Effect of season and species on the nutritive value of leaves of high stem trees

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Abstract

In order to investigate their potential contribution to ruminant diets, the nutritive value of the leaves of five tree species was evaluated across the seasons. The sampling campaign was conducted on a French network of agroforestry paddocks implemented 25 years ago located in the north, the centre and the south of France. Tree leaves were collected on ash (*Fraxinus excelsior*), service tree (*Sorbus domestica*), sycamore tree (*Acer pseudoplatanus*), walnut (*Juglans* × *regia* × *nigra*) and wild cherry (*Prunus avium*). The nutritive value of the collected leaves was evaluated in June, August and October 2016 by analysing their protein and fibre contents and *in vitro* digestibility. Tree leaves composition exhibited large variations between species and between seasons. From spring to autumn, average DM varied from 288 to 450 g kg^{-1}, fibre content from 383 to 338 g kg^{-1}m and crude protein content from 160 to 110 g kg^{-1}. On the contrary, *in vitro* digestibility remained quite constant across the seasons (from 67.7 to 66.9%). This result contrasts with what is observed on grasses and herbaceous legumes in which *in vitro* digestibility decreases in autumn.

Keywords: feeding value, fodder tree, species, season, leaves, agroforestry

Introduction

Summer grazing is often limited by the low production and quality of grasslands in regions with summer droughts i.e. currently the Mediterranean area but also in future European oceanic regions due to climate change. Leaves from hedgerows, coppices, shrubs or pollarded trees may become a forage resource for livestock during periods of low grasslands production (summer and autumn), either directly by browsing or fed after cutting (Papanastasis *et al*., 2008). In order to investigate their potential contribution to ruminant diets, the nutritive value of the leaves of five tree species was evaluated across the seasons, from June to October.

Materials and methods

The sampling campaign was conducted on a French experimental network of agroforestry paddocks implemented 25 years ago. Tree leaves were collected on high stem trees from eight sheep or dairy cattle farms located in the north, the centre and the south of France. The five tree species were ash (*Fraxinus excelsior*) collected at five locations, service tree (*Sorbus domestica*) collected at two locations, sycamore tree (*Acer pseudoplatanus*) collected at six locations, walnut (*Juglans* × *regia* × *nigra*) collected at two locations and wild cherry (*Prunus avium*) collected at three locations. At each location, two samples per species were collected on different trees. Leaves (blade and petiole) were collected on the trees in late June, mid - August and mid-October) 2016. Samples were oven dried at 60 °C during 72 h and grounded to 1 mm. They were analysed for nitrogen (N, Dumas method with a Flash 2000 CHNS / O Analysers from Thermofisher on samples ground again with a vibro-broyeur from Retsch), crude protein content (CP, calculated as N × 6.25), fibre content (neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL), Goering and van Soest method, 1970), *in vitro* dry matter digestibility (IVDMD) with the enzymatic method of Aufrère (1982) adapted with the DAISY Incubator from ANKOM, and ash (550 °C during 3 h in a muffle furnace). Data were analysed using the packages GrapheR and Rcmdr (R core team, 2017).

Results and discussion

The effects of species and seasons on the chemical composition parameters of tree leaves were highly significant ($P < 0.0001$) and largely more important than the Species × Seasons interaction. The comparison of species means is detailed in Table 1 and of season means in Figure 1. As ADF and ADL contents showed the same pattern of significance as the NDF contents, they were not presented in this paper. Dry matter content ranged from 232 g kg^{-1} in walnut collected in June to 592 g kg^{-1} in service tree collected in October. It was significantly higher for service tree than for other species and it rapidly increased from June to August for all species. Neutral detergent fibre concentrations varied from less than 300 g kg^{-1} in walnut in October to 410 g kg^{-1} in wild cherry in June and they were significantly higher for sycamore tree than for walnut. They decreased from June to October. Crude protein concentrations varied from 72 g kg^{-1} for service tree leaves collected in October to more than 200 g kg^{-1} for walnut in June. Crude protein concentrations strongly decreased across the seasons from 160 in June to 110 g kg^{-1} in October, service tree having the lowest CP content (91 g kg^{-1}). Digestibility (IVDMD) ranged from 60.3% for field maple leaves in October to more than 75.6% for walnut in June. We did not notice any effect of the season on IVDMD.

Our previous study (Emile *et al.,* 2017) and other studies also indicated that the chemical composition and IVDMD of tree leaves varied according to the tree species (Papanastasis *et al,*. 2008, Luske and Van Eekeren, 2015). An effect of the season on DM, NDF and CP was also highlighted by Smith *et al.* (2012) for willow, but they also noticed a season effect for IVDMD. This contrast with the present study could come from the fact that in Smith *et al.* (2012) the samples included leaves and little stems.

Table 1. Average chemical composition (DM, NDF and CP, g kg^{-1} DM) and digestibility (IVDMD, %), with standard error of mean (SEM) in brackets, of tree leaves collected in 2016.

		n	DM	NDF	CP	IVDMD
Ash	*Fraxinus excelsior*	30	351 (12)^{b}	360 (8)^{bc}	148 (5)^{b}	69.9 (0.8)^{b}
Service tree	*Sorbus domestica*	12	488 (29)^{a}	343 (7)^{ab}	91 (5)^{a}	62.5 (1.1)^{a}
Sycamore tree	*Acer pseudoplatanus*	36	381 (14)^{b}	388 (6)^{c}	133 (5)^{b}	63.9 (0.9)^{a}
Walnut	*Juglans × regia × nigra*	12	342 (25)^{b}	312 (8)^{a}	156 (12)^{b}	72.8 (1.5)^{b}
Wild cherry	*Prunus avium*	18	404 (20)^{b}	372 (16)^{ab}	126 (7)^{b}	67.8 (2.1)^{ab}
Mean			383	364	134	67.1

[1] Values with the same superscript letter in the same column do not differ significantly (Tukey test, $P < 0.05$).

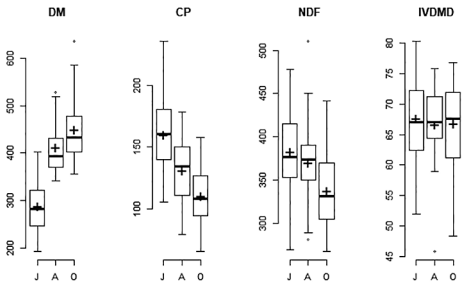

Figure 1. Effect of season (J=June; A=August; O=October) on chemical composition (DM, NDF and CP concentrations, g kg^{-1} DM) and digestibility (IVDMD, %) of tree leaves collected in 2016.

Conclusions

The chemical composition and digestibility of leaves of more than 20 years old high stem trees cultivated for timber production in agroforestry farms, exhibit large variation among tree species. Among the five studied species, walnut and ash presented the major interest for feeding ruminants. Although DM, fibre and protein contents of the leaves strongly depended on the season, the results show that the digestibility was constant from June to October, allowing the feeding of ruminants even during the seasons where grasslands are of lower productivity and quality. Further investigations have to be conducted to describe the effects of tannins and minerals on animal performances and health and to define the best practices for providing these alternative resources to ruminants.

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