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The comparison between FAMACHA© chart scores and blood parameters in goats raised under intensive and semi-intensive systems

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Abstract

The objective of this study was to assess the severity of anemia by using FAMACHA© chart and to compare the scores of FAMACHA© chart with some blood parameters in order to determine the anemia level in Saanen goats in intensive and semi intensive farm conditions. The FAMACHA© chart score results were compared to Red Blood Cells (RBC), Hemoglobin (HGB), Hematocrit (HCT), Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), Mean Corpuscular Hemoglobin Concentration (MCHC). FAMACHA© chart score was determined by using subjective score for the color of the inner eyelid. The relationships between FAMACHA© chart score and some blood parameters (RBC, HGB, HCT and MCH) were found statistically significant ($P<0.05$). Scorings of the conjunctiva color of goats were evaluated on a 1-5 scales according to FAMACHA© chart. It was found that RBC, HGB, HCT gradually decreased as the scores moved up from 1 towards 5. The FAMACHA© chart could be used to classify the anemic animals in terms of severity and, it can be used for screening of anemia at farm condition, regardless of the cause of anemia.

Keywords: Anemia; FAMACHA© chart; Saanen goats

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Introduction

Efficient and profitable production from small ruminant farming business can be achieved by minimizing animal losses through using handy, economical and simple disease diagonistic or managemental tools. A lot of studies have recently been carried out in practical, easy and economical applications in herd management in small ruminants breeding. For the purpose of an easier herd management, many methods including some scoring methods have been developed for animal fields, feeding, animal welfare and health (Russel et al., 1969; Cross and Parker, 1981; Malan et al., 2001; Ware,

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2005; Anonymous, 2007). The emphasis on practical applications is aimed to minimize the negative effects caused by environmental factors.

During the last decade it seems that FAMACHA© chart has been used and validated for the detection of anemia and blood born parasitic diseases (Van Wyk and Bath, 2002; Scheuerle et al., 2010; Papadopoulos et al., 2012). The FAMACHA© chart is a simple system to categorize the anemic status of small ruminants based on the conjunctiva mucosal color on a scale ranging from 1 (optimal eye color, red) to 5 (pale eye color, white). Especially when animals are predominantly infected by *Haemonchus contortus*, the FAMACHA© chart seems to be a suitable method to detect parasite infections (Malan et al., 2001; Van Wyk and Bath, 2002). FAMACHA© chart was developed in South Africa by Malan et al. (2001), and since then, it has been used in many countries including South Africa (Van Wyk and Bath, 2002), Brazil (Sotomaior et al., 2003), and southern USA (Kaplan et al., 2004) for the screening of anemia and parasitic infection in sheep and goat. The validity of diagnosing anemia by using FAMACHA© chart system has been tested in sheep and goats in different countries in recent years (Mors and Gauly, 2009; Molento et al., 2009; Di Loria et al., 2009; Scheuerle et al., 2010; Reynecke et al., 2011).

Successful and easy application by illiterate breeders is the major advantage of the FAMACHA©. Therefore, it might be considered as a valuable tool for the farmers with poor resources in developing countries (Van Wyk et al., 2006). In United States the demand of FAMACHA© by farmers has been increased significantly since its introduction (Kaplan et al., 2004). However, it is still largely unknown in Europe (Scheuerle et al., 2010). A study in Italy, the FAMACHA© chart using showed a low sensitivity in detecting anemic sheep (Di Loria et al., 2009). In other study in Greece, where prevalence of *Haemonchus contortus* is low, the FAMACHA© chart does not appear to be useful for identification of animals requiring anthelmintic treatment (Papadopoulos et al., 2012). It was shown that using FAMACHA© chart can have a positive influence on milk production, but that this method still needs further evaluation (Cringoli et al., 2009).

Parasitical infections are some of the important problems of sheep and goat breeding in Turkey. Gastro-intestinal nematodes have been neglected in terms of treatment; therefore, the breeders have to bear economic losses due to low yield loss and deaths of animals (Erkut and Kahyalioglu, 1965; Altas et al., 2006). Reynecke et al. (2011) demonstrated that the persons introduced to the FAMACHA© chart should not only be trained, but also be evaluated for the accuracy of application. The sensitivity of FAMACHA© chart diagnostic system should be evaluated at shorter intervals to avoid production losses due to failure to detect anemic animals which may be at risk of death. The calibration of the FAMACHA© chart scoring is essential per individual evaluator, and animals should be examined at weekly intervals during periods of the highest worm challenge.

This study was conducted aiming to compare FAMACHA© chart scores with some blood parameters and to determine anemia practicality at farm condition, regardless of the cause of anemia.

Materials and Methods

The study was conducted at three Saanen goat farms. The first farm was an intensive farm and located at Adnan Menderes University, Aydin, Turkey, where goats were feed without grazing throughout the year. It is 52 m above sea level and is 37°45′03.31″ N and 27°45′27.16 ″E. The second and third farms were 57 m (37°35′52.73″N and 27°59′34.33″E) and 42 m (37°25′09.24″N and 27°22′23.41″ E) above sea level located in Cine and Didim districts of Aydin, Turkey, respectively. The later both farms were semi-intensive. The numbers of goats were different at each first, second and third farm (40, 100 and 300 respectively). Goats were not grazed during the year and offered *ad libitum* feed and water in the first farm, whereas, in the second and the third farms, goats were allowed to grazing in the pasture every day. Supplementary feed was also offered in addition to grazing. Broad spectrum antiparasitic for internal parasites drug were given twice a year (spring and autumn) to all goats at each farm.

In this study, FAMACHA© chart measures were tested on 67 goats (3-4 years old) in three farms (intensive farm n=22, semi-intensive farms n=45) during the same week in August 2011. The color of the conjunctiva was clinically evaluated following the recommendations of the FAMACHA© chart method (Malan et al., 2001; Van Wyk and Bath, 2002). The colors of the conjunctiva of goats were scored on a 1-5 scale by the same person using the FAMACHA© chart. Ocular mucous membrane colors of each animal were classified into five categories according to the FAMACHA© chart color scale as; 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).

Blood samples were collected from the jugular vein of each goat and transferred to laboratory by 2 ml sterile EDTA tubes. The blood samples were analyzed with automatic blood count device (Abacus Junior Vet 5®) in the central laboratory of Veterinary Medicine in Adnan Menderes University. The blood parameters including red blood cells (RBC), hemoglobin (HGB), hematocrit (HTC), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean

corpuscular hemoglobin concentration (MCHC) were assessed. In this study, RBC: 8-18 10^6/µl, HGB: 8-12 g/dl, HCT: 22.0-38.0%, MCV: 16-25 fl, MCH: 5.2-8.0 pg, MCHC: 30.0-36.0% values were taken as the standard values for the determination of anemia for goats (Weiss and Wardrop, 2010). Finally the FAMACHA© chart scores were compared with the blood values for goats.

The blood sample means were compared with analyze of variance for FAMACHA© chart groups. The differences between subjects were found with the Tukey's test. The statistical analysis of data was done with SPSS 17.0 statistical package program.

Results

In this research, the average blood parameters were determined according to the scores of FAMACHA© chart. It was found that RBC, HGB, HCT gradually decreased as the scores went up from 1 to 5. Values of HCT for 1, 2, 3, 4 and 5 scale were found 27.30, 19.10, 17.80, 16.57 and 10.81, respectively. RBC, HGB, HCT and MCH mean differences were found statistically significant for FAMACHA© chart eye color scoring groups ($P<0.01$ and $P<0.05$) in goats of all three farms. With the increase in eye-scores ranging from 1 to 5, which means an increasing anemia according to FAMACHA© chart, deceasing HCT values were observed. Only HCT was found 27.31% which was within normal values for HCT for FAMACHA© chart score 1, while the other scores were separately considered to be increasing anemic (Table 1).

The anemia rate increases according to FAMACHA© chart scores, and HCT rates corresponding to these points reduced proportionally.

The FAMACHA© chart score value and the values for blood parameters (RBC, HGB, HCT, MCH, MCHC) were compared for each farm type. The means of intensive farm and semi-intensive farms were shown in Table 2 and Table 3.

The mean differences of RBC, HGB, HCT and MCH were found statistically significant ($P<0.05$) according to the FAMACHA© chart scores for goats reared in intensive farming (Table 2). As the FAMACHA© chart scores went from 1 to 5, the values of HCT, RBC HGB, MCH decreased. It was found that the values of HGB, HCT, MCV in this study were lower than the standard values, except for the values corresponding to eye-score 1.

No animal showed score 1 in FAMACHA© chart in semi-intensive farms. The mean differences of RBC, HGB and HCT were found statistically significant ($P<0.05$) according to the FAMACHA© chart scores for goats reared in semi-intensive farms (Table 3). Animal's blood levels were below the standard blood levels according to means of standard hematological blood parameters of goats, and as a result, it could be claimed that animals were anemic in this farm. Hematological levels of animals in semi-intensive farms were lower than the intensive farm. According to the results obtained from each of the farms, anemic differences of animals could be grouped by using FAMACHA© chart.

Discussion

In this study, the relationship between subjective score for the color of the inner eyelid (FAMACHA© chart score) and RBC, HGB and HCT were found statistically significant ($P<0.05$). RBC, HGB, HCT regularly decreased, as the FAMACHA© chart scores went up from 1 to 5. Generally the scores of FAMACHA© chart were compared with only HCT values in most of the previous studies conducted in the same area (Malan et al., 2001; Vatta et al., 2001; Burka et al., 2007; Mors and Gauly, 2009; Scheuerle et al., 2010). In the present study, the average values for HCT from all of the farms were found 27.30, 19.10, 17.80, 16.57 and 10.81 for 1, 2, 3, 4 and 5 FAMACHA© chart scales, respectively. According to standard values of HCT, non-anemic HCT values ranged from 25.0 to 38 (Weiss and Wardrop, 2010). With the increase in eye scores from 1 to 5, decrease in HCT values indicate increase in anemia severity according to FAMACHA© chart values. HCT was found 27.31% which was within in the standard values (25-38%) for only score 1 of FAMACHA© chart. Scores 2, 3, 4 and 5 were separately considered to be increasing anemic. Di Loria et al. (2009) found that the correlation between FAMACHA© chart score and both HGB and HCT was significant ($P<0.01$). Negative correlation between FAMACHA© chart scoring and HCT was significant in all study months and confirmed that the FAMACHA© chart was used correctly. Furthermore, this provided a proof for the general usefulness of the method for the detection of anemia under European conditions (Scheuerle et al., 2010).

The highest average of sensitivity and specificity, calculated according to Vatta et al. (2001), was achieved when HCT values were lower than 29% and 22%, and FAMACHA© chart scores of 3, 4 and 5 were classified as representing anemia. These HCT thresholds were higher than those in previous studies carried out in South Africa and Guadeloupe (Vatta et al., 2001). Koopmann et al. (2006) reported similar findings in sheep and goats in Northern Germany. The HCT value of 27% was considered as cut-off value for the treatment (Di Loria et al., 2009) in sheep in Italy. The sensitivity of FAMACHA© chart in detecting anemic goats was 93%, using the anemia criteria cut-

Table 1: Some blood parameters and FAMACHA© chart scores of all farms (n: 67)

Eye scores	n	RBC (10^6/µl)	HGB (g/dl)	HCT (%)	MCV (fl)	MCH (pg)	MCHC (%)
		X±SEM	X±SEM	X±SEM	X±SEM	X±SEM	X±SEM
1	2	15.77±0.53^{a}	10.60±0.80^{aL}	27.31±1.10^{a}	17.00±0.00	6.70±0.30	38.75±1.35^{H}
2	12	12.77±0.45^{b}	7.47±0.28^{bL}	19.10±0.77^{bL}	14.92±0.39^{L}	5.90±0.20	39.52±1.42^{H}
3	26	11.68±0.43^{b}	7.11±0.19^{bL}	17.80±0.62^{bL}	15.42±0.30^{L}	6.18±0.16	41.28±1.78^{H}
4	20	11.38±0.37^{b}	6.28±0.20^{bL}	16.57±0.55^{bL}	14.65±0.46^{L}	5.54±0.13	38.12±0.71^{H}
5	7	7.28±1.07^{cL}	3.95±0.46^{cL}	10.81±1.14^{cL}	15.29±0.68^{L}	5.58±0.23	36.64±1.46^{H}
Significance		***	***	***	N.S.	N.S.	N.S.

a,b,c: Within columns, means followed by the same letter are not significantly different according to Tukey (0.05); H: Higher means from standart values, L: Lower means from standart values, N.S. Nonsignificant, *** P<0.01.

Table 2: The blood parameters and FAMACHA© chart scores of intensive farm (n: 22)

Eye scores	n	RBC (106/µl)	HGB (g/dl)	HCT (%)	MCV (fl)	MCH (pg)	MCHC (%)
		X±SEM	X±SEM	X±SEM	X±SEM	X±SEM	X±SEM
1	2	15.76±0.53^{a}	10.60±0.80^{a}	27.31±1.10^{a}	17.00±0.00	6.70±0.30^{a}	38.75±1.35^{H}
2	7	13.37±0.61^{b}	7.643±0.34^{bL}	19.25±1.24^{bL}	14.43±0.52^{L}	5.78±0.27^{b}	40.42±2.27^{H}
3	6	12.88±0.65^{b}	7.28±0.37^{bL}	18.41±1.04^{bcL}	14.67±0.33^{L}	5.65±0.12^{b}	38.333±0.38^{H}
4	5	12.49±0.26^{b}	6.84±0.27^{bL}	17.99±0.78^{bcL}	14.40±0.74^{L}	5.48±0.21^{b}	38.080±0.21^{H}
5	2	10.85±1.54^{b}	5.35±0.85^{cL}	14.06±1.40^{cL}	13.00±1.00^{L}	4.95±0.05^{bL}	38.100±2.20^{H}
Significance		*	***	***	N.S.	*	N.S.

a, b, c: Mean in column in the same category with different letters differed significantly (P<0.05); H: Higher means from standart values, L: Lower means from standart values, N.S. Nonsignificant, * P<0.05; *** P<0.01

Table 3: The blood parameters and FAMACHA© chart scores of semi- intensive farms (n: 45)

Eye scores	n	RBC (10^6/µl)	HGB (g/dl)	HCT (%)	MCV (fl)	MCH (pg)	MCHC (%)
		X±SEM	X±SEM	X±SEM	X±SEM	X±SEM	X±SEM
1	-	-	-	-	-	-	-
2	5	11.94±0.52^{a}	7.24±0.51^{aL}	18.88±0.82^{aL}	15.60±0.51^{L}	6.06±0.32	38.26±1.36^{H}
3	20	11.33±0.51^{a}	7.06±0.23^{abL}	17.65±0.74^{aL}	15.65±0.37^{L}	6.35±0.20	42.17±2.29^{H}
4	15	11.01±0.45^{a}	6.10±0.24^{bL}	16.09±0.65^{aL}	14.73±0.58^{L}	5.56±0.17	38.13±0.96^{H}
5	5	5.86±0.62^{bL}	3.40±0.32^{cL}	9.51±1.05^{bL}	16.20±0.37	5.84±0.24	36.06±1.93^{H}
Significance		***	***	***	N.S.	N.S.	N.S.

a, b, c: Mean in column in the same category with different letters differed significantly (P<0.05); H: Higher means from standart values, L: Lower means from standart values, N.S.; Non significant, *** P<0.01.

offs FAMACHA© chart score ≥ 3 and HCT <22% (Scheuerle et al., 2010). The HCT cut-off value of ≤22% was selected as it is the upper limit of FAMACHA© chart score 3 (Bath et al., 2001). However, a cut-off value ≤19% was also included to provide an additional view of the data, since an animal with a HCT of ≤19% could be in grave risk of dying within 5-7 days, if not detected and treated. It would not be logical to compare the results observed in the studies above with our findings, because the values presented in the previous studies were determined throughout a year or for few years. However, our study was done only for screening purposes in order to decide whether eye scores worked to classify the animals according to severity anemia.

The, HCT values for each FAMACHA© chart score were found the same or decreased in a parallel manner at all three farms. According to the present study results, it can be assumed that FAMACHA© chart might be useful to determine the level of anemia approximately, and animals can be classified into groups according to their anemic status and thus may receive intensive care or treatment. However, for better results, longitudinal studies at least for one year period including more animals and farms at different locations may be conducted to determine HCT values for each FAMACHA© chart score in different periods.

In conclusion, The FAMACHA© charts could be used to classify the anemic animals and it should be used to diagnose anemia in field conditions and it can be successfully utilized by generally illiterate people, and can thus be a valuable tool for resource-poor farmers. It should be used to determine anemia practicality in farm condition, regardless of the cause of anemia. However, besides the requirement for the testing of FAMACHA© chart, new studies must be done to determine the cause of anemia. In addition to blood samples, fecal samples must also be collected to determine parasite species in the area.

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