Use of alternative forages for helminth control

With the rising incidence of resistance to broad spectrum anthelmintics in sheep systems, there is increasing interest in the use of novel methods to control helminth infections. There is also a need to reduce chemical inputs for some markets to meet consumer demands. In addition to the strategies of drenching, grassland management and sheep breeding, there are novel parasite control methods including alternative forages, vaccines, nematophagous fungi, condensed tannins and immunonutrition.

Alternative forages are thought to work in a range of ways either directly or indirectly, including the presence of condensed tannins and other plant metabolites, improved immunity through better protein nutrition and by reducing infectivity from the larvae by their sward micro-climate and plant structure.

Plant compounds and bioactive forages

The use of plants, 'Phytomedicine' has been used for centuries by farmers and traditional healers to treat parasites and improve livestock performance and many modern medicines are derived from plants. Worldwide more than 100 plants have been identified with anthelmintic activity. Although in some cases the active compounds have not been identified, plant enzymes, such as cysteine proteinases, or secondary metabolites, such as alkaloids, glycosides and tannins have shown dose-dependent anti-parasitic properties. Some of these active compounds reduce intake and animal performance and are not yet developed to be practical at the farm level. Plants containing compounds with anti -parasitic properties are called bioactive forages or nutraceuticals and contain secondary metabolites that offer beneficial effects on health rather than for their direct nutritional value for animals.

Tannin-rich plants have attracted most attention for their effect on internal nematodes in ruminants. Condensed tannins are polyphenolic compounds that naturally occur in plants where their roles include protecting the plant from predation, regulating growth and acting as a pesticide. These plants act through direct anti-parasitic activity through condensed tannin- nematode interaction which reduces nematode viability by decreasing egg hatching, larval development and mobility of larval stages. They also act indirectly by increasing host resistance by binding with dietary protein to give protection in the rumen from microbial breakdown with an ideal concentration of condensed tannin being identified as 20-40g/kg. These effects vary with the species of plant, parasite and host. Most studies investigating the effects of bioactive plants against gastrointestinal nematodes have focused on grazing sheep, with most published work focusing on forage legumes including sulla, sainfoin, birdsfoot trefoil, greater birdsfoot trefoil, Chinese bush clover (*Lespedeza cuneate*) and the non-legume, chicory.

Plant structures / sward micro-climate

Different pasture species have structures that are unsuitable for the parasites and reduce the larval population and number of larvae eaten by grazing livestock. This is due to the change in the micro environment of the sward as the moisture, humidity and temperature are all critical to egg /larval development, survival and migration. Differences between forages are due to their effects on larval development (from eggs), survival rates and also their ability to migrate up the plants to be consumed by grazing livestock. For example fewer larvae have been found on chicory, lucerne and birdsfoot trefoil than on various grasses. Grass based swards have been found to have higher larval populations than chicory, lucerne or birdsfoot trefoil with chicory lower than lucerne. Chicory swards offer a good opportunity to reduce larval intake in grazing animals compared to many other species. Amongst grasses, lower faecal egg counts have been reported from lambs grazing Yorkshire fog or ryegrass than common bent or tall fescue.

Nutrition effects

Studies have shown that anti-parasitic effects involve a combination of improved protein utilisation, improved trace element or mineral status and/or improved immunity to nematode parasites. These mechanisms may act separately, or in combination, with the effects of secondary plant compounds (e.g. condensed tannins) on parasites in the gut, leading to reduced nematode survival, growth and/or fecundity.

Which plants?

Work on alternative forages has highlighted the potential of these to contribute to parasite control. Legume forages like white clover improve animal performance through increased protein intake and improved immunity and can offset the effect of parasite burdens. Herbage species have been shown to alter the percentage of nematode parasite larvae that reach the infective stage in the faeces of parasitized sheep.

Chicory

Chicory is an alternative crop suitable for growing in Wales as a pure stand or incorporated in mixed swards and if managed carefully can persist for 4-6 years. Seeds mixtures available range from single stands to leys with red and white clover. It is important that the chicory selected for sheep systems is a forage chicory (e.g. Puna II) bred for yield and animal performance, and not the salad variety.

Chicory contains secondary metabolites including sesquiterpene lactone and small amounts of condensed tannins. Studies in New Zealand and the United Kingdom have shown that chicory can reduce faecal egg counts, the survival of adult and larval stages of internal sheep parasites and increase performance in grazing lambs when compared to grass species ryegrass, tall fescue, cocksfoot or ryegrass/white clover mixtures. Grazing studies have shown direct anthelmintic effects of pure-stand chicory (Puna-II) as well as consistently reduced worm egg output. Chicory has an excellent nutritional value and its leaf structure may reduce worm larvae migration. Lambs benefit through reduced challenge and improved nutrition which increases their resilience. Although ewes grazing chicory may not have reduced faecal egg counts, their lambs do have reduced egg counts and better growth rates than those grazing grass. Chicory works in two ways – it breaks the life cycle by reducing development, survival and migration of larvae above 5 cm and it acts directly on abomasal helminths which means that it does not always give a lower FEC despite lower total adult helminth burdens. At Scotland's Rural College, SRUC, a trial is currently looking at a 'basket of options' by working with organic farmers to generate novel information and

innovative tools to help farmers with the parasite control; a key option in the 'basket' is the use of chicory as a bioactive forage.

Birdsfoot trefoil

Birdsfoot trefoil (*Lotus corniculatus*) is grown extensively in many countries and lotus species are tolerant of acid soils with low fertility, and have good drought tolerance. It has been shown to have a beneficial impact on lamb growth rates and parasite burdens compared with ryegrass/white clover swards which is thought to be due to condensed tannins. There is limited use of birdsfoot trefoil in the UK because it is slow to establish and not competitive in productive swards. It does not overwinter well resulting in low productivity in the subsequent season.

Sulla

In New Zealand, Sulla (*Hedysarum coronarium) also known as sulla clover or honey plant h*as shown potential for good lamb liveweight gains due to its high soluble carbohydrate and protein contents. It contains a moderate level of condensed tannins and studies have shown lambs with parasite burdens growing well while grazing sulla. Sulla is a perennial legume with a tap root and resilient to drought conditions. Although not widely grown in Wales, it could have some potential in the drier warmer parts of the country where it requires inoculation with rhizobium bacteria but it can be susceptible to fungal infection in damp environments.

Sainfoin

Sainfoin has potential against gastro intestinal parasites due to its tannin content and high nutritive values. It has a lower yield than lucerne and needs to be grown on free draining soils with pH above 6.5.

Options for Wales

There are a range of benefits of using forage legumes and plants like chicory to improve growth rates and resilience to parasites. Legume forages have the potential to contribute to the control of abomasal but not small intestine nematode parasites in finishing lamb systems. There is evidence that grazing lambs can detect the presence of parasites and modify their intake of forage containing antiparasitic compounds like condensed tannins and 'self dose'. High quality forage diets are needed to finish lambs without concentrate feed. Crops like red clover and white clover leys, and chicory offer good nutritional options, some anthelmintic effect and are easy to grow in many parts of Wales. Where there is poorer soil fertility of less plant competition birdsfoot trefoil may have a role to play although establishment can be difficult. Sainfoin and lucerne are unlikely to grow as well except on high pH free draining soils but could be an option in some parts of Wales. A control strategy that uses alternative forages needs to be developed for each farm system to ensure that it is practical and effective and uses tools like faecal egg counting and grazing management and strategic drenching to optimise the value from alternative forages.

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