

Rethinking grasslands in 3D: feeding preferences of dairy cows between temperate fodder trees

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Abstract

Planting fodder trees in grasslands increases vegetation diversity, reduces grassland vulnerability to climate change and provides additional fodder resource during periods of drought. However, the palatability of temperate fodder trees remains poorly studied. During 10 mornings in July 2021, we allowed 12 dairy cows to feed freely in a 4-year-old chicory-based pasture planted with 168 pollarded trees from 4 species (common ash, white mulberry, Lutèce elm, Italian alder). Every 4 minutes, the number of cows browsing each individual tree was recorded (i.e. 550 scans per tree). A generalized linear mixed model (GLMM) was used to analyse the cows' feeding preferences among the four tree species. Results indicate a strong preference for Lutèce elm (280 of 470 feeding observations, i.e. 60% of browsing behaviour), and low preferences for common ash and Italian alder (respectively 7 and 6%). This study shows that fodder trees may represent a feeding resource complementary to herbage in summer. Further investigations are needed to confirm and understand this preference pattern, as well as to quantify the part of the diet fodder tree would represent.

Keywords: agroforestry, animal behaviour, browsing, pollard

Introduction

In many European regions, trees have been removed from agricultural ecosystems and this has adversely affected ecosystem services related to carbon sequestration, biodiversity conservation, soil enrichment and air and water quality (Jose, 2009). The use of woody species as animal fodder appears to offer an incentive to replant trees in agricultural systems. Tree browsing is already a common practice in Mediterranean and tropical areas, where herbage production is constrained during drought seasons (Vandermeulen *et al.*, 2018a). Recent *in vitro* studies have highlighted the good nutritional value of the leaves of certain tree species during summer, which were as much or even more nutritious than herbaceous forages such as ryegrass and cocksfoot under European temperate conditions (Mahieu *et al.*, 2021). However, these studies also highlighted that the contents of condensed tannins in tree leaves could exceed those in sainfoin, possibly decreasing their palatability and so feed intakes (Patra, 2009). Despite the growing interest for fodder trees in temperate areas, little is known about cattle preferences for different tree species. We therefore studied cow feeding preferences between four tree species.

Materials and methods

The study was conducted on a tree-planted plot within the OasYs system experiment (Novak *et al.*, 2016) located at the INRAE facility in Lusignan, western France (46°25'19.0"N, 0°07'18.1"E). We studied the feeding behaviour of 12 lactating dairy cows, from 2 to 7 years old and in their 1st to 4th lactation (101±17.1 days in milk). The cows were the product of a three-way crossbreeding between Hostein, Jersey and Scandinavian Red. The plot was a 4-year old chicory-based pasture of 2 ha, planted with 168 pollarded trees from 4 species (<https://doi.org/10.15454/SRBXQ9>): common ash (*Fraxinus excelsior*), white mulberry (*Morus alba*), Lutèce elm (*Ulmus* 'Nanguen') and Italian alder (*Alnus cordata*). Trees were planted in 2014 in four rows (20 m inter-row spacing), with a tree density of 84 trees ha⁻¹. Trees were pollarded at 50 or 80 cm above ground level in 2019. In July 2021, trees were classified into 6 foliar biomass classes, based on an expert's visual scanning. Before the browsing experiment, the grassland was

grazed with no access to trees in order to reduce herbage availability. Tree browsing occurred on the mornings of 12 to 21 July 2021, from 8:30 am to 12:30 pm. Four observers recorded cows' feeding preferences using a scan sampling focused on individual trees. Every 4 minutes, the number of cows that were feeding on each pollard was recorded (i.e. 550 scans per pollard, or 92,400 scans in total).

A generalized linear mixed model (GLMM) was used to investigate whether cows exhibited feeding preferences among the four tree species. The model was controlled by observer identity and tree biomass class, to avoid biases. We computed estimated marginal means to highlight food preferences among trees species. Statistical analysis were performed with R software (v 4.1.2), and the packages 'lme4' (v 1.1-27.1) and 'emmeans' (1.7.0).

Results and discussion

Cows were observed feeding on trees on 472 occurrences over the 10 mornings. Cows significantly preferred Lutèce elm (280 feeding occurrences, 60%), followed by white mulberry (128 occurrences, 27%), then common ash (31 occurrences, 7%) and finally Italian alder (28 occurrences, 6%) ($P \leq 0.003$, Figure 1, Table 1).

Our results confirm that cattle exhibit feeding preferences between tree species. Common ash was one of the least preferred browsed species, despite its high nutritional value (Mahieu *et al.*, 2021) and potential high voluntary intake, as observed in an *in vivo* study with sheep fed indoors *ad libitum* (Bernard *et al.*, 2020). These inconsistencies may be due to the choice situation that included other tree species potentially preferred by cows, to differences in chemical composition between directly browsed ash trees and cut then browsed trees, or to the lack of experience of cows relative to tree browsing. Differences in ash palatability between sheep and cows may also be involved as supported by the very low ash preference by dairy heifers observed by Vandermeulen *et al.* (2018b).

Lutèce elm was the most preferred species, although its nutritional value was lower than that of common ash, white mulberry and Italian alder in a previous *in vitro* study (Mahieu *et al.*, 2021). The assessment of our tree leaves chemical composition will help to better understand its role in cows' feeding preferences, relative to the one of sensory characteristics such as taste, odour or resistance to fracture. We noticed that Lutèce elm leaves were easier to detach from the branches and had a rougher texture, which may have facilitated their access by the cows, leading to a greater attractiveness.

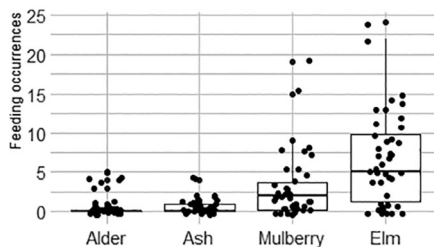


Figure 1. Number of cows observed feeding on trees (i.e. feeding occurrences). Each black dot represents one of the 168 studied trees.

Table 1. Feeding preferences between preferred tree species (first column) and less eaten tree species (first line). *P*-values are those of estimated marginal means.

	Mulberry	Ash	Alder
Elm	$P < 0.001$	$P < 0.001$	$P < 0.001$
Mulberry		$P < 0.001$	$P < 0.001$
Ash			$P = 0.003$

Conclusions

This study is one of the first offering lactating dairy cows the choice between four pollarded temperate tree species directly browsable at pasture. Cows expressed strong feeding preferences which were inconsistent with what is known about species nutritional values from literature. Further studies are needed to confirm and understand this preference pattern, as well as to quantify the part of the dairy cow diet that tree fodder would represent.

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