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Anthelmintic resistance in gastrointestinal nematodes in goats and evaluation of FAMACHA diagnostic marker in Uganda

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ABSTRACT

Gastrointestinal nematodes (GIN) are a challenge to goat production globally causing reduced growth, morbidity and mortality. We report here results of the first nation-wide anthelmintic resistance (AR) study and validation of assessment of clinical anaemia with FAMACHA eye scores in goats in Uganda. From August to December 2012 the efficacy of albendazole (7.5 mg/kg), levamisole (10.5 mg/kg) and ivermectin (0.3 mg/kg) against strongyle nematodes was tested on 33 goat farms in Soroti, Gulu, Mpigi, Mbarara and Ssembabule districts of Uganda. Altogether 497 goats were subjected to a total of 45 different faecal egg count reduction tests (FECRT), each involving 5–20 goats. On one farm all substances were tested. Faecal and blood samples were collected and FAMACHA eye scores evaluated on the day of treatment and 15 days later. A questionnaire survey was conducted on frequency, type and dose of anthelmintics used, farm size and grazing management system. Examination of infective third stage larvae (L3) from pooled faecal cultures demonstrated *Haemonchus* to be the predominant genus (>75%). Resistance to at least one anthelmintic group was detected on 61% of the 33 farms and in 49% of the 45 test groups. Prevalence of resistance to ivermectin, levamisole and albendazole was respectively 58%, 52% and 38%. Correlation between pre-treatment packed cell volume determinations and FAMACHA scores ($r_{498} = -0.89$) was significant. Paddock grazing system (Odds ratio 4.9, 95% CI 1.4–17.3) and large farm size of >40 goats (odds ratio 4.4, 95% CI 1.2–16.1) were significant predictors of AR. In all districts, resistance to all three anthelmintics was higher on large-scale goat farms practising mostly paddock grazing. Interestingly, resistance to albendazole, the most commonly used anthelmintic in Uganda, was lower than that to ivermectin and levamisole. We recommend adaptation of FAMACHA to goats to help restrict anthelmintic treatment to heavily infected individuals. This will limit selection pressure and hence delay development of anthelmintic resistance.

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1. Introduction

The majority of 13 million goats in Uganda are indigenous Mubende (60%), Small East African (35%) or Kigezi (5%) breeds (Siefert and Opuda-Asibo, 1993; van Wyk and Bath, 2002). Goats are mainly reared by small-scale farmers, comprising approximately four out of every ten households, each with an average of 2–5 goats (MAAIF, 2008). The large-scale farms, each with ≥40 goats on ≥2.5 hectares of land, have extensively cross-bred goats with imported exotic Boer goats (85%, meat) from South Africa, Savannah White (5%, meat) from Middle East and Toggenburg (10%, milk) from the Alpine region (Semakula et al., 2010). Breeding goats for small-scale farms (<40 goats) with minimum input–output productivity, are usually purchased from large-scale farmers or bucks are obtained in communal grazing systems (Semakula et al., 2010).

Gastrointestinal nematodes (GIN) remain a challenge to livestock production and productivity worldwide (Vatta and Lindberg, 2006b; Höglund et al., 2009; Hoste and Torres-Acosta, 2011), to the extent that it is regarded as the major animal health constraint on small ruminant production (Vatta et al., 2001). As in other tropical and sub-tropical regions of the world, haemonchosis is one of the most debilitating livestock diseases in small ruminants in Uganda. It causes financial losses directly through production losses or indirectly in control efforts (Katunguka-Rwakishaya and Rubaire-Akiiki, 2007; Lapenga and Rubaire-Akiiki, 2009; Ssewannyana et al., 2010). Use of chemotherapeutic drugs (i.e. anthelmintics) has for years been the most viable option when implemented with other strategies such as good farm management (Waller, 1997; Coles, 2003; Katunguka-Rwakishaya and Rubaire-Akiiki, 2007; Höglund et al., 2009; Van Wyk and Reynecke, 2011). Anthelmintic resistance (AR) is present when worms tolerate doses of an anthelmintic, which otherwise would prove lethal to the majority of individuals (http://www.scops.org.uk/what-is-resistance.html).
According to World Association for the Advancement of Veterinary Parasitology (WAAVP) guidelines, anthelmintic resistance (AR) is considered to be present in small ruminant nematodes when the efficacy of an anthelmintic drug is below 95% and the lower 95% confidence interval (CI) is below 90%, whereas AR is suspected when only one criteria is met (Coles et al., 1992). Many studies have demonstrated the existence of AR in small ruminants nematodes in several countries globally (Mckenna, 1994; Waller, 1997; Coles, 1998; Chandrawathani et al., 2004; Domke et al., 2011; Maharshi et al., 2011) including several African countries, notably South Africa (Van Wyk et al., 1999; Vatta and Lindberg, 2006b; Bakunzi, 2008), Kenya (Wanyangu et al., 1996; Maingi et al., 1998; Waruiru et al., 2003), Tanzania (Keyyu et al., 2002), Ethiopia (Sissay et al., 2006), and Zambia (Gabrie et al., 2001). A recent study at a research farm in eastern Uganda indicated reduced anthelmintic efficacy to the three main anthelmintic groups in goats (Byaruhanga and Okwee-Acai, 2013).

FAMACHA was developed to estimate clinical anaemia due to *Haemonchus contortus*, based on the colour of the lower conjunctiva, graded from 1 (normal, intensively red) to 5 (almost white). While developed primarily for sheep (van Wyk and Bath, 2002; Burke and Miller, 2008) it may be similarly applicable to goats (Kaplan et al., 2004). The FAMACHA score enables identification of the most anaemic animals that require treatment instead of the whole flock (Vatta et al., 2001). This reduces the selection pressure on the worm population and thereby delays development of AR and lowers the cost of treatment (van Wyk and Bath, 2002). Therefore, the objectives of this survey were; (i) to determine the prevalence of resistance to the commonly used anthelmintics and the associated risk factors in Uganda and (ii) to investigate the use and value of FAMACHA in goats under Ugandan conditions.

2. Materials and methods

2.1. Study design and area

A cross-sectional survey on AR to albendazole (ABZ), levamisole (LEV) and ivermectin (IVM) was conducted from August to December 2012. Thirty-three farms with flock sizes ranging from 10 to 150 goats from Mbarara (00° 36′S 30° 36′E), Soroti (01°43′N 33°36′E), Gulu (02° 45′N and 32° 00′E), Mpigi (00° 14′N 32° 20′E) and Ssembabule (00° 06′S 31° 30′E) districts were studied (Fig. 1). All these districts except Gulu are part of the great cattle corridor in Uganda, where there are two rainy seasons, which determine the farming activities. The first season starts in March to mid-June, and the second is from mid-July to early November.

2.2. Sample size estimation and sampling

The sample size for farms was estimated based on 90% helminth prevalence (Magona and Musisi, 2002), and 2 standard errors at 95% confidence ($d = 0.1$) using a formula by Thrusfield (2007) $4P(1-P)/d^2$ to give 35 farms. These were proportionately distributed in the five districts. Multistage sampling was done to select five districts with high goat production from four regions of Uganda. We purposively selected two sub-counties from each district and randomly selected two villages per region. The district veterinary extension staff participated in selection of farmers to be involved in the study. Naturally infected goats of local, exotic and cross breeds both on large (≥40 goats) and small-scale (<40) farms were enrolled into the study. Currently, goat breeds in Uganda are not phenotypically distinguishable, thus breeds were classified based on farm records. During data analysis, goat breed was dichotomised to local (mainly Mubende and Small East African) and pure exotic breeds (mainly Boer) or their crosses.

2.3. Data collection

Farmers with a minimum of 10 goats and a history of no deworming in the past 3 months were specifically approached. After explaining the objectives of the study, the farmers who consented to participate were recruited.