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Review

Alternative temperate forages containing secondary compounds for improving sustainable productivity in grazing ruminants

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Abstract

The use of alternative temperate forages to improve the sustainable productivity of grazing ruminants, relative to grass-based pastures, is reviewed. Particular emphasis is placed upon forages containing secondary compounds for sustainable control of internal parasites, for increasing reproductive rate in sheep, reducing bloat risk in cattle and for reducing methane production as a means of lowering greenhouse gas emissions.

Of the forages reviewed, the herb chicory (*Chicorium intybus*) and the condensed tannin-containing legumes *Lotus corniculatus* L. and sulla (*Hedysarum coronarium*) offered the most advantages. Chicory and sulla promoted faster growth rates in young sheep and deer in the presence of internal parasites, and showed reduced methane production in other studies. *L. corniculatus* was not as effective as chicory and sulla in promoting growth of lambs in the presence of internal parasites. Grazing on *L. corniculatus* was associated with increases in reproductive rate in sheep, increases in milk production in both ewes and dairy cows and reduced methane production, effects that were mainly due to its content of condensed tannins (CT). Grazing ewes on *L. corniculatus* during mating and very early pregnancy may also reduce lamb mortality. However, there are no data on the effect of

Abbreviations: CL, *corpora lutea*; CT, condensed tannins; cv., cultivar; D, deer; DM, dry matter; DMI, dry matter intake; DOMD, digestible organic matter in the dry matter (g)/100 g DM; EAA, essential amino acid; FEC, faecal nematode egg counts; GI, gastrointestinal; IRL, irreversible loss rate; LWG, liveweight gain; ME, metabolisable energy; MW, molecular weight; NA, no apply; NDF, neutral detergent fibre; NP, non-parasitized; NSC, non-structural carbohydrates; NZ, New Zealand; OM, organic matter; OMD, organic matter digestibility; OR, ovulation rate; P, parasitized; PEG, polyethylene glycol; S, sheep; SAA, sulphur-containing amino acid; SED, standard error of the difference; TMR, total mixed ratios; vs., versus

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mating ewes, which are grazing chicory on their reproductive performance, an important omission. Risk of rumen frothy bloat in cattle grazing legumes is reduced when the forage contains 5 g CT/kg dry matter (DM) or greater. Gene transfer techniques aimed at achieving this for lucerne (*Medicago sativa*) have made progress, but CT concentration needs to be further increased from calculated values of 0.75–1.25 g CT/kg DM in the transformed plants. Bloat control may be achievable in genetically transformed legumes before increased amino acid absorption, as the concentration of CT required for bloat control is lower (5 versus 30–40 g/kg DM) than that required to cause increased amino acid absorption and is not affected by differences in CT structure.

Key plant characteristics for improved sustainable productivity are a high ratio of readily fermentable: structural carbohydrate and the presence of CT and certain other secondary compounds.

Taking into account both nutritional and agronomic considerations, chicory is considered one of the best emerging plants for grazing livestock, with *L. corniculatus* being more suitable for areas with dry summers and warm winters. Some of the agronomic limitations of *L. corniculatus* and sulla could be reduced by mechanical harvesting and their inclusion as a component in total mixed rations (TMR), instead of grazing.

Keywords: Forages; Chicory; *Lotus corniculatus*; Perennial ryegrass/white clover pasture; Parasite control; Reproduction; Secondary compounds; Sulla; Bloat safe; Methane reduction

Contents

1. Introduction

Forages comprise a major proportion of the diet in most ruminant animal production systems. Grazed forages are used especially during the late spring, summer and early autumn in many countries, whilst in some regions, such as Australasian and South America, ruminant animal production is based on year round grazing of forages, with no indoor housing. Grazing systems are generally based upon swards of which the major portion consists of grasses (perennial ryegrass (*Lolium perenne*) in the case of New Zealand), with a legume (white clover (*Trifolium repens*) in the case of NZ) forming a minor portion (approximately 20%),