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Sensitivity and specificity of the FAMACHA© system in Suffolk sheep and crossbred Boer goats

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ABSTRACT

Sheep and goats are the species of farm animal with the highest growth rate in Paraná State. The main problems facing Paraná State flocks are gastrointestinal parasites and anthelmintic resistance. One of the newest resources used to slow down the development of anthelmintic resistance is the FAMACHA© system, a selective method useful for controlling gastrointestinal verminosis in small ruminants. The purpose of the present research was to evaluate the sensitivity and specificity of the FAMACHA© system in sheep and goats and to compare the results for both species. The conjunctivae of 83 Suffolk ewes and 60 adult crossbred Boer does were evaluated by the same trained person using the FAMACHA© system. The packed cell value (PCV) served as the gold standard for clinical FAMACHA© evaluation. To calculate the sensitivity and specificity of the FAMACHA© system, different criteria were adopted in turn: animals classified as FAMACHA© (F©) 4 and 5, or 3, 4 and 5, were considered to be anemic (positive test), and animals classified as F©1, 2 and 3, or 1 and 2 were considered to be non-anemic (negative test). Three standard values of PCV, namely ≤19%, ≤18% or ≤15%, were used to confirm anemia. At all cut-off levels, the sensitivity increased if F©3 animals were included as being anemic. However, changes in levels of sensitivity were associated with reciprocal changes in specificity. The sensitivity was higher for sheep than for goats, excepting when the criteria included PCV ≤ 18 and F©3, F©4 and F©5 were considered positive. In contrast, the specificity was always lower in sheep for any criteria adopted. Other than in goats, using the ≤15 cut-off level for sheep, it is possible to opt not to drench the animals that were shown to be F©3 because the sensitivity is still high, indicating that few animals that should have been drenched were overlooked. In goats, in contrast, the low sensitivity at all cut-off levels made it too risky to leave F©3 animals undrenched. Even though the number of correct treatments for goats was always higher than that for sheep, the opposite was true for the kappa index for all the criteria tested. Therefore, the FAMACHA© system is suitable for the identification of anemic animals of both species. It is necessary that all small ruminants classified as FAMACHA© level 3 are also treated to increase the sensitivity of the method.

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1. Introduction

Sheep and goats are the species of farm animals with the largest growth rate in Paraná State between 2004 and 2010, with increases of 26% from 488,000 to 614,000 in sheep and 90% from 96,000 to 182,000 in goats (IBGE, 2010). Most sheep and goats are raised on small and medium-sized farms in intensive or semi-intensive systems characterized by high stocking rates of 20–50 sheep/goat per hectare, and slaughter lamb and kid production is the primary economic endeavor. However, this is increasingly coming under threat from developing resistance of *Haemonchus contortus* to anthelmintics, since this parasite species constitutes one of the main problems of sheep and goat farming in Parana State (Depner et al., 2007).

The evolution of drug-resistant nematode populations throughout the world is well known (Kaplan, 2004; Papadopoulos, 2008). In Paraná State, the indiscriminate use of anthelmintics, including blanket treatment of all animals at fixed intervals as short as monthly, bimonthly or even weekly, and treating the entire group when one or more animals demonstrate clinical helminthosis has resulted in high levels of parasitic resistance to all the anthelmintic activity groups available in Brazil for use in sheep flocks (Thomaz-Soccol et al., 2004).

When an entire flock is treated, there can be great selection pressure for resistance in nematode populations, depending on the levels of refugia at the time. It is now recognized that the proportion of a given helminth population under drug selection is possibly the single most important factor that influences the rate at which resistance will develop. Therefore, nematode control programs should be designed to maintain the maximum amount of refugia (the portion of the population that is not exposed to the drug) that is commensurate with sustainable parasite management and animal production (Van Wyk, 2001).

Researchers worldwide have sought to develop practical methods of integrated parasite management (IPM) for reducing anthelmintic drug usage (Bath, 2011; Hoste et al., 2011). One such aid is the FAMACHA© (F©) system, a method of clinical evaluation of anemia, used primarily for selective anthelmintic treatment of only those individual animals which cannot manage unaided under field conditions of severe *H. contortus* challenge (Bath et al., 2001; Van Wyk and Bath, 2002). Through clinical identification and selective treatment of overly susceptible hosts, while leaving the resistant and resilient ones (i.e. those which are, respectively, able either to eliminate parasites or to withstand their effect), use of anthelmintic drugs can considerably be reduced (Malan et al., 2001; Van Wyk and Bath, 2002; Mahieu et al., 2007; Molento et al., 2009).

Since its induction the FAMACHA© system has been studied in a variety of different countries and production systems to optimize its use (Malan et al., 2001; Vatta et al., 2001; Kaplan et al., 2004; Ejlertsen et al., 2006; Di Loria et al., 2009; Molento et al., 2009; Riley and Van Wyk, 2009; Scheuerle et al., 2010). Possible variations among breeds (Moors and Gauly, 2009), animal categories and ages (Mahieu et al., 2007), evaluators (Burke et al., 2007), management systems (Reynecke et al., 2011b), environments and facilities must be investigated to determine the real limitations of this method.

In the light of the suggestion of Vatta et al. (2001) that the FAMACHA© technique could be less accurate in goats than in sheep, the present research was conducted to compare the sensitivity and specificity of the FAMACHA© system in these two species.

2. Materials and methods

The research was performed at LAPOC (Laboratório de Produção e Pesquisa em Ovinos e Caprinos – Laboratory for the Production and Research of Sheep and Goats), located in the Cangüiri Center of Experimental Stations, Federal University of Paraná, and in the Hospital Unit for Farm Animals at the Pontifical Catholic University of Paraná, from October 5, 2009 to November 20, 2009.

Eighty-three 2–8 year-old Suffolk ewes and 60 2–7 year-old crossbred Boer does were evaluated using the FAMACHA© system. While the ewes were toward the end of their period of lactation and grazed low quality Tifton pasture, only 20% of the does were similarly lactating, also on Tifton pasture, but the latter was of better quality and availability than that of the sheep. For both host species this evaluation was always performed by the same previously trained person according to Van Wyk and Bath (2002) by comparing the color of the conjunctiva to the appropriate FAMACHA© chart of Bath et al. (2001). At each evaluation occasion blood was collected for determining the packed cell volume (PCV) of every animal.

The FAMACHA© categories and their respective PCV values were analyzed according to Bath et al. (2001). For the calculation of the sensitivity and specificity of the FAMACHA© system, two different criteria were adopted: (I) animals classified as FAMACHA© 4 and 5 were considered to be anemic (positive test) and FAMACHA© 1, 2 and 3 non-anemic (negative test); (II) animals classified as FAMACHA© 3, 4 and 5 were considered to be anemic (positive-test) and FAMACHA© 1 and 2 non-anemic (negative test). For the PCV, the standard test used to confirm anemia, three different values were used ($\leq$19%, $\leq$18% or $\leq$15%), as no precise value for PCV has been clearly established at which anemia crosses the threshold of clinical importance (Kaplan et al., 2004; Burke et al., 2007). A true positive (TP) result was defined as animals that were anemic (PCV $\leq$15, $\leq$18 or $\leq$19%) with pale eye scores (4, 5 or 3, 4, 5). A false positive (FP) result was defined as animals that were not anemic (PCV >15, >18 or >19%) with pale eye scores. A false negative (FN) result was defined as animals that were anemic with red or pink eye scores (1, 2 or 1, 2, 3). A true negative (TN) result was defined as animals that were not anemic with pink or red eye scores.

Sensitivity, specificity, the predictive value of a negative and the predictive value of a positive were calculated according to Vatta et al. (2001) and Thrusfield (2005). Sensitivity (Se) is the proportion of infected or diseased individuals with a positive test or true positive (TP), or in the case of the FAMACHA© clinical assay, the proportion of anemic animals correctly identified as anemic, above all real anemic animals [$Se = TP \times 100/(TP + FN)$]. Specificity (Sp) is defined as the proportion of disease-free individuals that test