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*Topic 1 - Ecological approaches to systems' health*

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### DUDDINGTONIA FLAGRANS: A PROMISING FUNGAL BIOCONTROL AGENT FOR GASTROINTESTINAL NEMATODES IN SMALL RUMINANTS

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**Abstract:** Controlling gastrointestinal nematodes is a challenge for organic and conventional owners of small ruminants with access to pastures. A new biocontrol method using the nematophagous fungus *Duddingtonia flagrans* is expected to complement existing alternatives for controlling gastrointestinal nematodes in grazing animals in the future. Animals receive chlamydospores of *D. flagrans*, which pass through the gastrointestinal tract and germinate in the freshly deposited faeces. In parallel to the development of helminth larvae, the fungal mycelium grows and forms trapping structures with which it fixes, kills and "digests" the nematode larvae. This leads to reduced pasture contamination and infection of subsequently grazing animals.

In an experiment with organic dairy goats, a dose-dependent effect of *D. flagrans* administration was shown. Compared to horses, cattle and sheep, higher doses were required to obtain 70% reduction of helminth larval development in faecal cultures of goats.

**Introduction:** In organic husbandry systems it is aspired that animals should have pasture access throughout the grazing season. This exposure increases the risk of infection with pasture borne parasites such as gastrointestinal nematodes (GIN). Until recently, skilful pasture management and the targeted use of anthelmintics helped to control GIN infestation satisfactorily (Kyriazakis et al., 2013). However, increasing resistance to all available classes of active substances makes it necessary to use anthelmintics even more sparingly so that they remain effective in the longer term (Nabukenya et al., 2014).

The nematophagous fungus *Duddingtonia flagrans* is a promising element of a complementary strategy to control GIN in grazing animals. The fungus grows naturally in the soil or in rotting organic matter (for example in compost) and feeds on soil nematodes, which are very similar in size and appearance to the free-living juvenile stages of GIN. Robust chlamydospores of the fungus can pass undigested through the gastrointestinal tract of grazing animals. They then germinate in the freshly deposited faeces, and trap and digest GIN larvae, which develop from eggs in parallel to the growing fungus (Figure 1).

Based on older work from the 1990s (e.g. Faedo et al., 1997; Githigia et al., 1997) and on new studies, *D. flagrans* appears to be a promising element in the integrated control of GIN in small ruminants. Recent Australian studies have shown that *D. flagrans* leads to a reduction of GIN in grazing sheep; GIN infestation of lambs fed *D. flagrans* spores was reduced by 58 - 84% compared to untreated control animals (Healey et al., 2018). Other work showed that the use of *D. flagrans* led to lower anthelmintic use and better lamb growth (Santurio et al., 2011). In addition, lambs of treated ewes had better weight gains (Gomez-Rincon et al., 2007). Studies with goats exist (e.g. Paraud et al., 2006; Vilela et al., 2012), but are scarce as compared to studies with sheep. Therefore, we aimed at obtaining more information on the dose-dependent biocontrol activity of *D. flagrans* in goat faeces.

**Material and methods:** An experiment with 30 lactating Alpine goats was carried out on the organic farm of the Visp Agricultural Centre (Valais, Switzerland) in summer 2017. All goats were naturally infected with low-to moderate levels of GIN (faecal egg counts between 150 and 1'900 GIN eggs/g faeces). Three groups of 10 animals each received either a feed additive without *D. flagrans* spores (control), a feed additive with *D. flagrans* spores in sheep/cattle dosage (low) or a feed additive with *D. flagrans* spores in 10 times the sheep/cattle dosage (high). Each goat received the individual dose of the additive during three days in the milking parlour. Faecal samples were taken from all animals on the day before and on the last day of feeding *D. flagrans* spores. For each sample, faecal egg counts were determined by a modified McMaster technique and a faecal culture was cultivated during 14 days at 25°C. GIN larvae were then separated from faeces by a Baermann method. Biocontrol efficacy of *D. flagrans* was then calculated for each animal as a % reduction of number of larvae developed after treatment compared to the number obtained in samples taken before treatment.

**Results:** The feed additive was readily eaten by all goats. As compared to the control, in the group with the low *D. flagrans* dose, infective larvae were reduced by about 20% on average, whereas reduction was almost 70% in the high *D. flagrans* dose group.

**Discussion:** A reduction of larval development by 70% in goats corresponds approximately to the reduction that we observed in other animal species with the same method, but at the low dose (sheep and cattle: 70-90%, horse and donkey: 75-95%; unpublished data). The observed reduction of larval development in faeces indicates that *D. flagrans* reduces numbers of infective larvae more efficiently than other alternative control feeds (e.g. sainfoin; Werne et al., 2013). The reduction of GIN larvae in the faeces is expected to lead to lower pasture contamination and, consequently, to lower GIN infestation in grazing goats.

The administration of *D. flagrans* presents a possible drawback of the method, because chlamydospores must be fed regularly over a longer period in order to achieve the desired reduction in infection pressure in the pasture. Except for dairy goats and dairy sheep, most small ruminants receive no concentrates at the time of the highest excretion of worm eggs (e.g. a few weeks after the start of grazing). An extra effort is therefore needed to administer the spores to animals on pasture. In order to keep this effort and costs as low as possible, the method must therefore be adapted to the epidemiology of GIN as precisely as possible.

Overall, the biocontrol method is a promising tool for controlling GIN in small ruminants on organic farms with a minimum of anthelmintic use. Moreover, we expect *D. flagrans* to become an important element on all farms with grazing animals in case of anthelmintic resistance.

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**Figure caption**

Figure 1: Mycelium of *Duddingtonia flagrans* with gastrointestinal nematode larva trapped in lasso-like structure (Microscopic image: © FiBL).

**Image:**



**Disclosure of Interest:** None Declared

**Keywords:** Biocontrol, *Duddingtonia flagrans*, Gastro-Intestinal Nematodes, goat