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Nutritional aspects of the main natural fodder resources in the locality of Ngouye in Senegal

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Abstract

The study was carried out in the locality of Ngouye which is an agro-pastoral area located in the Karffine region in Senegal. The breeding that is practiced is of the extensive type on natural pastures. The study aims to know the nutritional aspects of woody fodder found in the area. During our ethnobotanical survey, we identified 28 woody species, 23 of which are fodder. All species showed high levels of nitrogenous matter (MAT) ranging from 15.66% to 18.21% dry matter (DM). However, among these 23 species, 9 are considered to be better fodder. These 9 species have much greater dry matter ingestion and digestion capacities and low parietal components, in particular lignin and cellulose. These fodder species are *Eucalyptus Alba, Securidaca longepedunculata, Acacia ataxacantha, Adansonia digitata, Azadirachta indica, Balanites aegyptiaca, Combretum glutinosum, Anogeissus leiocarpus*, and *Acacia nilotica*. The calcium phosphorus imbalance with respective averages of 0.17 and 1.16 shows that most species are phosphorus deficient.

Keywords: Woody fodder; Nutritional aspects; Agropastoral zone; Senegal

1 Introduction

During the dry season, fodder trees represent up to 35, 70 and 90% of the diet of cattle, sheep and goats respectively [1, 2]. During this period, the herbaceous cover and cereal crop residues represent the main feed resource for livestock. These poor forages contain no more than 5% total nitrogenous matter with poor digestibility [3]. Currently, woody species that keep their freshness provide almost all of the nitrogen in the food ration of ruminants in traditional environments. The main value criterion for ligneous plants is their MAT content, which can reach up to 35% [4, 5, 6]. Woody fodder represents food resources without which the survival of livestock would be impossible in the Sahelian and Sudanian zones of West Africa. Indeed, shrub fodder is a non-negligible complement to the diet of cattle, whereas it represents the staple food for small ruminants for which it reaches more than 70% of the dry matter of the diet in the dry season [1, 2]. Although wood fodder in tropical countries has been the subject of many studies [7, 8], its nutritional value is still poorly known. The bromatological and nutritive characterization of fodder ligneous plants are therefore priorities for an optimal integration of ligneous plants in the livestock systems of the Sudanian and Sahelian zones of West Africa.

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2 Material and methods

2.1 Presentation of the study area

2.1.1 Geographical and administrative situation

The study was carried out in the central part of Senegal, in the administrative region of Kaffrine. It belongs to the central zone of Senegal, the heart of the groundnut basin, thus it borders six regions and a state: the regions of Diourbel and Louga to the north, the Republic of Gambia to the south, the region of Tambacounda to the east, the Kaolack region to the west and southwest, the Matam region to the northeast and the Fatick region to the northwest.

The study was carried out specifically in the site of Ngouye which belongs to the department of Birkelane in the commune of Ndiognik (Figure 1).

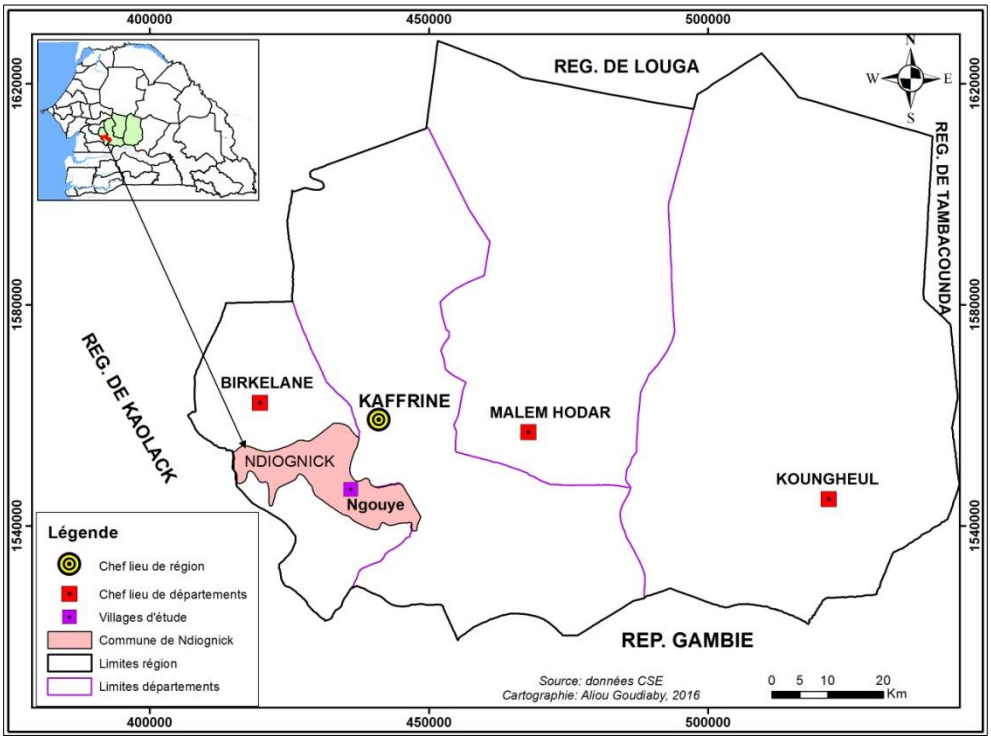


Figure 1 Geographical location of the study area (village of Ngouye, municipality of Ndiognik)

It is also an ecological transition zone between the Sahelian North with its pastoral vocation and the Sudanese South. It is an area that hosts or through which many ruminants pass through in the dry season, and where the advance of the agricultural front puts strong pressure on the available wood resources.

2.2 Biophysical characteristics

2.2.1 The climate

The climate is of the Sudano-Sahelian type with a short rainy season, from June-July to October, and a long dry season of 8 to 9 months. This situation is due to the dynamics of the general atmospheric circulation prevailing in West Africa. It is characterized by two dominant winds [9]:

- The continental trade wind or harmattan, a hot and dry easterly wind which generally blows from February to May;
- The monsoon, a hot and humid south-westerly wind whose arrival heralds the start of the rainy season (May - June).

The region experiences average monthly minimum and maximum temperatures of between 14.9°C and 43.1°C respectively. The minimum is recorded in January with fairly cool nights with temperatures often below 15°C while the

maximum reaches more than 40°C in April. The average annual temperature is around 29.6°C. Rainfall is irregular. The average rainfall (between 1965 and 2013) is 625.2 mm at the reference station (Koungheul, Kaffrine). These regions are characterized by a persistent rainfall deficit since 1970, with a large proportion of biologically dry years, leading to a total amount of rain collected below the annual average corresponding to 24 years of deficit (Figure 2).

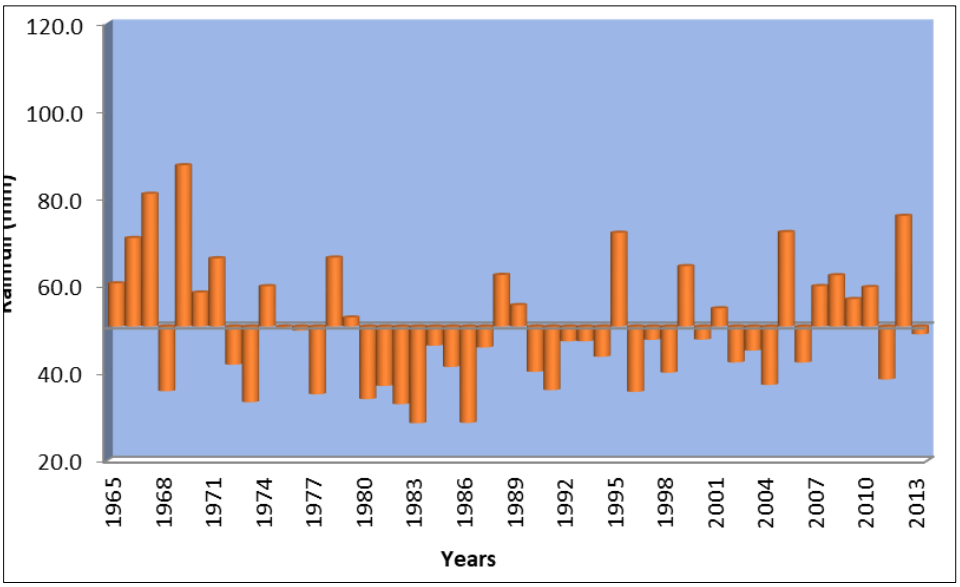


Figure 2 Inter-annual variability of rainfall at the Kaffrine station (from 1965 to 2013)

The rainy season occurs from May to October, which makes it possible to distinguish two periods in the year: a dry period (P<2T where P and T correspond respectively to the average monthly rainfall and temperature in the region) of 7 to 8 months (from October to May) and a rainy season (P>2T) of 4 to 5 months (Figure 3).

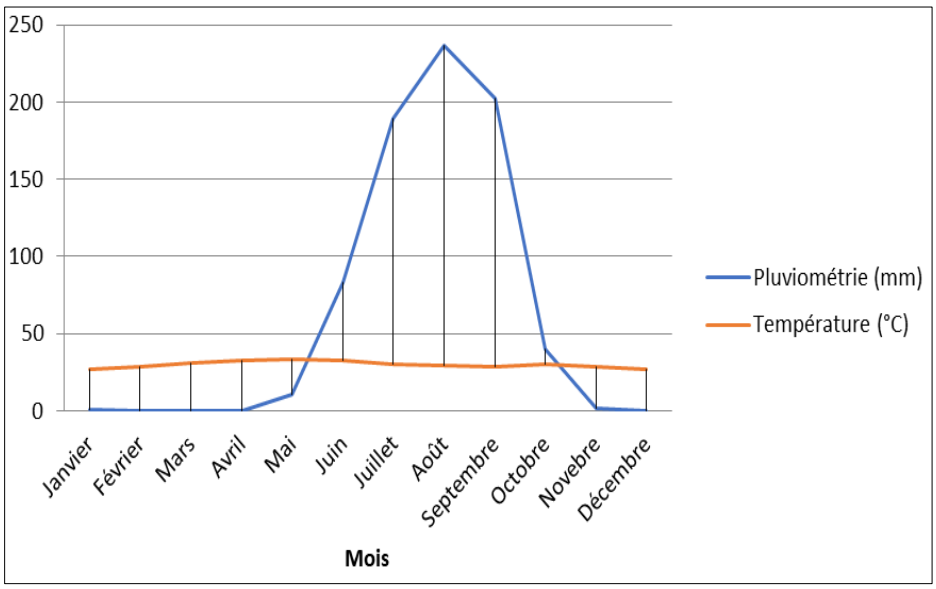


Figure 3 Ombrothermal diagram of the Kaffrine region (Data: ANACIM)

P: Average monthly rainfall in the Kaffrine region from 2000 to 2011.
T: Monthly average temperature (minimum and maximum) of the Kaffrine region from 2000 to 2011.

The months of July, August and September totaling almost all the precipitation, constitute the biologically wet period, August being the rainiest month (Figure 3). The months of July, August and September total 82.12% of precipitation, constitute the biologically wet period, August being the rainiest month (30.94%).

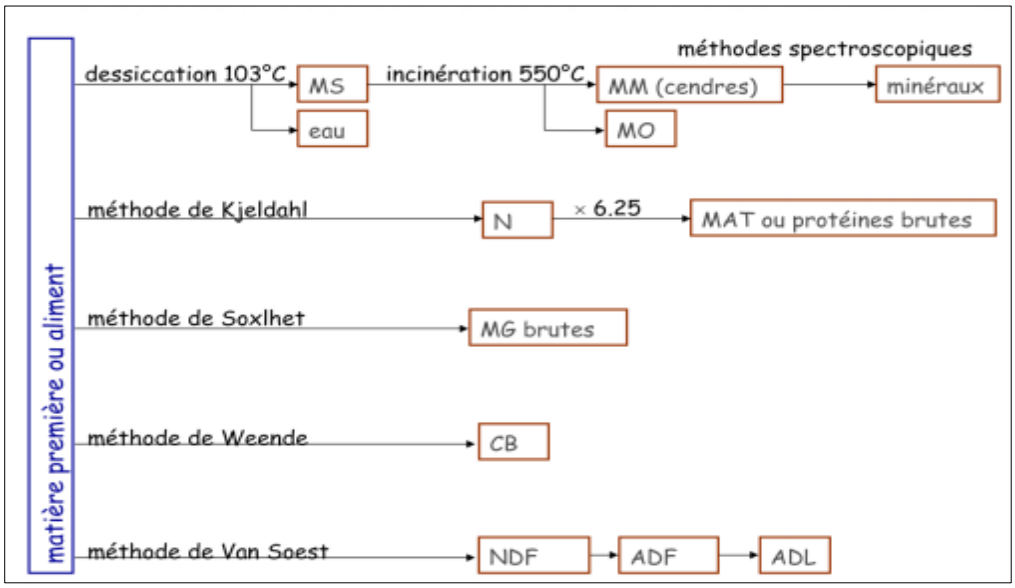
2.3 Sampling mode

Participatory surveys were conducted with breeders and pastoralists in the locality of Ngouye. Participatory surveys were carried out with 60 pastoralists and/or livestock breeders (cattle and small ruminants). Knowledge of natural rangelands and fodder consumed by ruminants was prioritized in the choice and selection of participants. The samples were taken in the forest and in the fields of the study area. On each ligneous fodder the leaves are taken.

Each food sample is weighed on the spot at harvest, wrapped in kraft paper packets, and then identified with a local name based on the harvest date, location and plant unit from which it was collected. Samples were air-dried to reduce water content and prevent denaturation of plant compounds. Samples were sent to the Chemistry and Nutrition Division of the National Livestock and Veterinary Research Laboratory (LNERV) for determination of the chemical composition and nutritional value. The identification of this species is based on the flora of [10] and [11].

2.4 Bromatological analysis: Chemical compositions and nutritional values

Different methods are used to determine the constituents of a food (Figure 4) from dried and ground samples. In general, bromatological analysis procedures are schematized and carried out as follows.



(Source: Rakatonanahary, 2012.)

Figure 4 Food bromatological analysis methods

The analyzes of the chemical composition focused on the determination of the dry matter (MS), mineral matter (MM) to determine the content of Ca and P, total nitrogenous matter (MAT) or crude protein (PB) according to the method of Kjeldahl, crude cellulose (CB) according to Weende's method, and parietal constituents such as neutral detergent fiber (NDF), Acid detergent fiber (ADF) and Lignin according to Van Soest's method. For each analysis, the results are reported in % relative to the MS except for the MS which is reported in % of fresh material.

For each forage, the bromatological analysis was repeated twice.

The estimated nutritional values relate to the nitrogen values of fodder (PDIN and PDIE) in grams per kilogram of MS (g/kg of MS), the digestibility of organic matter (dMO) in %, and the energy values of fodder for ruminants (UFL and UFV) in Unit per kilogram of MS (U/kg of MS).

2.5 Data processing and analysis

The data was mainly processed using Microsoft Office Excel 2016. Many files were created, including a raw data file, a calculation file and a statistical processing file.

In order to estimate the availability of nutrients in the study area, a descriptive analysis of the samples was carried out. First, the calculation of the basic statistical characteristics of all the variables was performed (standard deviation, mean, median, minimum, maximum, coefficient of variation and quartiles). Second, the distribution of variables was carried out with R software version 3.1.2 with FactoMiner package; a multivariate analysis method was carried out: Boxplot

3 Results and discussion

3.1 Inventory of woody fodder and degree of palatability

The surveys showed that of the 28 woody species identified; 23 are considered as fodder, i.e., 82.14% (Table1).

Table 1 Inventoried ligneous species with their degree of palatability, families, and local names

Families	Species	Local names	Palatability
Anacardiaceae	*Anacardium occidentale* L.	Anacardier	PA
	Heeria insignis (Del.) 0. Ktze	Wosswassor	A
Arecaceae	*Borassus aethiopum,* Mart.	Ronier	NA
Balanitaceae	*Balanites aegyptiaca* (L.) Del.	Soump	TA
Bignoniaceae	*Stereospermum kunthianum* cham.	Yatou deum	NA
Bombacaceae	*Adansonia digitata* L.	Gouye	TA
Combretaceae	*Anogeissus leiocarpus* (DC.) G. et P.	Guédiane	PA
	Combretum glutinosum Perr. ex DC.	Rate	PA
	Guiera senegalensis J. F. Gmel	Nguer	TA
	Terminalia avicennioides Guill. et Perr.	Reub Reub	A
	Terminalia macroptera Guill. et Perr.	Wolo	TA
Ebenaceae	*Diospyros mespiliformis* Hochst. ex DC.	Alom	NA
Fabaceae (subfamily Caesalpinioideae)	*Cassia sieberiana* DC.	Sendiène	NA
	Cordyla pinnata (Lepr. ex A. Rich.) Milne-Redh.	Dimb	PA
	Piliostigma reticulatum (DC.) Hochst.	Nguiguis	A
	Tamarindus indica L.	Dakhar	TA
Fabaceae (subfamily Faboideae)	*Acacia ataxacantha* DC.	Sam	PA
	Dichrostachys cinerea (L.) Wight et Arn.	Sintch	NA
Fabaceae subfamily Mimosoideae)	*Acacia nilotica* (L.) Willd. ex Del.	Nep nep	PA
	Acacia seyal Del.	Founakh	A
	Faidherbia albida Del.	Kad	TA
	Prosopis africana (Guill. & Perr.) Taub.	Yiir	TA
Meliaceae	*Azadirachta indica* A. Juss.	Neem	PA
Moraceae	*Ficus capensis* Thunb.	Soto	TA
Myrtaceae	*Eucalyptus alba* Reinw.	Eucalyptus	PA
Polygalaceae	*Securidaca longepedunculata* Fresen.	Funf	PA
Rhamnaceae	*Ziziphus mauritiana* Lam.	Sidem	TA
Sterculiaceae	*Sterculia setigera* Del.	Mbep	TA

Among the 82.14% of species inventoried as fodder, 43.47% are very palatable (TA), 17.39% are palatable (A) and 39.13 are not very palatable (PA).

The legume family (*Fabaceae*) has the most woody fodder species *Mimosoideae* (4), *Caesalpinioideae* (3) and the *Faboideae* (1) followed by the *Combretaceae* family with 5 species.

82.14% of woody species inventoried are considered fodder. This shows that woody plants play a particular role in animal fodder during the dry season, since according to [12] more than 75% of trees and shrubs in West Africa are fodder. Among the 82.14% of species inventoried as fodder; 43.47% are very palatable (TA), 17.39% are palatable (A) and 39.13% are not very palatable (PA). These results confirm those of [13] who achieves significantly, for the species inventoried in common, with almost the same magnitudes of proportions (respectively 57.12; 13.76 and 29.12%) in the soil of Tiogo in the Sudanian zone. This importance of the forage character of the tree is also noted by [14]. The latter, by studying 56 woody species in the Sahel, notes that 95% of them are important fodder. Our observations differ from those of [15] who, for the same climatic zone, rather emphasizes the numerical importance of unpalatable species. This can be explained by intra-zone variations in the supply of woody fodder species [16], edaphic conditions and rainfall variations.

3.2 Chemical and nutritional values of our woody fodder

Our results show that there is a difference between species in terms of chemical composition in these woody species. [17] had already made this observation on woody fodder in northeastern Nigeria.

The Boxplots of the different variables (Figures 5, 6, and 7) summarize this variability.

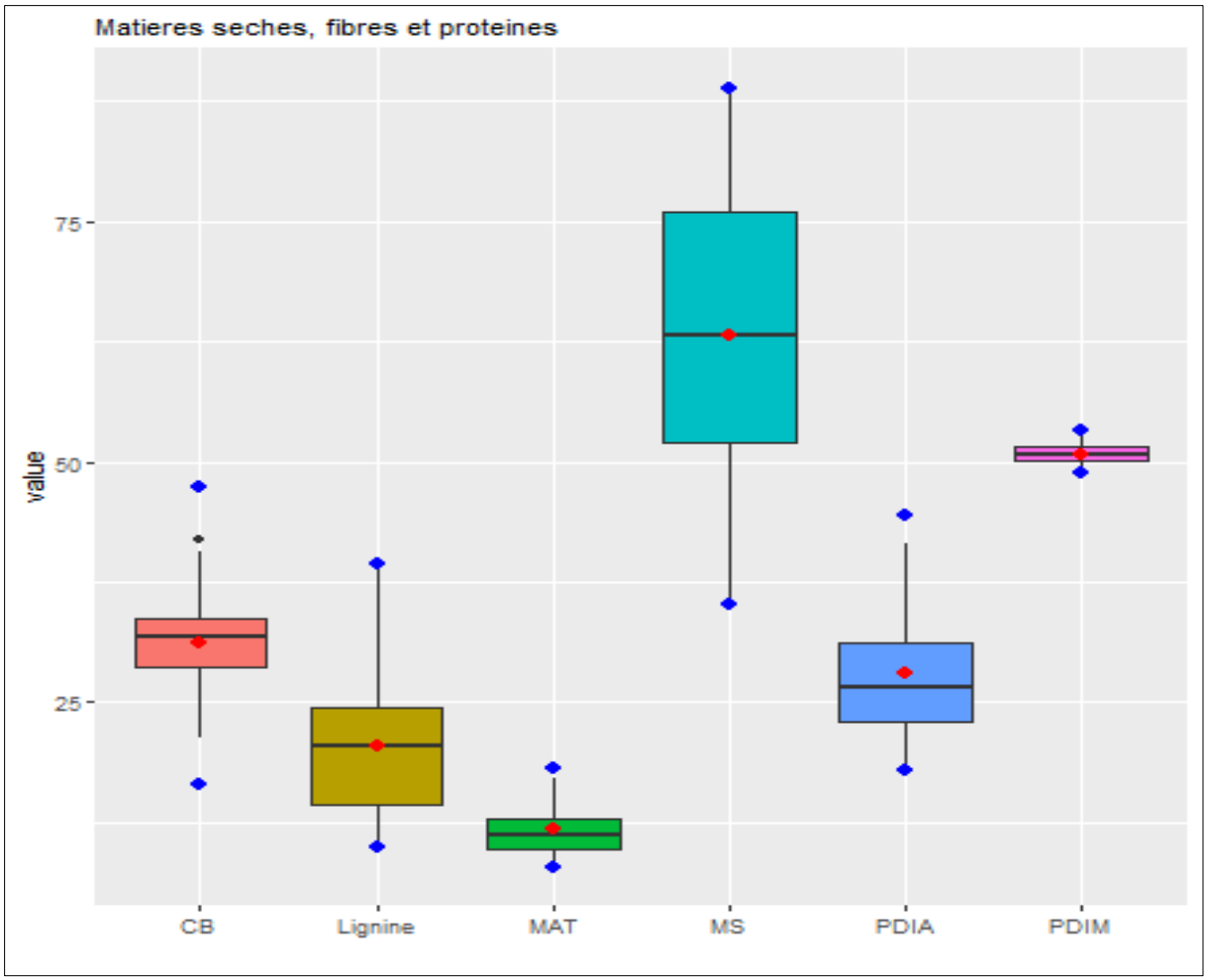


Figure 5 Boxplots of dry matter, fiber and protein variables

Fairly high MAT contents, with an average of 11.77%, varying from 7.79 for *Eucalyptus Alba* to 18.21% for *Piliostigma reticulatum* were observed. According to some nutritionists [18, 19, 20], a minimum MAT content of 8% MS is required to ensure adequate functioning of rumen microorganisms.

The total wall content of an average of 50% is not very high compared to that of poor forages which can reach 75% of MS [21]. It varies from 38.55 for *Adansonia digitata* to 67.47 for *Heeria insignis*. This parietal fraction is mostly composed of lignin and cellulose (25% for *Balanites aegyptiaca* and 65.54% for *Heeria insignis*) or 86% of the walls. The lignin reaching an average of 20% is quantitatively quite significant, however the lignin content of *Combretum glutinosum*, *Anogeissus leiocarpus* and *Balanites aegyptiaca* with respectively 9.88; 10.5 and 10.82 are relatively low.

For CB, NDF and ADF, significant differences ($p < 0.05$) are noted between forages. The CB, NDF and ADF contents of *Eucalyptus Alba*, *Securidaca longepedunculata*, *Acacia ataxacantha*, *Adansonia digitata*, *Azadirachta indica*, *Balanites aegyptiaca*, *Combretum glutinosum*, *Anogeissus leiocarpus*, *Acacia nilotica* are lower than those of other woody forages. This clearly shows that this group of forages has much greater dry matter ingestion and forage digestion capacities than other woody species.

Figure 6 below illustrates the summaries of the variability of the chemical composition of forages in digestibility and in energy values.

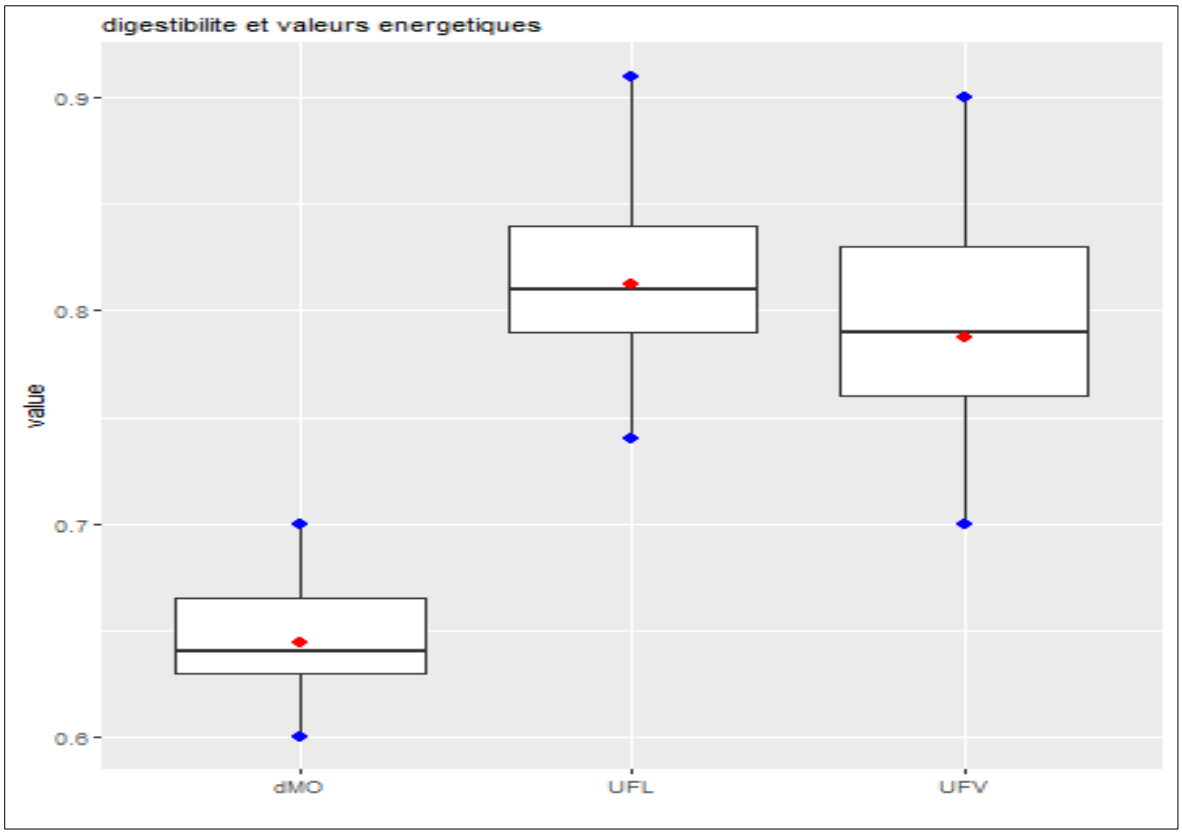


Figure 6 Boxplots of digestibility and energy values variables

These woody plants have a fairly high average digestibility of 64.39% with extremes varying between 60% (*Faidherbia albida*, *Terminalia avicennioides* and *Tamarindus indica*) and 70% (*Balanites aegyptiaca*). Due to the close relationship between the digestibility of organic matter (dMO) and the net energy values of fodder [22], the UFL (0.81% on average) and UFV (0.79% on average) contents) of these ligneous are generally high. [23] points out that it uses 0.80 UFL/Kg MS to ensure the fattening of ruminants in tropical environments. This leads us to say that these woody plants have low anti-nutritional quantities (tannins and phenolic compounds). According to [24]tannins condensed at a low level (< 3% MS) improve the absorption of amino acids in the small intestine. Studies conducted by [25] in the same study area revealed condensed tannin contents for *Balanites aegyptiaca* < 1% MS.

Figure 7 represents the variability of the forages studied in terms of mineral elements.

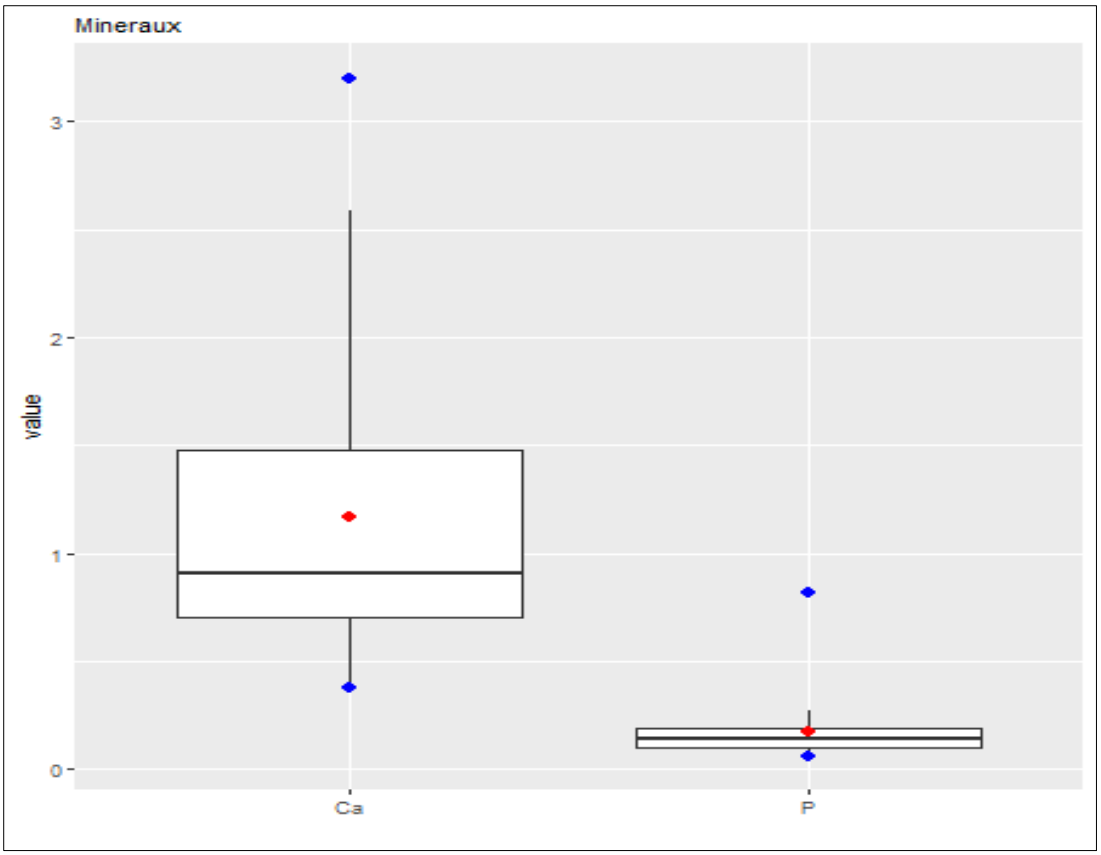


Figure 7 Boxplots of mineral variables

The phosphorus content of the ligneous plants studied, varying from 0.06 to 0.82, is generally low. With an average of 0.17, it is below the threshold of 0.3% MS considered minimal for ruminants [26]. The absorption of phosphorus in the case of the ligneous plants studied is especially disadvantaged by a fairly high calcium content with an average of 1.16 (and a maximum of 3.20) and could cause a phospho-calcic imbalance. These results are similar to [27] for the same study area with an average of 0.18% for phosphorus and 3% for calcium. The distribution of these ligneous species therefore does not dispense with the supply of minerals to balance the ration of ruminants. Woody plants cannot be used to limit phosphorus deficiencies, the main mineral imbalance encountered in the Sahelian zone in ruminants. Indeed, the phosphorus content is often below the threshold of 0.2%. The absorption conditions for this element can also be adversely affected by a fairly high calcium content which unbalances the phospho-calcium ratio. Most of the species existing in the Sahelian zone are deficient in phosphorus whereas they can be sources of calcium [28].

4 Conclusion

These few results complete the abundant bibliographical data relating to the nutritional aspect of the fodder species cultivated in the area. They confirm the interest of woody species as sources of fodder rich in nitrogenous matter.

At the end of our work, we can say that ligneous plants offer a real chance of overcoming the nutritional deficiencies faced by farm animals whose diet is based on the use of natural pastures.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

There is no competing interest.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

References

[1] Dicko MS, Sangare M. The eating behavior of domestic ruminants in the Sahelian zone. Second International Rangeland Congress, Adelaïde, Australia, 13-18.5.84. 1984. 8 p. (tab. And fig.).

[2] Guerin H. Food of domestic ruminants on natural Sahelian pastures and Sudanian Sahelo : methodological study in the Ferlo region in Senegal [PH.D.thèse]. France: University of Montpellier ; 1987.

[3] Richard D, Guwin H, Fall ST. Feeds in the dry tropics. In: R. Jarrige Ed. Ruminant nutrition. Recommended allowance and feed tables. INRA. France. 1989; 345-357.

[4] Rivière R. 1977. Food manual for domestic ruminants in tropical environment. Paris: Ministry of Cooperation, 522 p. (Manuals and Breeding Precise: IEMVT, 9).

[5] Kearl LC., "Nutrient Requirements of Ruminants in Developing Countries" (1982). All Graduate Theses and Dissertations. 4183. https://digitalcommons.usu.edu/etd/4183.

[6] LAMPERY HF, Herlocker DJ, Field CR. Fourrets in East Africa, in: H.N. Le Houérou (Ed). Local fodder in Africa: Current state of knowledge, Addis Ababa: CIPEA ; 1980. p. 33-55.

[7] Houerou, H.N. (Ed.); International Center for Livestock in Africa, Addis Ababa (Ethiopia) Fre; Symposium on woody fodder in Africa Free 8-12 April 1980 Addis Abeba (Ethiopia).

[8] Devendra C. Ruminant Production Systems in Developing Countries Resource Use. Vienna : IAEA ;1989.

[9] National Agency for Statistics and Demography (ANSD). Economic and Social Situation of Senegal 2017-2018; 11-243.

[10] Berhaut J. Flore from Senegal. 2nd ed. Dakar : Clairafrique ; 1967.

[11] Guerin H. Lexico 'Latin Wolof' Plant species consumed by domestic ruminants in Thyssé-Kaynor-Sonkorong. Dakar: Lnerv/Isra; 1984.

[12] Sène A. Dynamics and peasant management of agroforest parks in the Senegal Arachidier basin. Environment and rural changes in changing. 2004: 185-199.

[13] Savadogo P. Pastures of the classified forest of Tiogo: plant diversity, productivity, nutritional value and uses. [Engineer memory]. Burkina Faso: Polytechnic University of Bobo-Dioulasso (UPB); 2002.

[14] Lykke AM. Local perceptions of vegetation change and priorities for conservation of woody-savanna vegetation in Senegal, Journal of Environmental Management. 2000; 59: 107-120.

[15] Bakaye S. Potential of woody fodder in the soil of Sokouraba (Burkina Faso). Master's thesis. 2014; 66.

[16] Dessey N. Dynamics of vegetation and climate: study by remote sensing of five Brazilian biomes, dense and open umbrophilic forest, Cerrados, Caatingu and Campanhagaúcha [Ph. D. thesis]. Nanterre : Paris University ; 2006.

[17] Njidda AA, Ikhimioya I. Correlation between Chemical Composition and In Vitro Dry Matter Digestibility of Leaves of Semi-Arid Browses of North-easten Nigeria. American-Eurasian J; Agric and Environ. Sci. 2010; 9(2): 169-175.

[18] Milford R, Minson DJ. Intake of tropical pasture species. Proceedings of the IX International Grasslands Congress. 1966; 1: 815 – 822.

[19] Minson DJ. The chemical composition and nutritive value of tropical legumes. FAO plant production and protection series. 1990 : 185-193.

[20] Coleman SW, Hart SP, Sahlu T. Relationships among forage chemistry, rumination and retention time with intake and digestibility of hay by goats. Small Ruminant Research. 2003; 50: 129-140.

[21] Fall TS, Friot D, Richard D. Nutrient value of five West African woody species. Their ability to improve rations based on poor fodder distributed to sheep. Final report, ISRA/LNERV, (Research agreement between ILCA and ISRA), Res. PSU. 1993; 34: 27.

[22] INRA. Know the food value of its fodder: the calculation of the food value of its fodder. France: Livestock Institute; 2018.

[23] Rivière R. Manual of the food of ruminants in tropical environment. Paris, France: French documentation; 1991.

[24] Barry TN, McNabb WC. Review Article: The Implications of Condensed Tannins on the Nutritive Value of Temperate Forages Fed to Ruminants. British Journal of Nutrition. 1999; 81: 263-272.

[25] Fall TS, Friot D, Richard D, Guerin H. Use of woody fodder in the diet of domestic ruminants in the Sahelian zone. Chemical composition, digestibility and influence on the performance of young sheep. Final report, ISRA/LNERV (FIS Fellowship), Res. PSU. 1994; 16: 13.

[26] Mc Dowell IR, Conrad JH, Ellis GL, Loosli JK. Mineral for grazing ruminant in tropical rogions. Gainesville : Animal Science Dept., Center for Tropical Agriculture, University of Florida ;1993.

[27] Fall TS, Friot D, Richard D, Guerin H. Use of woody fodder in the diet of domestic ruminants in the Sahelian zone. Chemical composition, digestibility and influence on the performance of young sheep. Final report, ISRA/LNERV (FIS Fellowship), Res. PSU. 1994; 16: 13.

[28] Diagayété M, Schenkel H. Mineral composition of ligneous plants consumed by ruminants in the Sahelian zone. Rev. Elev. Méd. Vét. Pays Trop. 1986; 39 (3-4): 421-424.