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# Evaluation of the feeding value of leaves of woody plants for feeding ruminants in summer

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## Abstract

The nutritive value of a set of 10 woody forage resources (Italian alder, ash, chestnut, field elm, hazel, lime, black locust, white mulberry, holm oak and vine) was investigated. Leaves were collected in summer 2015. Protein and fibre concentrations, condensed tannin concentration, *in vitro* digestibility (enzymatic method), and dry matter (DM) and nitrogen *in sacco* effective ruminal degradability were determined. Results show a large variability between species: crude protein varied from 82 to 245 g kg<sup>-1</sup> DM, *in vitro* digestibility from 47 to 84%, and effective nitrogen degradability from 18 to 78%. White mulberry is the most interesting species but ash, alder, elm and lime also present sufficient *in vitro* digestibility and nitrogen characteristics to be included in the diet of ruminants. Black locust, vine and holm oak present high levels of condensed tannins and low effective nitrogen degradability.

**Keywords:** feeding value; woody leaves, ash, mulberry, agroforestry

## Introduction

Summer grazing is often limited by the lack of high quality 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 grassland production (summer and autumn), either directly by browsing or fed after cutting (Papanastasis *et al.*, 2008). The lack of data on the nutritive value of this unusual forage is an important limitation to its adoption in forage systems of oceanic regions. In the frame of a long term mixed crop-dairy system experiment integrating agroforestry (Novak *et al.*, 2016), a large evaluation of the feeding value of leaves from many woody resources has been initiated. This paper presents the results obtained on 10 woody species evaluated through their protein and fibre concentrations, condensed tannin concentration, *in vitro* digestibility and effective ruminal degradability.

## Materials and methods

The leaves of 10 woody species were collected from 3 to 10 August 2015 in the INRA experimental farm located at Lusignan (France, WGS84: XY, 46.42 0.12). Leaves were sampled on at least 3 individuals of each species: Italian alder (*Alnus cordata*), ash (*Fraxinus excelsior*), chestnut (*Castanea sativa*), field elm (*Ulmus minor* × *resista*), hazel (*Corylus avellana*), lime (*Tilia platyphyllos*), black locust (*Robinia pseudoacacia*), white mulberry (*Morus alba*), holm oak (*Quercus ilex*) and vine rootstock (*Vitis* sp.). Alder, ash, mulberry, elm and holm oak were young trees established in 2014, while limes were adult pollarded trees, and vine, chestnut, hazel and black locust were old coppiced trees. Lucerne (*Medicago sativa*) was also collected (3 samples on a 500 m<sup>2</sup> plot) as a herbaceous forage control, harvested after 6 weeks of regrowth. All samples were oven dried at 60 °C during 72 h. For each species, a bulked subsample (500 g dry matter (DM)) was ground to pass through a 0.8 mm sieve. Dry matter and nitrogen effective ruminal degradability (EDDM and EDN, respectively) were determined by the incubation of nylon bags (7.5 × 15 cm, 46 µm pore size) containing 3 g of fresh sample in the rumen of three ruminally fistulated dry cows, during 2, 4, 8, 16, 24 and 48 h (Michalet-Doreau *et al.*, 1987). The dry cows were stall-fed 9 kg DM/day of a diet based on 70% of high-quality grass hay and 30% of a concentrate based on barley, beet pulp and

soyabean. Another subsample (50 g DM ground to 1 mm) was analysed for nitrogen (N, Dumas method with a Flash 2000 CHNS/O Analyzers from Thermofisher on samples ground again with a vibro-broyeur from Retsch), crude protein (CP, calculated as  $N \times 6.25$ ), fibre (neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL), Goering and Van Soest method, 1970), *in vitro* DM 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). Two fresh subsamples (20 g) were also frozen to -20 °C before being freeze-dried, and the condensed tannin concentration was determined using the HCl-butanol method (Grabber *et al.*, 2013). The condensed tannin content was extracted twice and purified tannin from sainfoin was used as standard.

## Results and discussion

Main characteristics of the woody leaves are given in Table 1. The leaf DM content ranges from 284 g kg<sup>-1</sup> in black locust to 573 g kg<sup>-1</sup> in holm oak. The CP concentration varies from less than 85 g kg<sup>-1</sup> in holm oak to more than 200 g kg<sup>-1</sup> in black locust, chestnut and white mulberry. The ADL concentration varies from less than 30 g kg<sup>-1</sup> in mulberry to more than 150 g kg<sup>-1</sup> in Italian alder and ash. The highest condensed tannin concentrations ( $P < 0.001$ ) are observed in black locust, vine and holm oak (respectively 168, 94 and 52 g kg<sup>-1</sup>). The *in vitro* DM digestibility (IVDMD) ranges from less than 50% in holm oak to 76% in ash and 84% in white mulberry.

DM and CP degradation curve kinetics highlight the large differences between species. EDDM ranges from less than 50% in holm oak, chestnut, hazel and black locust to 75% in ash and 81% in mulberry. EDN varies from less than 25% in hazel and vine, to 79% in mulberry and 81% in lucerne. The lower EDN of locust, vine and holm oak could be linked to their high levels of condensed tannins, reducing protein availability for ruminal microbes. However, chestnut and hazel have few condensed tannins but low EDN suggesting that other compounds are responsible of this effect. The most effective compromise between DM digestibility, protein concentration and protein degradability is obtained with mulberry and ash, which are species traditionally fed to cattle respectively in oceanic and Mediterranean conditions. Hazel, vine rootstock and holm oak seem to be of poor nutritive quality for ruminants, at least for feeding to high-producing animals. These results agree with our first evaluation (Emile *et al.*, 2016) and with other studies (Doran *et al.*, 2007; Luske and Van Eekeren, 2015; Papanastasis *et al.*, 2008).

Table 1. Chemical composition (g kg<sup>-1</sup> dry matter (DM)), *in vitro* DM digestibility (IVDMD, %), and effective degradability of DM (EDDM, %) and of nitrogen (EDN, %) of leaves of woody species during summer 2015.<sup>1,2</sup>

Species	DM	Ash	CP	NDF	ADL	Condensed tannin	IVDMD	EDDM	EDN
<i>Alnus cordata</i>	412	60	173	373	172	13 <sup>cd</sup>	61	57	45
<i>Fraxinus excelsior</i>	545	95	141	251	157	2 <sup>a</sup>	76	75	66
<i>Castanea sativa</i>	300	55	207	408	62	2 <sup>ab</sup>	64	45	33
<i>Ulmus minor</i> × <i>resista</i>	463	130	148	354	33	30 <sup>e</sup>	64	63	45
<i>Corylus avellana</i>	449	68	153	334	44	8 <sup>bc</sup>	55	46	17
<i>Tilia platyphyllos</i>	311	119	183	380	72	23 <sup>de</sup>	58	59	60
<i>Robinia pseudoacacia</i>	284	53	245	333	64	171 <sup>h</sup>	57	48	36
<i>Morus alba</i>	372	123	204	173	28	2 <sup>a</sup>	84	81	79
<i>Quercus ilex</i>	573	39	82	528	117	52 <sup>f</sup>	47	40	30
<i>Vitis</i> sp.	296	60	128	158	30	94 <sup>g</sup>	62	52	24
<i>Medicago sativa</i> (control)	355	85	176	389	66	1 <sup>a</sup>	64	68	81

<sup>1</sup>Values within a column with the same superscript letter do not differ significantly.

<sup>2</sup>CP = crude protein; NDF = neutral detergent fibre; ADF = acid detergent fibre; ADL = acid detergent lignin.

## Conclusions

The composition, nutritive value and ruminal degradability of leaves from woody resources collected during summer exhibit large variation among species. White mulberry and ash have sufficient digestibility and nitrogen degradability in summer to be included in the diet of lactating cows in mixed crop-livestock systems. These results have to be confirmed by replications over several years. Our next studies will also consider the effects of season (spring, summer, autumn) and of tree management (pollarding or pruning, mechanical or browsing) on the nutritive value of leaves. Further investigations have to be conducted to obtain more precise information on the effects of condensed tannin concentration and minerals on animal performance and health.

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