Genetic Parameter Analysis of Indicator Traits of Gastrointestinal Nematode Infection in Sheep Breeds

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ABSTRACT

This study was undertaken with an aim to analyse the indicator traits of gastrointestinal nematode infection viz., FAMACHA score, FEC and PCV and to estimate the correlation among these traits. This study was carried out in a total of 100 sheep, 50 of each Kilakarsal and Vembur sheep breeds. The data were analysed using a mixed model least-squares analysis for fitting constants and the relationship among traits were estimated. The overall least-squares mean for FAMACHA scores were 2.88±1.144 and 2.9±0.151; FEC were 792±121.448 and 767.0±100.576; PCV were 26.38±0.199 and 26.14±0.189, in Kilakarsal and Vembur sheep, respectively. The Pearson Correlations study revealed that there is highly significant (P<0.01) positive correlation between FAMACHA scores and FEC in Kilakarsal (0.835**) and Vembur (0.863**) sheep, But PCV is highly significantly negatively correlated with FAMACHA scores (Kilakarsal: -0.843**and Vembur: -0.883**) and FEC (Kilakarsal: - 0.874** and Vembur: -0.924**). According to Spearman's rho correlations analysis, FAMACHA scores (Kilakarsal: -0.802** and Vembur: -0.893**) and FEC (Kilakarsal: -0.811** and Vembur: -0.920**) had negative associations with PCV which are highly significant (*p*<0.01) and the FAMACHA scores exhibited a highly significant positive association with FEC with values of 0.957** and 0.954** in Kilakarsal and Vembur sheep, respectively. It is concluded that the FAMACHA score, FEC, PCV are the best indicator traits for gastrointestinal nematode infection, especially *Haemonchus contortus* is major disease causing pathogen. The correlation analysis of indicator traits will help in selection of genetically resistant animals against gastrointestinal infection.

KEYWORDS: FAMACHA, correlation, FEC, gastrointestinal nematode, kilakarsal, PCV, vembur

1. INTRODUCTION

In sheep, *Haemonchus contortus* is the most economically significant gastrointestinal nematode due to the severity of the parasitism, high mortality and the emerging anthelmintic resistance (Goel et al., 2020; Muhammad et al., 2021). It has a small tooth that lacerates the abomasum wall and it feeds on the blood that is released which result in anemia. The Parasite cause major loss to farmers by reducing the animal production, weight, conception rate, altered carcass composition and clinical effects viz. roughness of coat, edema, diarrhoea (Praveen et al., 2018). Controlling of gastrointestinal nematode requires an integrated control strategy which combines chemical and nonchemical approaches (Qokweni et al., 2021). The integrated control strategy includes management practices that minimize infection, strategic deworming of infected and highly susceptible individuals, known as targeted selective treatment, and the genetic selection of lines or breeds of hosts to increase host resistance and/ or resilience to parasites (Pereiraa et al., 2016). Rapid diagnosis, strategic prevention, and pasture management will facilitate the control of gastrointestinal nematode infection (Peter, 2006; Ngere et al., 2018).

The clinical diagnosis of haemonchosis is based mostly on the detection of anemia through faecal worm egg counts (FEC), packed cell volume (PCV) and the FAffa MAlan CHArt (FAMACHA) conjunctival-colour index (Beh and Maddox, 1996; Hailey et al., 2020). Both FEC and PCV are traits of value, as FEC is an indirect measure of resistance and PCV is an indicator of resilience, i.e. the ability of the animal to withstand the effects of infection. In ideal circumstances, it would be desirable to select for both decreased FEC and increased PCV (Dominik, 2005).

In haemonchosis, anemia is the principle clinical problem and the mucous membrane pallor is one of the easiest ways to diagnose. The FAMACHA system uses a 5-point scale to measure ocular mucous membrane color, which correlates with packed cell volume. The FAMACHA system was developed to estimate the level of anemia in sheep and goats associated with *Haemonchus contortus* infection. It is a tool that matches the color of the eye mucous membranes of small ruminants with a laminated color chart showing 5 color categories that correspond to different levels of anemia. Category 1 represents "not anemic", with category 5 representing "severely anemic". The FAMACHA© system is an important tool in identifying and selectively deworming sheep. It can also aid in selective breeding decisions by identifying those animals that are most susceptible to *Haemonchus contortus* infection (Burke et al., 2007). The successful use of FAMACHA system of clinical evaluation of anaemia associated with haemonchosis has facilitated the adoption of targeted selective treatment which is regarded as an alternate approach to reduce anthelmintic resistance in sheep (Thomas and Syamala, 2016; Cintra et al., 2020). The FAMACHA system is based on the principle of the correlation between the eye mucous colour and the PCV values and identifying animals that are able to withstand infections by *Haemonchus contortus*. Using this approach one would allow the survival of an anthelmintic sensitive parasite population to persist on the environment, without being exposed to anthelmintic treatment, reducing the selection pressure towards resistance (Vinicius et al., 2012; Cintra et al., 2018)

Knowledge on correlation among economic indicator traits of gastrointestinal nematode infection is essential for selection of sheep for disease resistance. This study was undertaken with an aim to study the indicator traits of gastrointestinal nematode infection viz., FAMACHA score, FEC and PCV in Kilakarsal and Vembur breeds of sheep and further to estimate the correlation among the traits.

2. MATERIALS AND METHODS

This study was carried out in Kilakarsal breed of sheep maintained at Livestock Farm Complex, Veterinary College and Research Institute, Tirunelveli and Sheep farm, Sattur and Vembur breed of sheep maintained at Livestock Farm Complex, Veterinary College and Research Institute, Tirunelveli and District livestock farm, Abishegappatti, Tirunelveli during 2014–16. A total of 100 sheep, 50 of each breeds, aged from 6 to 18 months and both male and female were randomly selected for this study. All the animals were maintained under semi-intensive system of management and normal natural grazing conditions and were dewormed routinely once in three months with different rotational anthelmintics as per the standard procedure. The faecal egg count, packed cell volume and FAMACHA score were recorded as per the standard protocol. The faecal egg counting was conducted using the modified McMaster technique. Faecal cultures were prepared from pooled faecal samples taken from a random sample to define the species composition of the nematodes that infected the flock. Fresh blood samples were collected on the day of faecal sampling for measuring packed cell volume. PCV was estimated by the microhaematocrit centrifuge method (Maff, 1977). Data on FEC, PCV and FAMACHA score were used for subsequent analyses. The data were analysed using a mixed model least-squares analysis for fitting constants (Preston and Allonby, 1978). The relationship among FEC, PCV and FAMACHA score were estimated by Pearson correlation coefficient and Spearman's Rank-Order correlation coefficient methods

using SPSS statistics tool. Before performing correlation coefficient, a scatter plot is used for bivariate data which is a visual presentation that gives information about the extent of the relationship between the two variables.

3. RESULTS AND DISCUSSION

The overall least-squares means for FAMACHA score, FEC and PCV of Kilakarsal and Vembur sheep are presented in Table 1. In Kilakarsal and Vembur sheep, the overall least-squares mean for FAMACHA scores were 2.88±1.144 and 2.9±0.151; FEC were 792 ± 121.448 and 767.0±100.576; PCV were 26.38± 0.199 and 26.14±0.189, respectively.

Table 1: Least-squares means FAMACHA scores, FEC and PCV of Kilakarsal and Vembur sheep

	Kilakarsal	Vembur
FAMACHA	2.88±1.144	2.9±0.151
FEC	792 ± 121.448	767.0±100.576
PCV	26.38± 0.199	26.14±0.189

The Figures 1 and 2 shows the scatter plot of bivariate data of various combinations of FAMACHA score, FEC and PCV in Kilakarsal and Vembur sheep. The figure 1 and 2 showed the uphill pattern which indicates a positive relationship between FAMACHA scores and FEC. The downhill pattern indicates a negative relationship between FAMACHA score and PCV and between FEC and PCV in Kilakarsal and Vembur sheep, respectively. These results confirm that higher FAMACHA scores were associated with higher FEC.

The Pearson Correlations of FAMACHA scores, FEC and PCV in Kilakarsal and Vembur Sheep are presented in Table 2 and 3, respectively. From this result it has been observed that there is highly significant ($P < 0.01$) positive correlation between FAMACHA scores and FEC in Kilakarsal (0.835^{**}) and Vembur (0.863^{**}) sheep. But, PCV is negatively correlated with FAMACHA scores (Kilakarsal: -0.843^{**} and Vembur: -0.883^{**}) and FEC (Kilakarsal: -0.874^{**} and Vembur: -0.924^{**}), which is also highly significant ($p < 0.01$). The Faecal egg culture results showed that the sheep were infected mostly with blood sucking *Haemonchus contortus* which is substantiated by the higher FAMACHA scores and FEC was associated with lower PCV in this study.

Spearman's rho Correlations analysis: The comparable kind of result is also observed in the Spearman's rho Correlations analysis (Table 2 and 3). Where the FAMACHA scores (Kilakarsal: -0.802^{**} and Vembur: -0.893^{**}) and FEC (Kilakarsal: -0.811^{**} and Vembur:
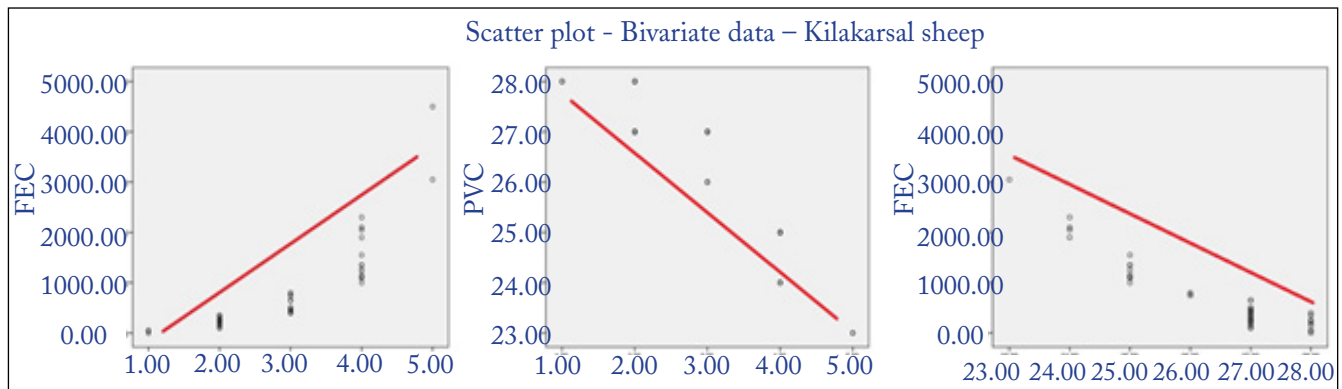

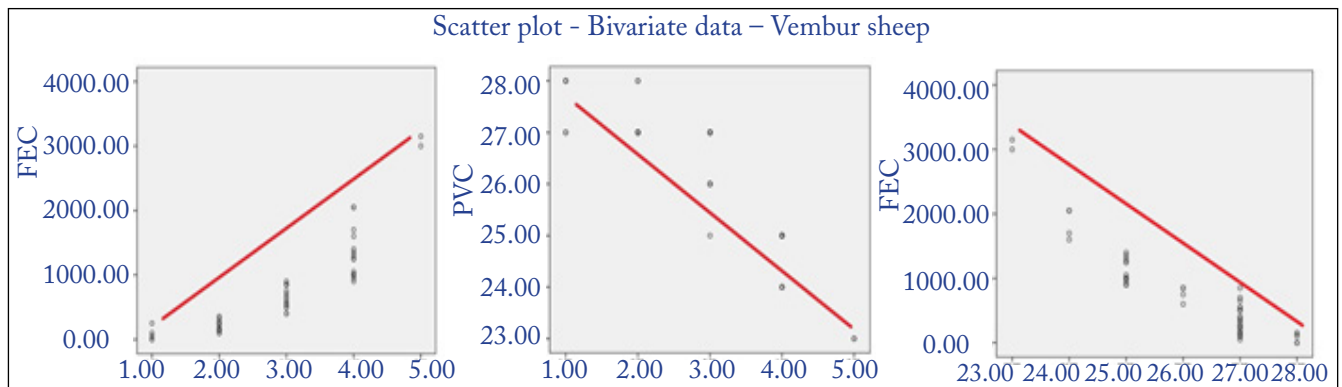Figure 1: Scatter plot - Bivariate data – Kilakarsal sheep

Figure 2: Scatter plot - Bivariate data – Vembur sheep

Table 2: Pearson and spearman rho correlations of FAMACHA scores, FEC and PCV of kilakarsal sheep

	Pearson correlation coefficient			Spearman rho correlation coefficient		
	FAMACHA	FEC	PCV	FAMACHA	FEC	PCV
FAMACHA	1	0.835[**]	- 0.843[**]	1	0.957[**]	- 0.802 [**]
FEC	0.835[**]	1	- 0.874[**]	0.957[**]	1	- 0.811[**]
PCV	- 0.843[**]	- 0.874[**]	1	- 0.802[**]	- 0.811[**]	1

Table 3: Pearson and spearman rho correlations of FAMACHA scores, FEC and PCV of vembur sheep

	Pearson correlation coefficient			Spearman rho correlation coefficient		
	FAMACHA	FEC	PCV	FAMACHA	FEC	PCV
FAMACHA	1	0.863[**]	- 0.883[**]	1	0.954[**]	- 0.893[**]
FEC	0.863[**]	1	-0.924[**]	0.954[**]	1	- 0.920[**]
PCV	- 0.883[**]	-0.924[**]	1	- 0.893[**]	- 0.920[**]	1

-0.920[**]) had negative associations with PCV which are highly significant (p<0.01). The FAMACHA scores exhibited a highly significant positive association with FEC with values of 0.957[**] and 0.954[**] in Kilakarsal and Vembur sheep, respectively.

In the present study, the faecal egg culture results showed that the sheep were infected mostly with *Haemonchus contortus*. Mugambi et al. (2005) stated that the *Haemonchus contortus* often lead to the lower PCV values and other haematological disturbances and it is attributed to the loss of blood through gastrointestinal tract by the injuries caused by this parasite. In this study the PCV is negatively correlated to FEC and FAMACHA scores, whereas, FEC is positively correlated with FAMACHA scores. Similar findings were reported in various studies. Guash et al. (2015) reported that a highly significant negative correlations between PCV and FAMACHA score and FEC and positive correlations observed between FAMACHA score and FEC. Burke et al. (2007) reported a highly significant exponential increase in mean FEC with increasing FAMACHA scores in sheep and a correlation of 0.44 between FAMACHA score and FEC. Notter et al. (2017) concluded that a higher FAMACHA scores were associated with higher FEC in Katahdin lambs. Hailey et al. (2020) also reported that the FAMACHA score was highly related to FEC in sheep. In Kilakarsal sheep, Selvam and Venkataramanan (2018) recorded significant negative correlation in FEC with PCV (-0.705) and In Vembur sheep. The negative correlation between FEC and PCV was reported in fine-wool Merino lambs (Woolaston and Piper, 1996) in Polish Long Wool sheep (Greer et al., 2009), in Scottish Blackface lambs (Bouix et al., 1998). Adamu et al. (2020) state that the FAMACHAsystem is suitable indicator of anaemia and may provide an additional part of integrated anthelmintic control of sheep, and its use may reduce chances of anthelmintic resistance development.

The result implies that when FEC and FAMACHA score increases, PCV reduces. The correlation of FAMACHA scores with FEC and PCV may assist in field diagnosing animals with gastrointestinal nematode infection and aid in treating the animals and also in selection of genetically resistant animals against gastrointestinal nematode infection.

4. CONCLUSION

In this study the FAMACHA score was highly significantly positively correlated with the FEC and negatively correlated with PCV in Kilakarsal and Vembur sheep. These data indicate that the FAMACHA score, FEC, PCV are the best indicator traits for gastrointestinal nematode infection. Also this analysis will help in selection of genetically resistant animals against gastrointestinal infection. In future this study can be further extended with genomic studies to identify the markers for the genetic resistance to gastrointestinal nematode infection.

5. ACKNOWLEDGEMENT

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