Potential of fodder trees in high-output dairy systems

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Abstract

The reform of the EU's Common Agricultural Policy (CAP) has created renewed interest in the implementation of agroforestry and silvopastoral systems. The multifunctional use of trees for energy and wood production, nutrient cycling, carbon storage, biodiversity, landscape quality and – last but not least – fodder makes trees a potential third crop next to grass and maize on farmland including high-output dairy farms. To decide which trees to use for planting, it is important to have insight into the feeding value of the different species. Therefore we created a database on the feeding values, using data from the literature. The database includes records of tree leaves, twigs, and twigs with leaves of 40 different temperate tree species (620 records in total) (www.voederbomen.nl/nutritionalvalues). Using this database, we compared the nutritive value of the leaves of a number of temperate fodder trees. The nutritive values for grass (*Lolium perenne* L.) are shown for comparison. These data show that, compared to grass, the *in vitro* organic matter digestibility of tree leaves is relatively low. However, for some species the concentrations of crude protein, and of macro- and micronutrients, are relatively high, which shows the potential value of tree leaves as an additional feed source on dairy farms.

Keywords: tree leaves, digestibility, crude protein, minerals, CAP, greening measures

Introduction

The reform of the EU's Common Agricultural Policy (CAP) has created renewed interest in agroforestry and silvopastoral systems. The CAP includes several 'greening measures' that aim to enhance biodiversity on farmland, such as creating Ecological Focus Areas (EFA) and requiring farmers to grow at least three crops on their farms. The multifunctional use of trees for energy and wood production, nutrient cycling, carbon storage, biodiversity and – last but not least – fodder, makes trees an interesting candidate to grow as a third crop on Dutch dairy farms, next to grass and maize. The introduction of fodder trees on dairy farms requires insight into the cultivation, harvest, production and feeding value of different species. The objective of this survey was to create a database for application in The Netherlands of feeding values (energy, protein, and macro- and micronutrients) of common tree species, and compare these data to the feeding value of grass (*Lolium perenne* L.).

Material and methods

Based on a literature review, records about the feeding value of leaves and twigs from temperate tree species were collected into a database (www.voederbomen.nl/nutritionalvalues). The database includes studies from Germany (Becker and Nehring, 1965; Rahmann, 2004), the UK (Smith *et al.,* 2012), the Netherlands (Van Eekeren, unpublished results), France (Trémolières, 1999), Finland (Saramäki and Hytönen, 2004), Greece (Papachristou and Papanastasis, 1994) and also studies from outside Europe (Burner *et al.*, 2005; Chen *et al.*, 2011; Roder, 1992; Singh *et al.*, 1997). The database includes records of tree leaves, twigs, and twigs with leaves of 40 different temperate tree species (620 records in total). Using this database we compared the nutritive value of the leaves of a number of temperate fodder trees: alder (*Alnus glutinosa* L. Gaertn.), hazel (*Corylus avellana* L.), beech (*Fagus sylvatica* L.), ash (*Fraxinus exelsior* L.), robinia (*Robinia pseudoacacia* L.), large-leaved lime (*Tilia platyphyllos* Scop.) and willow (*Salix alba* L.). The nutritive values for grass (*Lolium perenne* L.) are shown for comparison.

Results

The literature study showed that there are ample data available on feeding values of temperate fodder trees. Compared to grass, the *in vitro* organic matter digestibility (OMD) of the different tree leaves is generally low (average values ranging from 30.6 to 57.8% for tree leaves, compared to 79% for grass) (Table 1). This is probably related to the high lignin and fibre content of tree leaves and/or the presence of secondary plant compounds such as tannins. Crude protein levels of the different tree species range from 15.7 to 21.4% of DM (Table 2). Some species, particularly lime (*T. platyphyllos*) and robinia (*R. pseudoacacia*) have a higher average crude protein content than perennial ryegrass in the Netherlands (16.5%) which could replace other protein sources in the diet. Average copper levels in tree leaves range from 7.7 to 15.3 mg kg^{-1} for the different species, compared to 8.9 mg kg^{-1} in grass (Table 3). Leaves of hazel and beech, particularly, contain high levels of copper. This micronutrient is of interest because in the Netherlands it is often lacking in the roughage for lactating cows and goats, and especially growing young stock.

Discussion and conclusions

Our analysis shows that various tree species are of interest in terms of their feeding value for livestock. Tree leaves could serve as alternative source of proteins, and of macro- and micronutrients. However, the records in the database show a considerable range in feeding values for the same tree species. This range is probably due to seasonal differences (Smith *et al.*, 2012), local soil conditions (Saramäki and Hytönen, 2004) and the ability of tree species to adapt to local conditions (Robinson, 2005). Unfortunately, most

Table 1. *In vitro* organic matter digestibility (%) of tree leaves. Average, minimum, maximum values and number of records (n) found in the literature are provided.

Species	Common name	Average	Min	Max	n
Alnus glutinosa	alder	48.1	10.4	69.1	6
Corylus avellana	hazel	47.7	46.4	50.0	3
Fagus sylvatica	beech	30.7	7.4	59.0	5
Fraxinus excelsior	ash	34.1	12.8	55.3	2
Robinia pseudoacacia	robinia	56.7	37.3	77.4	7
Salix spp.	willow	57.8	4.5	70.5	5
Tilia platyphyllos	large-leaved lime	30.6	15.0	46.2	2
Lolium perenne	grass	79.0			

Table 2. Crude protein levels in tree leaves (% of dry matter). Average, minimum, maximum values and number of records (n) found in the literature are provided.

Species	Average	Min	Max	n
Alnus glutinosa	19.2	14.4	26.2	6
Corylus avellana	16.1	14.1	20.4	7
Fagus sylvatica	18.0	14.3	23.3	18
Fraxinus excelsior	15.7	5.9	26.8	8
Robinia pseudoacacia	20.4	11.6	27.0	16
Salix spp.	15.9	9.8	23.1	10
Tilia platyphyllos	21.4	15.3	28.0	13
Lolium perenne	16.5			

Table 3: Copper levels in tree leaves (mg kg^{-1} dry matter. Average, minimum, maximum values and number of records (n) found in the literature are provided.

Species	Average	Min	Max	n
Alnus glutinosa	12.3	6.0	20.0	4
Corylus avellana	13.1	8.5	18.0	4
Fagus sylvatica	15.3	6.5	24.0	2
Fraxinus excelsior	10.0	10.0	10.0	1
Robinia pseudoacacia	7.7	7.0	8.3	2
Salix spp.	8.3	5.5	12.9	5
Tilia platyphyllos	8.0	8.0	8.0	1
Lolium perenne	8.9			

studies did not record the soil conditions. Therefore, we are now conducting a follow-up field study to investigate the relation between feeding value of fodder trees and harvest date, soil type and soil fertility.

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