

Relationship between yield, chemical composition and reported palatability of browse in southern Mali

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Abstract

Monthly dry matter (DM) yields, DM concentrations, and N, P, crude fibre and ash concentrations of the DM of browse material of 19 woody species from rangelands in southern Mali were measured and analysed to determine factors controlling palatability. During the late dry season, when browse consumption is significant, most material showed highest N and P levels with highest values found amongst the more palatable species. Hence, a positive relationship between palatability and nutritive value of browse is indicated. The more palatable species often showed relatively low DM yields during this period, reflecting a stronger deciduousness. No relationship was found between palatability and the other studied parameters. More systematic research on nutritive value of various woody species during the late dry season is warranted for the evaluation of rangelands in semi-arid and subhumid regions. Such studies could identify species of interest for cultivation and/or protection. Deciduousness of the woody species may be an indicator for monitoring of rangeland condition. Some suggestions have been made for the management of browse material.

Introduction

Browse consumption by cattle in arid to sub-humid climates can reach substantial levels, and in southern Mali comprised up to 54% of the total diet during the late dry season (Leloup *et al.* 1996). It has been suggested that seasonality of browse consumption by cattle reflects mainly a

declining quality and availability of herbs (Conner *et al.* 1963).

Conflicting data are found in the literature on the relative palatability of woody species. This is partly the result of varying relative availability of browse and herbaceous feed, both in time and in space (De Leeuw 1979; Walker 1980; Bayer 1990). Palatability also varies with the species of the consumers. Walker (1980) suggested that palatability is positively related to protein concentration, percentage of minerals (especially Na) and moisture concentration and negatively related to crude fibre concentration and the presence of tannins and aromatic substances.

In this study, an attempt was made to identify factors determining seasonal and relative palatability of woody species to cattle. Therefore, monthly dry matter (DM) yields and concentrations, and N, P, crude fibre and ash concentrations of the DM of browse of 19 woody species (Table 1) were determined. The species were from different palatability classes as reported in the literature and were sampled in a heavily grazed zone in southern Mali.

Table 1. Woody species sampled.

Name	Abbreviation
<i>Pterocarpus erinaceus</i>	Per
<i>Feretia apondanthera</i>	Fap
<i>Sclerocarya birrea</i>	Sbi
<i>Bombax costatum</i>	Bco
<i>Piliostigma reticulatum</i>	Pre
<i>Anogeissus leiocarpus</i>	Ale
<i>Combretum fragrans</i>	Cfr
<i>Guiera senegalensis</i>	Gse
<i>Terminalia avicennoides</i>	Tav
<i>Securinega virosa</i>	Cvi
<i>Acacia macrostachya</i>	Ama
<i>Pterocarpus lucens</i>	Plu
<i>Detarium microcarpum</i>	Dmi
<i>Combretum glutinosum</i>	Cgl
<i>Combretum micranthum</i>	Cmi
<i>Combretum nigricans</i>	Cni
<i>Terminalia macroptera</i>	Tma
<i>Lannea microcarpa</i>	Lmi
<i>Pteleopsis suberosa</i>	Psu

Materials and methods

Woody species and palatability

Species were selected from the rangelands of the village of Minso, in the Sudan zone of southern Mali, with an average annual rainfall of 700 mm. The selected species differed in palatability as assessed in published studies pertaining to the West African Sahel zone, the Sudan zone and the Guinean zone. On the basis of these published studies, 4 palatability classes (highly, moderately, limited, unpalatable) were distinguished. Data for the selected species were tabulated. The palatability of sampled species for which no information was found in the literature, was arbitrarily estimated from our own observations (Leloup *et al.* 1996). Finally, the species were grouped into 3 palatability classes (highly, moderately, limited) as derived from all studies together (Table 2).

Table 2. Classification of sampled species into palatability classes (highly *, moderately +, limited ^, unpalatable -) according to the literature and as a result of this study (A = highly, B = moderately, C = limited). See Table 1 for identification of species.

Sp.	Literature reference ¹										
	1	2	3	4	5	6	7	8	9	10	11
A Per		+	+	*	*	*				*	*
A Fap		+	*	*	+	*		*	*		*
B Sbi				+	+	^		+			+
B Bco		+		+	^						+
B Pre		+		^	+	*					+
B Ale			+	^	^	*				+	+
B Cfr			+				-			^	+
B Gse		+		+	^	^		+		^	+
B Tav			+		^	^	*			+	+
B Svi					^	^				+	
B Ama											
B Plu		+			*	*		^	*		*
C Dmi			-		^						^
C Cgl					-	^			-		-
C Cmi					-	^			-		+
C Cni					-				-		-
C Tma	^				^						
C Lmi											
C Psu											

¹ 1 = Piot (1969); 2 = Boudet (1970); 3 = De leeuw (1979); 4 = Toutain (1980); 5 = Le Houérou (1980); 6 = Von Maydell (1983); 7 = Asare *et al.* (1984); 8 = Kew (1984); 9 = Le Houérou (1989); 10 = Bayer (1990); 11 = Breman and De Ridder (1991).

Data collection and calculations

Monthly from September 1988–May 1990, except for October 1988, a constant number (5–30) of branches of a certain diameter

(5–10 mm) of each species (the particular number and diameter depending on species) were sampled. All green parts (twigs, leaves, fruits) and old leaves and fruits were weighed and air dried. This material will be referred to as “browse” throughout this paper. For each species, DM yields and concentrations were calculated. Subsamples were analysed for N, P, crude fibre and ash concentrations as follows: N and P concentrations from the extracts after Kjeldahl digestion, using titration and spectrophotometry, respectively; crude fibre from the residue after reaction of a triacid concentrate solution at boiling point for 30 minutes; and ash from the residue in the oven at 600°C. Relative DM (rDM) yield of a species in a particular month was defined as the DM yield relative to the highest DM yield of that species measured during the study period (Cissé 1986). For each parameter, mean, minimum and maximum values per month of all species together were calculated. For the main browse consumption period, April–June 1989 (Leloup *et al.* 1996), the average value of each parameter was calculated for each species and the species were ranked according to reported palatability.

Rainfall during the study period was recorded by gauges placed in the village territory.

Results

Relative DM yield

The mean, maximum and minimum rDM yields of browse of all woody species (Figure 1a) showed a strong seasonality with highest values during the rainy season and lowest values in mid-dry season. The period of browse consumption coincided with a strong increase in rDM yield, starting just before the first rains (Figure 1g). Most of the highly or moderately palatable species, from now on referred to as “more palatable” species, showed low rDM yields during this period (Figure 2a). *Pterocarpus lucens* (Plu), ranked as moderately palatable, showed no browse production at all during the browse consumption period. A notable exception was *Pterocarpus erinaceus* (Per), marked as highly palatable, which had the highest rDM yield of all species during the browse consumption period.

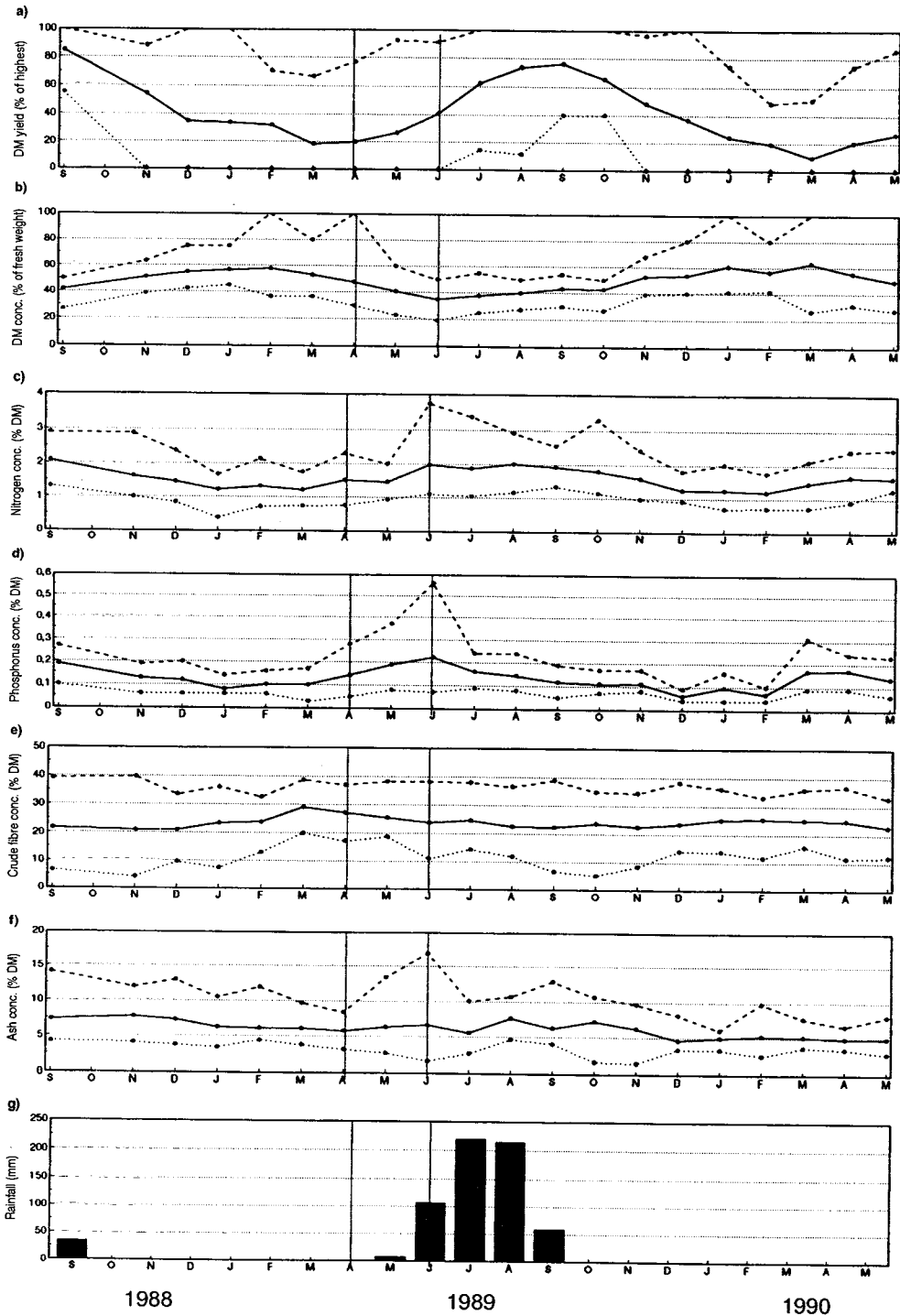


Figure 1. Monthly mean (—), minimum (···) and maximum (---) values for relative dry matter yields and dry matter concentrations and nitrogen, phosphorus, crude fibre and ash concentrations for all species together and rainfall between September 1988–May 1990. The main browsing period is indicated by the vertical lines.

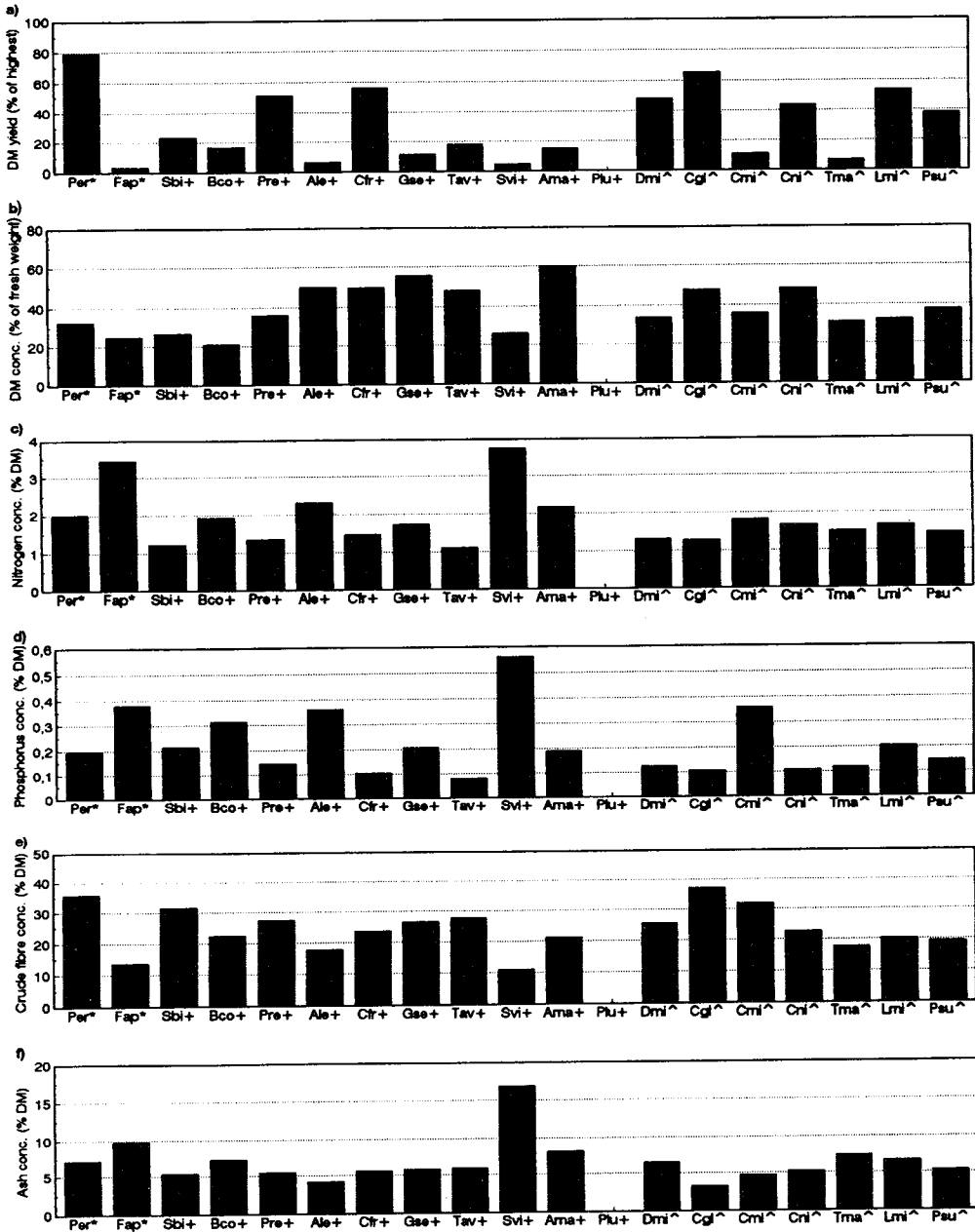


Figure 2. Mean monthly values during April–June 1989 for relative dry matter yields and dry matter concentrations and nitrogen, phosphorus, crude fibre and ash concentrations for individual species. See Table 1 for identification of species. Palatability classes: * high, + moderate, ^ limited.

DM concentration

DM concentration varied with season (Figure 1b), increasing during the first part of the dry season and declining to lowest values at the end of the dry season. The browsing period corresponded with the period of decreasing and lowest DM concentration. During this period, the "more palatable" species were evenly distributed over the whole range of measured DM concentrations (Figure 2b).

N and P concentrations

Mean N and P concentrations were lower during the dry season than during the rainy season. Peak values occurred early in the wet season, when browse consumption was also at its highest (Figure 1c, 1d). Mean N concentration remained above 1.2%N throughout. The species with highest N (3.5%N) and/or P (0.37–0.59%P) concentrations were among the "more palatable" ones (Figures 2c, 2d). However, *Terminalia avicennoides* (Tav), although "more palatable", had lowest N and P concentrations. Several "more palatable" species had N and P concentrations similar to those of species with limited palatability. Among the lowly palatable species, *Combretum micranthum* (Cmi) reached relatively high N and P concentrations.

Crude fibre concentration

Only minimum values for crude fibre concentration varied during the year (Figure 1e), with highest values late in the dry season and lowest at the beginning of the dry season. During the browse-consumption period, the minimum values were decreasing. The "more palatable" species were distributed over the whole range of measured crude fibre concentrations (Figure 2e).

Ash concentration

Mean ash concentration remained constant throughout. Both the minimum and maximum values showed a more erratic pattern with highest as well as lowest values found during the browse consumption period (Figure 1f). There was no relationship between ash concentration and palatability of species (Figure 2f).

Discussion

Factors controlling palatability

Browse consumption during the second half of the dry season coincided with the regrowth of young browse, as recognised by many other workers (e.g. De Leeuw 1979). Compared with the other seasons, browse material during this period showed the lowest rDM yields and highest N, P and ash concentrations. This is in agreement with the seasonality of nutrient quality of deer browse species in North America (Blair and Epps 1969). There was a tendency for "more palatable" species to show lower rDM yields and higher N and/or P concentrations than those of limited palatability during the browsing period. Walker (1980) stated that moisture, mineral and protein concentrations may be of importance to palatability. However, in contrast to his statement, we found no differences in crude fibre concentrations of browse material in different seasons or of species in differing palatability classes. It seems that the seasonality of browse consumption may be a function of a declining availability and quality of herbage (Conner *et al.* 1963), as well as a higher absolute nutritive value of browse.

Some authors expressed doubts on the nutritive value of browse because of anti-nutritional factors involved (Harrington and Wilson 1980; De Bie 1991). We consider that these factors may be of minor importance during the main browsing period, coinciding with early regrowth. From De Bie's data (1991), it appears that the lowest tannin concentration in browse is found during the early growing season, with large differences between species. Unfortunately, it was not possible, for financial reasons, to carry out tannin analyses in this study.

Exceptions

A more detailed study of the results for each species shows some exceptions to the above stated trends and raises new questions. The exceptions probably can be divided into "false exceptions", which relate to confusion about the palatability of the species, and "true exceptions", which relate to particular characteristics of the species. Examples of "false exceptions" are probably *Pterocarpus lucens* (Plu) and *Sclerocarya birrea* (Sbi). Both are ranked as moderately or highly palatable to livestock in some studies but only to camels and goats in another study.

Combretum micranthum (Cmi), classified here as of limited palatability, although showing low rDM yield and high N and P concentrations, would have been classified as "more palatable" if we had taken into account our own observations in southern Mali. A "true exception" is the highly palatable *Pterocarpus erinaceus* (Per), which showed high N and P concentrations but also had the highest rDM yield of all species. This species represents a deciduous tall tree which is frequently lopped by herdsman and shows strong regrowth. Unfortunately, this may also explain its low abundance (S. Leloup, unpublished data). The status of *Terminalia avicennoides* (Tav), ranked as of moderate palatability, whilst having low N and P concentrations, remains unclear. From the literature, it would appear that either fallen dry leaves (Asare *et al.* 1984) or recently emerged leaves (Von Maydell 1983) are consumed, whereas, in our case, live leaves from adult trees were sampled. Differences in reported palatability cannot be fully explained by the parameters we measured. Anti-nutritional parameters may be the cause of "limited palatability" of species which show relatively high N and P concentrations.

Although a tendency for lower rDM yields and higher N and P concentrations was found within the "more palatable species", the highest rDM yields and lowest N and P concentrations were found among these species. These results suggest a larger diversity in growth and nutrient flow characteristics of "more palatable" species, in contrast to more conservative growth patterns and nutrient cycling of stronger evergreen species — with reservations regarding conifers — protected by high concentrations of anti-herbivore defence compounds (Chapin 1980).

Trends in the vegetation

The apparent differences in nutritive value of different woody species may result in relatively high exploitation of some species. In the region of study, species of "limited palatability" are relatively abundant (S. Leloup, unpublished data). At the same time, these species showed higher rDM yield, indicating a trend towards evergreenness, while the "more palatable" species were more deciduous. Therefore, it is suggested that evergreenness or deciduousness of the species constituting a woody community may be a good indicator for rangeland condition.

Further research

To evaluate more precisely the woody component of rangelands in semi-arid to subhumid regions, future research should focus on the recognition of woody communities or transition states of vegetation as defined by Westoby *et al.* (1989) and the estimation of relative palatability and nutritive value of the constituent woody species. The determination of anti-nutritional factors should be included. Studies should concentrate on the late dry season and consider both abundant and rare species. From these studies, species of interest for cultivation or protection may be revealed.

Management

Lopping and storing of young material during good rainfall years could be an option for managing future periods of nutritional stress. Some browsing was observed during the other seasons and certain parts of browse material of particular species seemed palatable to cattle. These could also be useful for similar management strategies. In the area, herdsman were observed beating sticks against shrubs of *Acacia macrostachya* to release pods for their cattle. As mentioned above, the cultivation and/or protection of some "more palatable" species seems desirable for the region.

Acknowledgements

Gratefully acknowledged are the "Institut d'Economie Rurale" and the "Division de Recherches sur les Systèmes de Production Rurale" in Mali for permission to publish results obtained within their institution. Highly appreciated was the assistance during field work of many colleagues, especially M. Traoré, S. Bagayogo, B. Diarra and M. Sanogo-Diabaté.

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(Received for publication November 10, 1993; accepted January 10, 1996)