



Tree leaves as supplementary feed for ruminant livestock

N.R. Kendall^a, J.Smith^b, L.K. Whistance^b, S. Stergiadis^c, C. Storate^d,
H. Chesshire^e and A.R. Smith^f

November 2019

Contact research@woodlandtrust.org.uk

Summary:

- **Silvopastoral agroforestry – integrating shelterbelts, hedgerows or in-field trees with grazing livestock – can provide domestic animals with benefits, including shelter and shade, as well as supplementing their diets as tree browse or fodder.**
- **This study sampled leaves from three native deciduous tree species – willow, alder and oak – from three sites across the UK, and analysed their mineral, energy and protein content.**
- **Willow leaves from all sites were found to contain higher concentrations of zinc and cobalt than sheep requirements for these minerals. Selenium concentrations were found to be more dependent on the site than the tree species.**
- **Metabolisable energy of leaves sampled was greatest in alder, while higher crude-protein content was associated with spring in all species.**
- **More research is required to investigate the value of different tree species as a mineral supplement for ruminant livestock, and to address how leaf feed could be integrated into their diet.**



The Organic Research Centre conducting leaf sampling at Elm Farm and one of their grazed fields with recent tree planting. Photo: ORC

The role of trees on farms

Protecting and enriching the UK's landscape of native woods and trees is a core objective of the Woodland Trust. Working with the farming sector is crucial for achieving this, and there are various approaches that can be taken to foster a treed and resilient farmed landscape. The deliberate integration of trees and shrubs into farming systems is a land management approach with multiple benefits. Often referred to as agroforestry, it can enhance farm productivity, increase wildlife, improve soil health and animal welfare, manage water flow and contribute to climate change mitigation. It can be designed in such a way that avoids potential trade-offs between food production and the delivery of public goods. Common designs include scattered and clumped groups of trees within field

boundaries; alley planting; traditional hedgerows and shelter belts.

Trees on livestock farms integrate shelter belts, hedgerows or in-field trees with grazing livestock (silvopastoral systems) and provide domestic animals with multiple benefits, including access to shade and shelter. Another less understood benefit is the utilisation of tree browse and fodder for nutritional and medicinal purposes. In general, browse (tree leaves and small branches) and tree fodder (preserved browse) are good sources of nutrients and micronutrients, particularly minerals. Browse from different tree species can provide pain relief or help animals manage internal parasites. Use of tree browse and fodder is not new and historically was widely practised, utilising a network of hedgerows, parkland trees and shelter belts.

However, we need a greater understanding of the benefits that silvopastoral systems can deliver for livestock to help improve advice on integrating silvopastoral approaches into modern farming.

This investigation adds to a growing body of evidence on the nutritional composition of tree browse and fodder and the supplementary potential for livestock, by examining common tree species found on UK farms. Ultimately, it will help develop guidance to enable farmers to implement

silvopastoral systems that will enhance livestock performance and health while also delivering benefits for the wider environment.

Investigating tree fodder

This study sampled leaves from three native deciduous tree species from three sites across the UK, in order to conduct analyses of their mineral, energy and protein content. This process is shown in Figure 1.

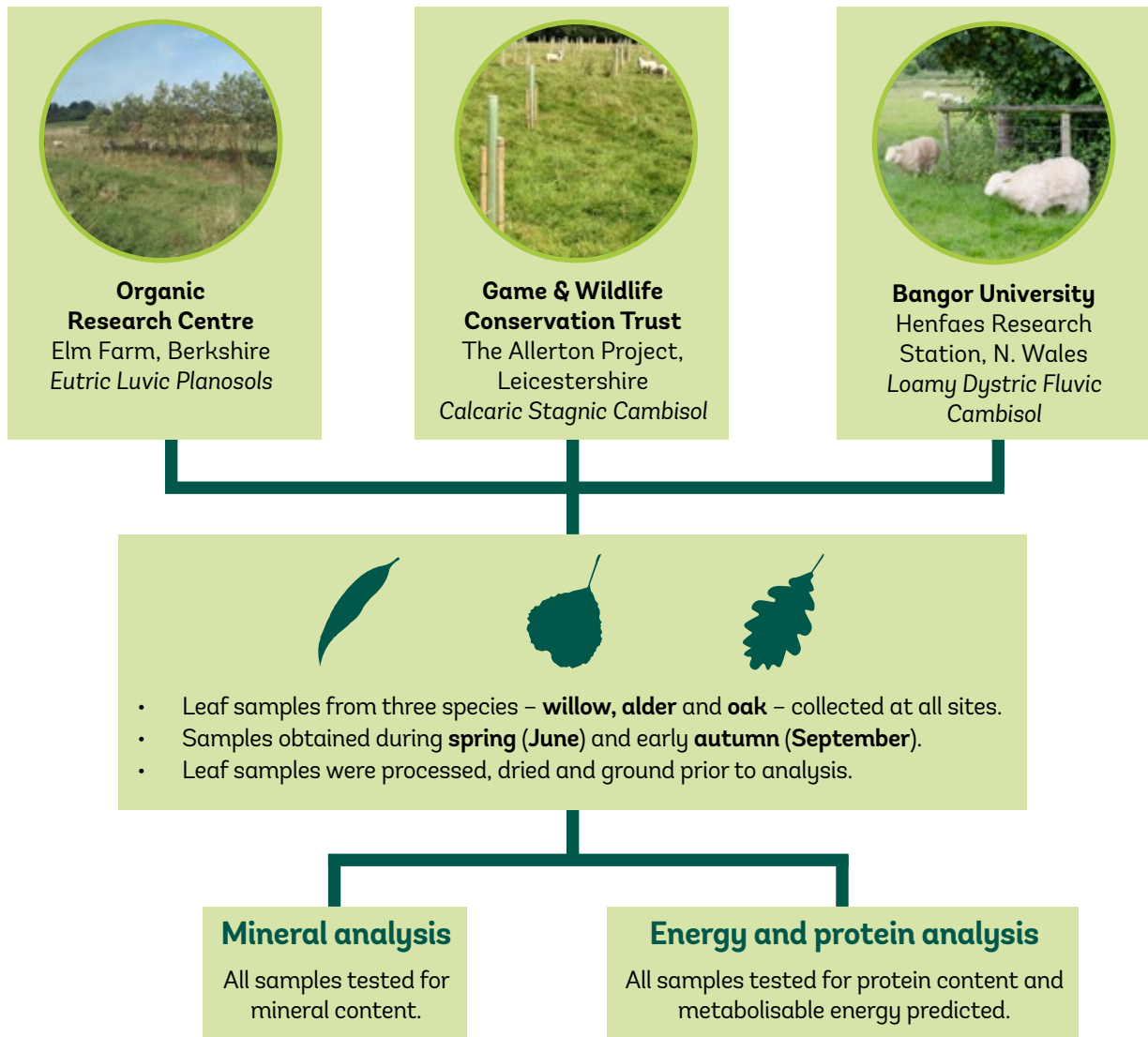


Figure 1: Sampling and analyses carried out as part of this study. Soil classifications follow the World Reference Base (WRB) for soil resources. Note that at each site, four trees from each species were sampled, except that only one willow tree was available at Henfaes Research Station.

Key findings

Mineral analysis

Twenty two essential minerals are relevant to ruminant nutrition and some of these are prone to imbalances; through diets containing too much or too little, or through interactions with other elements. The minerals which are likely to cause issues within grazing ruminants are imbalances in the trace elements: cobalt (especially in growing lambs), selenium, iodine, copper (through interactions with molybdenum, iron and sulphur), zinc, and the macro-minerals magnesium (through an interaction with high potassium) and calcium¹.

This analysis found that tree leaves can be considered good sources of a number of key minerals. For example:

- Zinc concentration was higher in willow than alder and oak, while alder had higher concentrations than oak (Figure 2a).
- The concentration of cobalt was higher in willow than in oak and alder (Figure 2b).
- The concentration of selenium was affected more by the site than the tree species.
- Other trace minerals were found to occur within the requirement range for sheep, potentially offering similar concentrations as sward.

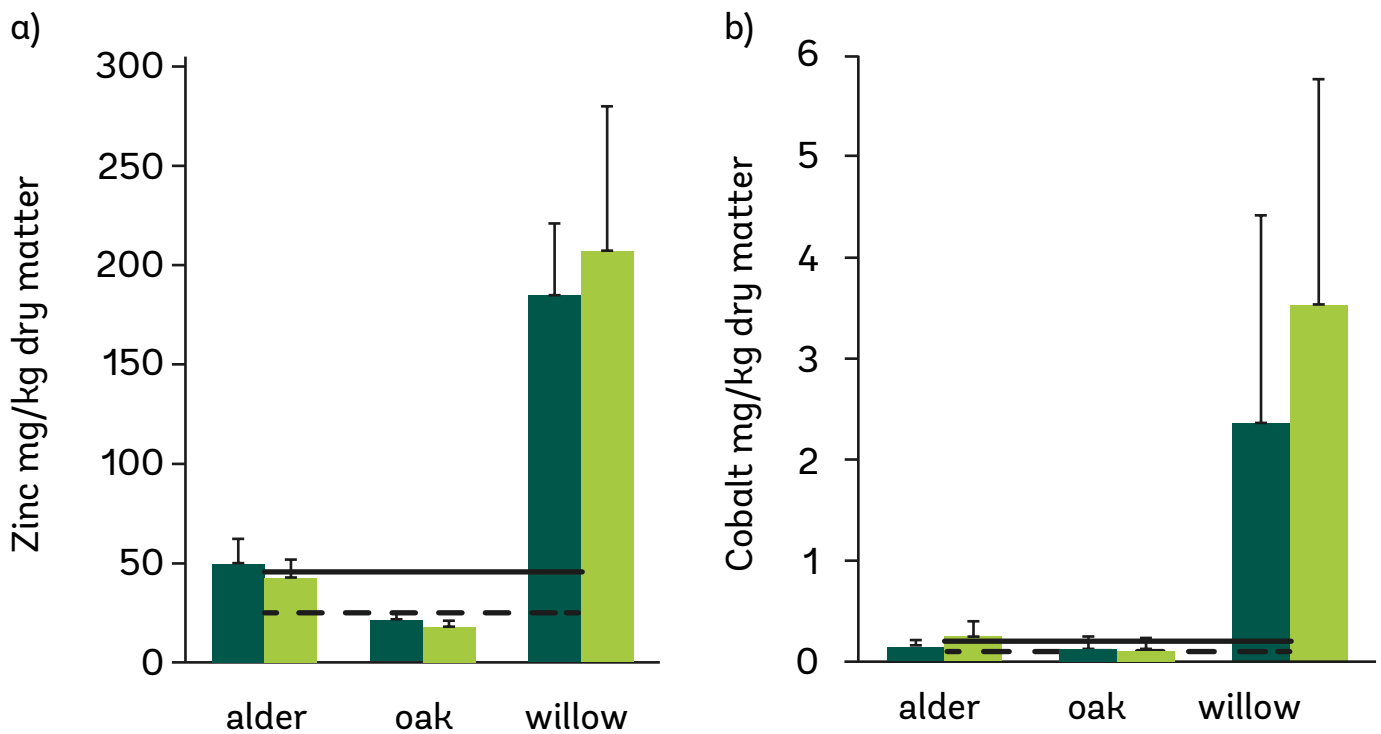


Figure 2: Concentrations of a) zinc and b) cobalt in tree leaves collected in June (dark green) and September (light green) for three tree species. The range of sheep requirements for each mineral is shown by the solid black line (upper limit) and dotted black line (lower limit). Results shown include trees from all sites.

Potential impacts on ruminant livestock

Looking at these results in the context of sheep requirements for these minerals², willow leaves provide zinc and cobalt at concentrations exceeding the requirement in mg/kg of dry matter. Other minerals in the analysis were found to fall within the requirement range for sheep. The elevated cobalt and zinc concentrations found in willow leaves could actively correct deficiencies of these minerals in grass, requiring a partial replacement of grass by a willow biological supplement. This could be especially useful in growing grazing lambs where cobalt deficiency is typically prevailing across the dry summer period. Further work is required to determine what amount (kg) of willow supplementary tree feed would meet such needs under different conditions.

Willow leaves were slightly higher in potassium, which reduces magnesium availability within the rumen, but magnesium concentrations within the leaves were found to be at the higher end of sheep requirements or just above, alleviating this concern.

Across all tree species tested, calcium was approximately 1.5-2-fold higher than in grass and could be of benefit in lactating ruminants. However, late dry cows often have their calcium intake controlled to prevent milk fever; therefore supplementary tree feed may need to be limited at this stage. All tree species tested also had very low molybdenum and iron concentrations and so would be unlikely to have significant interactions that induce copper-responsive conditions, especially when compared to grass and legume-grazing.

Energy and protein analysis

The metabolisable energy and protein levels in leaf samples were found to differ depending on the tree species and season. For example:

- Alder had higher concentrations of metabolisable energy than oak and willow, while oak had higher concentrations than willow.
- Crude protein content was higher in leaves sampled in spring (June) than those sampled in autumn (September).
- Crude protein content was higher in alder compared to oak, although willow was not found to differ from either alder or oak.

These results indicate that tree leaves contain energy and protein in amounts that mean their use as a supplementary feedstuff should not be detrimental to the growth rate of livestock. More work is required to examine the amount of supplementary tree-leaf feed appropriate for meeting specific mineral deficiencies, while ensuring optimum growth.

Conclusion and next steps

This study has identified a number of areas that warrant further investigation to improve the body of knowledge around the use of tree leaves as a supplementary feed for ruminants. In particular:

- Willow has been identified as a potentially valuable supplement for addressing cobalt and zinc deficiencies. Practical trials using willow supplements to meet these deficiencies in ruminant diets are now needed.

- There is variation in the mineral content between different tree species, and this also varies by site. Expanding the number of tree species and sites sampled would improve understanding of the circumstances under which different tree species could be used as a biological supplement.
- Many factors affect the feasibility of using tree leaves to supplement ruminant diets, and the following questions are among those that need to be addressed:
 - o How many trees and what type of planting would be required to support the use of tree-leaf supplements in ruminant diets?
 - o How is livestock preference for tree-leaf feed affected by the presence and condition of other food sources?
 - o How does the palatability of leaves from different tree species affect livestock intake?
 - o How does the content of beneficial condensed tannins vary in leaves of different tree species throughout the grazing season? What impact does this have on their potential medicinal value for livestock?
 - o How does the type of tree-leaf feed being accessed by livestock, such as browse or fodder, affect their preferences and intake?

A further trial into the palatability of willow and its use as a supplement is being undertaken by the University of Nottingham and the Allerton Project as a follow-up to this study.

Recommended citation:

N.R. Kendall, J.Smith, L.K. Whistance, S. Stergiadis, C. Stoate, H. Chesshire and A.R. Smith, 2019. *Tree leaves as supplementary feed for ruminant livestock*. Woodland Trust Research Briefing.

Author contacts:

^aSchool of Veterinary Medicine and Science, University of Nottingham, Nigel.Kendall@Nottingham.ac.uk; ^bThe Organic Research Centre, jo.s@organicresearchcentre.com; ^cThe Organic Research Centre, lindsay.w@organicresearchcentre.com; ^dSchool of Agriculture, Policy and Development, University of Reading, s.stergiadis@reading.ac.uk; ^eGWCT Allerton Project, cstoate@gwct.org.uk; ^fThe Woodland Trust, HelenChesshire@woodlandtrust.org.uk; ^gSchool of Natural Sciences, Bangor University, a.r.smith@bangor.ac.uk.

Acknowledgements:

Sampling was supported by Professor Kevin Sinclair, Pui Mak, Ting-Yu Chen and Linda Kenwell from the University of Nottingham; Anais Rousseau, Ellie Brown and Lucie Lombard from the Organic Research Centre; and Dr Hillary Ford, Bid Webb, Jamie Collier and Patrick Clancy from Bangor University. This note was produced with input from Christine Tansey (the Woodland Trust).

References:

1. Underwood, E.J. & Suttle, N.F. (1999). *The mineral nutrition of livestock*. 3rd edition. CABI publishing. Wallingford, Oxon, UK.
2. NRC (2007). *Nutrient requirements of small ruminants: sheep, goats, cervids, and New World camelids*. The National Academies Press, Washington D.C., USA.

Further reading:

1. Whistance L. (2018). *Browse, preserved tree fodder and nutrition – How offering access to browse and feeding tree fodder can supplement the diet of domestic animals*. AFINET Factsheet 12. zenodo.org/record/2454797
2. Whistance L. (2018). *Trees for shade, shelter, survival and body maintenance – How offering access to trees can improve the welfare of domestic animals*. AFINET Factsheet 13. zenodo.org/record/2454775

woodlandtrust.org.uk 0330 333 3300

The Woodland Trust, Kempton Way, Grantham NG31 6LL

The Woodland Trust is a charity registered in England and Wales no. 294344 and in Scotland no. SC038885. A non-profit making company limited by guarantee. Registered in England no. 1982873. The Woodland Trust logo is a registered trademark. 1355112/19



WOODLAND
TRUST