Breeding for resistance to nematode infections in organic goat production in Germany – A way forward?

Muth PC[1], Tietgens G[1], Pöhlmann I[1], Reiber C[1,2] & Valle Zárate A[1]

Keywords: organic goat production, parasite resistance, genetic improvement.

Abstract

Organic goat production in Germany could benefit from genetic improvement strategies that take the resistance of goats to nematode infestations and the resilience and tolerance for infections into consideration. However, there still is an immense research need before such traits can be incorporated in a breeding program.

Introduction

Gastro-intestinal nematode (GIN) infections represent a constraint for goat production worldwide. Particularly goats with access to pasture are concerned, because they are infested by the intake of larvae during grazing. Within the EU, access to pasture is mandatory for organically farmed small ruminants. In addition to essential flock and grazing management the use of plant-based treatments such as feeding of tanniferous plants became popular for combatting endoparasitic infections in organic farming. But because of the threat of the coevolution of resistant nematode genera, the problem of GIN infections requires a holistic approach. This work is based on an extensive literature review on the options for the genetic improvement of the resistance of small ruminants to GIN. Because few sources dealing with goats were available, also reports on sheep were considered to add to the picture. Notably, most of the studies on goats originated from tropical and subtropical countries. The objective was to identify the steps required for the implementation of incorporating resistance into genetic improvement for goats in Germany.

State of knowledge – A brief overview

A precondition for the choice of resistant breeds and selecting resistant individuals as parents for the next generation is that (relative) resistance to GIN infections has a genetic basis. Although the genetic architecture of resistance is not fully understood to date, most studies point toward an involvement of pathways related to the immune response (reviewed by de la Chevrotière et al. 2011; McManus et al. 2014). It is generally assumed that the genetic basis of resistance is polygenic and varies from breed to breed. The choice of an appropriate breed, i.e. between-breed selection, is the first decision when initiating a genetic improvement program. Particularly under tropical conditions local goat breeds exhibited a superior resistance and/or resilience and tolerance for GIN infections compared to imported breeds (Baker & Gray 2004; de la Chevrotière et al. 2011). In Europe hardly any study on differences in the resistance to GIN infections between goat breeds have been carried out in the last decade. In 2001, a remarkable report from France showed that pronounced breed differences in

[1] Animal Breeding and Husbandry in the Tropics and Subtropics (490h), Hans-Ruthenberg-Institute of Agricultural Sciences in the Tropics, University of Hohenheim, Garbenstr. 17, 70599 Stuttgart

[2] C_Reiber@uni-hohenheim.de

the fecal shedding of worm eggs were probably related to differences in feeding behavior (Hoste et al. 2001). This indicates that besides the immune response also behavioral aspects ("self-medication") contribute to resistance which cannot be grasped in trials where animals are artificially infected and receive a standard diet. Selective breeding, i.e. within-breed selection, for resistance is considered a sustainable approach to improve the resistance to GIN infections (McManus et al. 2014). Besides fecal egg count, which not only indicates resistance to GIN infections but also shedding of the pathogen, other traits relating to resilience and tolerance have to be considered (for further trait definitions see Bishop 2012). Holistic approaches focus on the animals' ability to maintain productivity in spite of an infestation, thus reducing the risk of a coevolution of parasites. For selective breeding a sufficiently high heritability (h^2) of a trait is a precondition. For sheep, particularly Merinos, numerous studies reporting heritabilities for resistance are available, while for goats we identified only nine studies. For these, we computed a weighted estimate of 0.15 for h^2 and a large standard error of 0.35, indicating that the estimates are imprecise and vary from one study to another. Thus, while the heritability for resistance in sheep is well-established and the traits have been systematically recorded and included into commercial breeding programs, data availability for goats is poor. Yet, it can be assumed that a certain proportion (~15%) of the phenotypic variance appears to be due to (additive) genetic variation among individuals.

Steps to be taken

For the inclusion of resistance to GIN into the set-up of breeding programs for organic goats in Germany, we identified the following research needs:

- Comparison of GIN resistance of local and imported breeds and their crossbreds in on-station and on-farm trials.
- Surveys on the epidemiological situation with respect to GIN infections on organic goat farms and evaluation of the economic impact of reducing GIN infections.
- Computation of genetic parameters of resistance, resilience and tolerance including genetic correlations with performance and reproduction traits for different breeds, ages, sexes and production environments.
- Evaluation of the economic and organizational feasibility of including resistance, resilience and tolerance in an organic goat breeding program.

Literature

Baker RL & Gray GD (2004) Appropriate breeds and breeding schemes for sheep and goats in the tropics. In: Sani RA, Gray GD & Baker RL (Eds.) Worm control for small ruminants in tropical Asia. ACIAR Monograph No. 113, Canberra: 63-95.

Bishop SC (2012) A consideration of resistance and tolerance for ruminant nematode infections. Front Genet. 3: 168.

de la Chevrotière C, Moreno C, Jaquiet P & Mandonnet N (2011) La sélection génétique pour la maîtrise des strongyloses gastro-intestinales des petits ruminants. INRA Prod Anim. 24: 221-234.

Hoste H, Leveque H & Dorchies P (2001) Comparison of nematode infections of the gastrointestinal tract in Angora and dairy goats in a rangeland environment: relations with the feeding behaviour. Vet Parasitol. 101: 127-35.

McManus C, Paim TDP, de Melo CB, Brasil BSAF & Paiva SR (2014) Selection methods for resistance to and tolerance of helminths in livestock. Parasite 21: 56.