals depending on these reasons. For instance, internal and external parasites could cause anemia in goats. Although there was a significant relationship between BCS and HCT, it may not be a good indicator of the infection with parasites; particularly H. contortus. In a study positive correlation was observed between BCS and PCV, and it was claimed that BCS was a useful tool in estimating the energy and protein status of goats (Cabiddu et al., 1999). Haemonchosis can develop so rapidly that a reduction in body condition or body weight will not be apparent most probably during an acute infection. (Vatta et al., 2001).

In our study, as BCS increased, blood values also increased, what means lower FAMACHA© chart scores. There was a negative and high correlation between BCS and FAMACHA© chart scores. While BCS increased, FAMACHA© chart scores decreased. In other words, if the BCS was high, FAMACHA© scores were low, what means the animal is not anemic. In the opposite case, the animal is anemic.

Extensive investigations on a farm in South Africa have revealed a statically significant relationship between BCS, live weight, FAMACHA© and haematocrit (Bisset et al., 2001) underlining the potentially valuable role that BCS can play in determining internal parasites in small ruminants. In the study, BCS and live weight with eye scores by using FAMACHA© cart were compared a month before birth and a month after birth in Saanen goats. A significant and negative correlation between BCS and the eye scores, as well as between live weight and the eye scores for two periods was found (Ardahan et al 2011). In another study, PCV was positively ($p<0.05$) correlated with BCS and negatively correlated with FAMACHA© scores ($p<0.001$). It was determined that BCS was negatively ($p<0.001$) correlated with FAMACHA© scores (Marshall et al. 2012). Similarly, in this study, there is a statistically significant negative and high correlation (-0.559) between BCS and FAMACHA© Chart' score. The BCS means for 1, 2, 3, 4 and 5 eyes scores were 3.17, 2.34, 1.82, 1.62 and 0.96 respectively, as long as BCS of goat falls the level of anemia of the animal increases according to FAMACHA© chart.

The main purpose of this study was to decide practically, in the fastest and the easiest way, whether there was an anemic state in the animal rather than find out the reason of the anemic situation. Similar studies should be done using more animal material and FAMACHA© chart scores for BCS and, level of hemotocrit and other blood parameters should be compared with fecal egg counts (FEC).

In conclusion, it could be said that when animals are raised in good management and feeding conditions, they will have good BCS and be more resistant against diseases and parasites. If animals have low BCS and high FAMACHA© chart scores in herd under the same feeding and management conditions, parasitic infection should be considered for animals in the first place. The FAMACHA© system could be used to select the anemic animals by growers quite easily. For profitable production, animals with poor BCS and weak resistance should be removed from the herd. A new study must be done to determine the cause of anemia and, in addition to blood samples fecal samples must be collected to determine parasite species in this area.

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