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Endoparasitic infections and prevention measures in sheep and goats under mountain farming conditions in Northern Italy

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ABSTRACT

In mountainous areas, where small ruminants form an integral part of livestock farming, an effective control of parasites is of high importance, because the animals are grazing on communal pasture land during the summer months. But knowledge on the infection status of the animals, which is needed for an effective control, is very limited in these areas. Therefore, this study aimed to assess the prevalence of endoparasitic infections and the use of preventive measures in sheep and goat farms in South Tyrol, a mountainous region of Northern Italy. A questionnaire was used to collect information on farm structure and management as well as routine parasite control measures. Following the survey, a total of 3536 individual fecal samples from 123 sheep and goat flocks were analysed over three periods in autumn 2015, spring and autumn 2016 with routine methods including fecal egg counts (FEC) and oocysts counts (FOC). Animals were classified into < 6 months, 7–12 months and > 12 months of age. Goat flocks had an average herd size of 31 (range 5–125) and sheep flocks of 28 animals (range 2–100). Mountain sheep and goat breeds were dominant. More than 60% of the sheep and 40% the goat flocks were grazed on communal summer pastures at altitudes > 1500 m a.s.l. Both sheep and goat farmers perceived gastrointestinal strongylid nematodes (GIN) as the most frequent parasites. Only 16% of the sheep and 30% of the goat farmers ever before this study did coprological examinations. More than 90% of the farms applied anthelmintic treatments; usually once (sheep: 32%, goats: 53%) or twice (sheep: 68%, goats: 42%) per year. Independent of the season, macrocyclic lactones were the most commonly used anthelmintics. More than 30% of the sheep-12 months and 16% > 12 months were GIN-negative. Sheep < 6 months had a lower FEC than animals of both other age classes ($P < 0.05$). In goats, 15.9% of the samples collected from animals < 6 months were GIN-free. Age classes, however, did not differ for FEC in goats ($P > 0.05$). Third-stage larvae identified in coprocultures were dominated by *Teladorsagia/Trichostrongylus* in both sheep (56.5 ± 24.5%) and goats (60.5 ± 25.8%). While in sheep lambs had a higher FOC than both other age classes, kids did not differ from goats at an age of 7–12 months but only from those > 12 months ($P < 0.05$). In sheep, tapeworms were found in around 13% in both groups below 12 months and 6.5% in sheep > 12 months, while these parasites were identified in 18.5, 7.3 and 5.7% in goats < 6 months, 7–12 months and > 12 months, respectively. The prevalence of lungworms at flock level varied between seasons from 18 to 50% in sheep and 44–78% in goats. This first report on endoparasitic infections of sheep and goats in the mountainous region of South Tyrol reveals a high prevalence of endoparasites, especially GIN at a medium infection level, tapeworms and lungworms. Anthelmintics are regularly used, while fecal sampling for selective treatment only exceptionally. Therefore, parasite control measures should be optimized to reduce the risk for the development of anthelmintic resistance, which was already reported from neighboring regions.

1. Introduction

In many mountain regions small ruminants constitute an integral part of livestock farming and populations remained stable during the last years (Di Cerbo et al., 2010; Ringdorfer and Finotti, 2015). Beside meat and milk production, sheep and goat farming – mostly conducted by small-scale farms – play an important role for the conservation of mountainous landscapes, especially at high altitudes and steep slopes and are closely linked to agritourism activities (MacDonald et al., 2000; Ringdorfer and Finotti, 2015). Compared to more intensive production systems, autochtonous breeds are still widely used in mountain regions and for many of the farmers breeding activities rather than economic benefits are a major motivation to substantiate livestock farming (Manfredi et al., 2010). Specific for small ruminant farming in

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mountain areas is the extensive use of communal alpine pastures during summer months and a distinct barn period during winter months. An alteration between pasture areas at lower altitudes in spring and autumn and communal summer pastures at high altitudes might impact parasitological infections, even though is knowledge in this specific field limited. The management of refugia is complicated and common strategies such as targeted (selective) treatments (Charlier et al., 2014) to combat parasitic infections and especially limit the spread of resistant parasites are not widely adopted by farmers using communal grazing land. Furthermore, it has to be considered that mountain livestock farming is partly impacted by a lack of infrastructures and services (López-i-Gelats et al., 2011), including for example veterinary services.

However, infections with helminths in small ruminants are of economic importance not only in mountain areas but worldwide and cause deaths, reduced weight gains, decreased milk yields and discarded organs at slaughter (Gauly et al., 2004; Hoste et al., 2010; Rinaldi et al., 2007). In dairy goats, helminth infections can lead to a decrease of the milk yield by almost 20% (Chartier et al., 2000). Furthermore, economical losses are related to the increased feed demand and additional costs for medical treatments. Beside gastrointestinal strongylid nematodes (GIN), *Eimeria* spp. infections belong to the most important parasitic infections in goat flocks leading even to deaths (Matthews, 1991). Generally, infections are higher in goats than in sheep (Hoste et al., 2010). The major reason is that immunity also develops during the first year of age, but is less pronounced than in sheep (Hoste et al., 2008). Another reason may be that the dosage used by veterinarians or farmers in goats is usually the same as for sheep, but needs to be higher (Manfredi et al., 2010). In a recent study of Di Cerbo et al. (2010) conducted in Lombardy (Northern Italy), GIN were found in almost all goats.

Because parasitic infections constitute such a problem for small ruminants causing economic losses (Waller, 2006a,b), special attention has to be given to the available control measures. Most commonly, infections are controlled by applying anthelmintics (Domke et al., 2012; Manfredi et al., 2010; Zanzani et al., 2014). However, their decreasing efficiency caused by its regular use has gained interest and anthelmintic resistances in small ruminants are proven in a growing number of countries worldwide (Domke et al., 2012; Holm et al., 2014; Van den Brom et al., 2013; Schoiswohl et al., 2017; Kupčinskas et al., 2015; Čerňanská et al., 2006). In Central Italy, Traversa et al. (2007) already reported multiple resistances in gastrointestinal trichostrongylids of sheep. Recently, Zanzani et al. (2014) found an alarming number of dairy goat flocks in Northern Italy with problems of anthelmintic resistance and emphasized the need for strategies to prevent the development of anthelmintic resistance. The application of alternative prevention measures such as selection for genetic resistance, feeding of plant extracts or rotational use of pasture areas which have been proven effective against GIN infections (Jackson et al., 2009; Sayers and Sweeney, 2005; Waller, 2006b) is limited under the specific conditions of mountain regions, which is partly due to the small scale of farms and because they are run as part-time farming or hobby activity. The use of communal land is further complicating an efficient parasite control management.

Given that for South Tyrol, a mountainous region of Northern Italy, no studies on endoparasitic infections in livestock are available, yet, this study aimed to assess the prevalence and abundance of gastrointestinal parasites (nematodes, cestodes and trematodes) and current routine prevention measures in sheep and goats of this region.

2. Materials and methods

Sampling protocols applied met the International Guiding Principles for Biomedical Research Involving Animals as issued by the Council for the International Organizations of Medical Sciences.

2.1. Farm selection and study area

Sheep and goat farmers of the province South Tyrol, Northern Italy (46.73° North, 11.29° East) were invited through an announcement in the local agricultural magazine in autumn 2015 to participate in this study. The study was also promoted by the South Tyrolean farmer association for small ruminants. First, farmers were asked to answer a questionnaire and second individual fecal samples were collected for parasitological measurements. Data from a total of 123 sheep and goat flocks raised on 103 different farms were included in the study. Farms that raised sheep and goats together or dairy and meat breeds of one species answered one questionnaire per species or breed.

2.2. Farm questionnaire

The questionnaire was designed to collect data on farm management, including husbandry system, herd size, breeds, other livestock on the farm, and sizes, elevations and management of pastures. In addition, farmers were asked for their perception of parasitic diseases and applied preventive measures against parasites. Furthermore, drenching practices were surveyed including the choice of anthelmintics, application practices, rotation of anthelmintics and the perceived effectiveness and side effects. An invitation letter to participate in the study described the purpose of the study, provided assurance of confidentiality, asked for permission to publish the anonymous responses and the willingness to participate in the fecal samplings. In total, the questionnaire consisted of 32 closed and 3 open questions.

2.3. Fecal sampling

After completion of the survey, farmers were contacted by phone to describe procedures to collect fresh fecal samples directly from the rectum of the individual animals. Twenty percent of the farmers collected the samples themselves, the remaining farms were visited by the researchers for sample collection. At each farm, at least 90% of the individuals older than 3 months were sampled. The age of the animals was recorded and classified into < 6 months, 7–12 months and > 12 months. Another pre-condition for sampling was that the animals were not treated with anthelmintics within the previous three months. A total of 3536 samples were taken in three periods, namely autumn 2015 (952 sheep and 1045 goat samples), spring 2016 (325 sheep and 615 goat samples) and autumn 2017 (421 sheep and 178 goat samples). After collection, the samples were stored cool during transportation to the laboratory and then stored at 4 °C in the refrigerator until analysis to avoid hatching of the eggs. Each sampling period lasted for approximately 2 months.

2.3.1. Parasitological measurements

Fecal egg counts (FEC) and oocyst counts (FOC) were done using a modified McMaster method (MAFF, 1986) with 60 ml of saturated NaCl solution as the flotation fluid (specific gravity = 1.2) and 4 g of feces to determine eggs per gram of feces (EPG) and *Eimeria* oocysts per gram of feces (OPG). Each egg counted represents 50 eggs per gram of feces. For tapeworms, individual animals were classified as infected if at least one tapeworm egg was identified in a sample. For further identification of nematode species, third-stage larvae (L3) were cultured with pooled feces (10–20 g) of each flock (only for farms with > 10 individual samples). L3 were recovered from the coprocultures by applying the Baermann technique (MAFF, 1986). The first 100 randomly selected L3 of each sample were identified to the generic level *Teladorsagia/Trichostrongylus, Oesophagostomum/Chabertia, Haemonchus, Nematodirus, Bunostomum* and *Cooperia* by microscopy according to MAFF (1986). The percentage of larval type was calculated on the basis of the counted L3 when fewer than 100 L3 were isolated from a sample. A pooled sample of each farm was used to detect the eggs of liver flukes applying