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Botanical and Ethnoveterinary Surveys of Two Acacias (*Acacia raddiana* and *Acacia nilotica*) Exploited in Small Ruminant Rearing in Sahelian Area of Burkina Faso

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Abstract: In Burkina Faso, rural livestock farmers in arid and semi-arid areas rely heavily on woody plant resources such as *Acacia nilotica* and *Acacia raddiana* to satisfy the needs of small ruminant rearing. The assessment of the availability and the use of these two species are therefore essential to better manage them sustainably for their preservation. The survey carried out in the area showed that the questioned farmers exploited the leaves and pods of the two Acacia for the needs of the ruminants. 100% of the farmers exploit *A. raddiana* only for the feeding of small ruminants. However, *A. nilotica* was exploited for animal feed and health. The most commonly reported treatments are Foot and Mouth Disease (98.7%) followed by diarrhea (73.7%) and foot wounds (51.2%). In order to compare the results of the survey, a botanical inventory was carried out in the area and the results showed that *A. raddiana* is more available compared to *A. nilotica*. Also, other local species such as Faidherbia albida, *Acacia senegal, Balanites aegyptiaca* and Acacia siberiana are also exploited for the needs of small ruminant rearing in the study area. The most important constraints were excessive cutting, drought and overexploitation that negatively impact their survival. Data on these constraints provide the basis for a campaign to raise awareness among herders' communities to preserve these plants to sustainably improve the productivity of small ruminants and consequently farmer's income.

Keywords: *Acacia nilotica*, *Acacia raddiana*, Surveys, Small Ruminants, Sahelian Area, Burkina Faso

1. Introduction

In Africa, the effects of climate change are particularly acute. The impact of this phenomenon on livestock production systems in general is the reduction in the quantity and quality of forage available from pasture for feeding livestock [1]. In Burkina Faso, the livestock sector alone

provides more than thirty billion CFA francs annually to the national economy, with a contribution from small ruminants around 32% [2]. At the level of rural households, small ruminants constitute an important factor in the food and nutritional security of the populations and also in the fight against poverty through the incomes generated by the activity [3]. However, this sector of small ruminant rearing still faces various development problems which are the reduction of pasture areas due to the extension of arable land, the increasing of population and the declining grazing productivity due to the precariousness of rains and soil degradation [4, 5]. To these problems, it is necessary to add those of the increase of the animal load [6] and wooden needs of the population which reduce qualitatively and quantitatively the natural pastures.

This evolution of the production context threatens the sustainability of the traditional endogenous exploitation strategies of the natural plant resources set up by small ruminant farmers, in particular those of the arid and semi-arid zones of Burkina Faso. Among these strategies, the use of natural woods is important for rural populations [7] and for the needs of livestock [8, 9].

In this context, the present study was conducted to (i) study availability (based on dendrometric studies) and (ii) analyze the exploitation practices of two species of Acacia (*A. nilotica* var adansonii (Guill. and Perr.) O. Ktze and *A. raddiana* Savi) in small ruminant rearing in the Sahelian area to propose solutions for a sustainable management.

2. Materials and Methods

2.1. Site of the Study

Figure 1. *Site of the botanical study and the ethno-veterinary survey.*

The study was conducted in Burkina Faso in the region of Dori of Séno province (14° and 15° N; 0° and 3° W) located in the arid Sahel area of the country (Figure 1). The climate of the region, classified as sahelian, is marked by a long dry season from November to June and a short rainy season from July to September. Average annual temperatures range from 10°C (minimum) to 45°C (maximum) with an annual rainfall of around 400 mm. The vegetation consists to ligneous covered with discontinuous plant formations of varying densities. These plant formations are mainly shrub steppes dominated by spiny plants and annual and perennial grass species.

2.2. Methodology

An ethno-veterinary survey coupled with a floristic inventory survey was carried out. For the ethno-veterinary survey, information was collected through semi-structured interviews with 80 farmers who were randomly selected from the region. The information collected on the two species of Acacia related to (a) their areas of use for small ruminant rearing, (b) the parts used in feeding and possible treatment of small ruminant diseases, (c) the current availability of the two species, (d) the main reasons for the scarcity of species, and (e) the conservation options for plant species used in small ruminant production.

In order to compare the responses of farmers to the field data, dendrometric inventory surveys were carried out in the same region during May - June 2015. To this, data were collected in 40 squares of 50m x 20m of 1000 m^2 per square. Five plots per axis (four defined axes) and for each species were made during the survey and the minimum distance between two plots varied between 300 and 500 m. Inside each large square, five smaller 25 m^2 (5 x 5 m) plots were delimited to determine regeneration.

In each large plot, a measurement of all the feet of both plant species was performed. For each adult foot, measurements and / or observations were made on the height of the tree, the circumference of the trunk at the base (20 cm and 1, 30 m from the ground), health status (breast, sick, cut, insect attack) and observation (presence of leaf, fruit, pasture area, etc.).

To account for natural regeneration, the total number of stump discharges and possible terrestrial ponds was counted. Measurements were taken on the number and height of the feet.

Collected data were used to calculate the site and species averages of the structural parameters of a) density, b) basal area, c) cover rate, and diameter class structure. For the class structure of diameter, the plants were grouped in classes of diameter of 5cm of interval which gives us 17 classes of diameter for *A. nilotica* and 8 classes of diameter for the specie *A. raddiana*. The calculations were carried out on the basis of the following formulas:

- *density*: The density of a species represents the number of individuals of the species per unit area. The measurements were carried out on 302 plants for *A. nilotica* and 685 for *A. raddiana* according to Ouédraogo et *al.* [10]:

a) - determination of the diameter of the trunks of adult feet:

Circumference (C) = π * Diameter (D) where Diameter (m) = [C / π] / 100

b) - Calculation of the average density of individuals (Dm):

Dm (indiv/ha) = [(number of indiv/species/axis) / (number of plots/species/axis)]*10

- *basal area*: it corresponds to the sum of the horizontal sections of the trunks, taken by convention at 1m30 m from the ground. It can therefore be calculated for the whole stand, by species or groups of species, and it also allows us to estimate the dominance of small or large feet of each plant species [11]:

a) calculation of the basal area by plants:

The basal area (m^2/ha) was calculated according to the relationship: $S = \pi r^2$ r = D/2 St = [(π*D^2)/4] with: S = Surface of the circle, r = radius of the circle, St = basal area (m^2ha^1) and D = diameter at 1m30 from the ground;

b) - Calculation of the average basal area (Sm):

Sm (m^2/ha) = [(Σ basal area/species/axis) / (number of plot/species/axis)]*10

- re*covery rate*: it is the area of the crown of the tree projected vertically to the ground. It varies according to the different zones because its value depends strongly on the presence of large trees with large crowns [12]:

T (x)% = [(means of crown of each species/site)/number of plot]*10 with T (x) = cover rate

2.3. Statistical Analysis

Collected data were used to realize a descriptive analysis by calculating the means ± standard deviations and the percentages. Then, they were used to perform one-way analysis of variance to discriminate the measured parameters. Obtained means were compared using the Student Newman Keul test at 5% with Genstat software.

3. Results

3.1. Density, Basal Area and Recovery Rate

Table 1 presents the means of three measured parameters (mean density (D), basal area (St) and recovery rate (Tx)) that show a significant difference ($p<0.05$) between the two species plant. The means density per species was 151 ± 105.026 plants / ha for *A. nilotica* and 342.5 ± 146.426 plants / ha for *A. raddiana* with respectively mean basal area of 8.70 ± 4.738 m^2/ha and 3.734 ± 2.887 m^2/ha with relatively high standard deviations.

Table 1. *Summary of averages density, basal area and recovery rate for both Acacia species per axis.*

Measured parameters	Species	Axis				Means
		1	2	3	4	
D (indv/ha)	*An*	116 ± 27.0 a	92 ± (21.6)a	282 ± (133.49)a	112 ± (67.60)a	151 ± (105.03)a
	Ar.	272 ± (129.3)b	472 ± (197.4)b	354 ± (90.7)a	272 ± (66.10)b	342.5± (146.43)b
St (m^2/ha)	*An.*	7.385± (3.0)a	6.603± (5.9)a	8.674 ± (4.7)a	12.151± (4.13)a	8.703± (4.74)a
	Ar.	4.189 ± (3.5)a	1.724 ± (0.8)a	4.19 ± (2.22)a	4.830 ± (3.81)b	3.734 ± (2.89)b
Tx	*An*	170 ± (83.6)a	90 ± (54.7)a	420 ± (290.6)a	238 ± (289.7)a	229.5 ± (230.6)a
	Ar.	640 ± (232.9)b	720 ± (90.8)b	670 ± (75.8)a	560 ± (114.0)b	647.5 ± (143.7)b

D: Density; indv / ha: individual to hectare; St: Basal area; Tx: recovery rate; An: *Acacia nilotica*; Ar: *Acacia raddiana;* (ab): Means significant differences ($p<0.05$) between species on the same column.

3.2. Structure in Class of Diameter

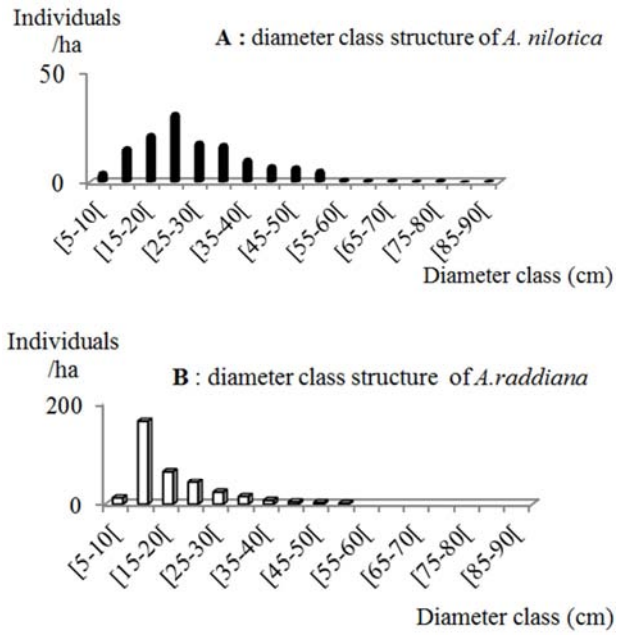

Figure 2. *Diameter class structure of A. nilotica (A) and A. raddiana (B).*

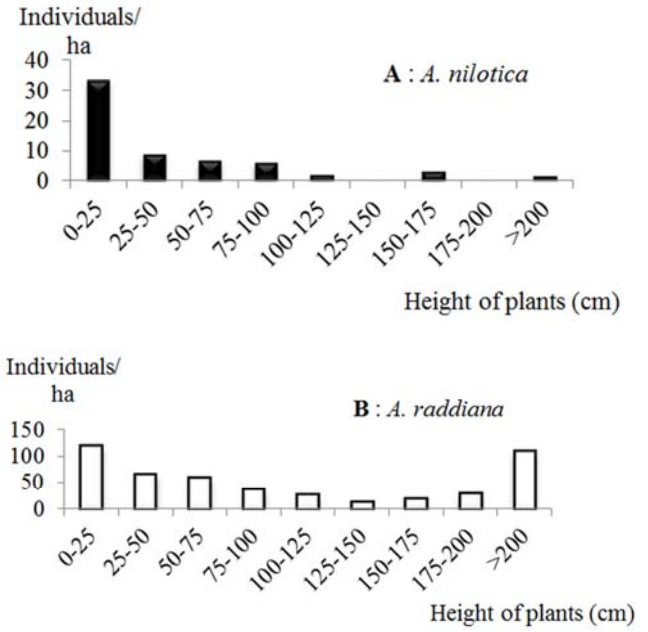

Figure 3. *Average number of regeneration (average of individuals / ha) according of the size of A. nilotica (A) and A. raddiana (B).*

Figure 2 presents the means of diameter class distribution of individuals. The diameter class distribution of *A. nilotica* was globally similar Gaussian distribution. The dominant class corresponds to individuals comprised between 15 and 50 cm. For the species *A. raddiana*, the diameter class distribution formed an inverted "L" or "J" shaped curve with a modal class comprised between 15 and 20 cm.

3.3. Regeneration and Availability

In the study, it was considered seedlings stems with a diameter at the base is less than 20 cm. On this criterion, examination of the graphs shows that the regeneration capacity of A. *nilotica* was globally very low compared to *A. raddiana* (Figure 3).

The largest average regeneration of *A. nilotica* was comprised between 0 to 25 cm of height. Compared to *A. nilotica*, *A. raddiana* presented many seedlings (0 to 25 cm) and plants with a size > 00cm with respectively 119.5 and 109.5 individus / ha.

3.4. Knowledge of the Uses of Species

The frequency of use were varies depending on the used parts and domain of use. The results of the survey showed that both species are solicited in six categories of use that were the feed, the crafts, the building, the wood, fodder and veterinary medicine. In the small ruminant rearing, leaves and pods are essentially the most used organs. These organs are either consumed directly by animals or crushed. 100% of farmers use *A. raddiana* only in the diet contrary to *A. nilotica* which is used for feeding and the treatment of small ruminant diseases (Figure 4).

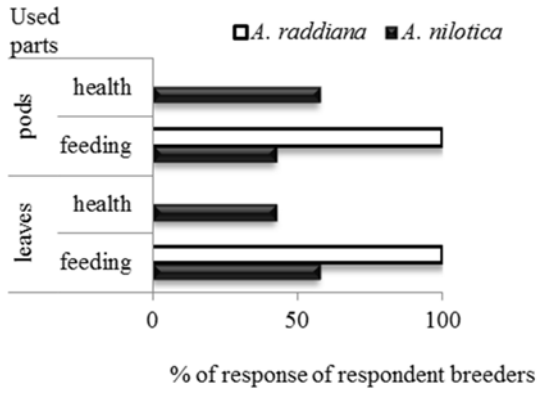

Figure 4. *Parts used of the two species of Acacias.*

For the disease treatment, leaves and pods of *A. nilotica* are used either as decoction or filtrate and the diseases commonly treated are those against foot-and-mouth disease (98.75% of farmers) and diarrhoea (73.75%) (Figure 5).

Similar to *A. nilotica* and *A. raddiana*, other local species are used for the feeding and the treatment of animal diseases in the study area. These are the species of the family of *Fabaceaes* (Faidherbia albida, Acacia siberiana), *Mimosaceae* (*Acacia senegal*) and *zygophyllaceae* (*Balanites aegyptiaca*) (Figure 6). All these plants are confronted with five main constraints that negatively impact their survival in the study area; the most important are woodcutting, dryness and overexploitation (Figure 7).

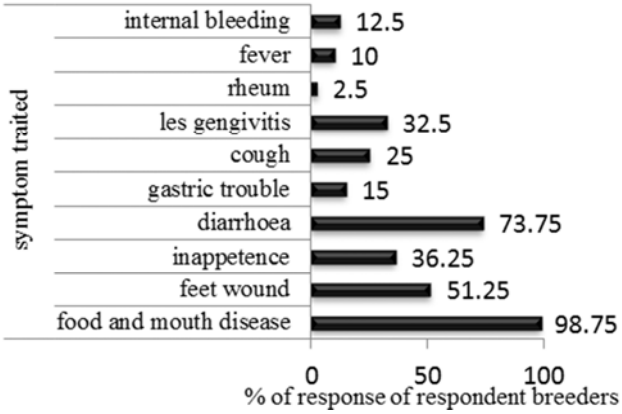

Figure 5. *Main diseases treated with A. nilotica plant according to the farmers.*

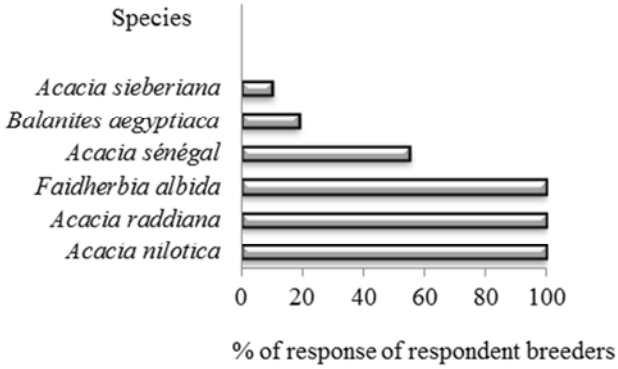

Figure 6. *Other natural plant used by farmers for small ruminant rearing in the study area.*

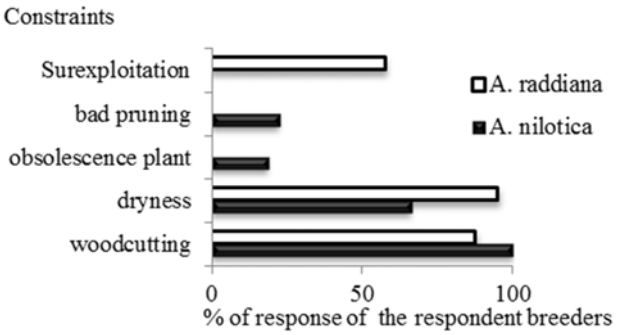

Figure 7. *Main constraints of natural plants in the study area according to the farmers*.

4. Discussion

The measured parameters give us an overview of the current population structures and the regeneration capacities of *A. nilotica* and *A. raddiana* species in our study area. In general, the analysis of the dendrometric data collected in the study reveals a lower density and a lower tree cover in the area. These results do not corroborate those obtained by Paré [13] on the diversity of light forests in southern Burkina

Faso. This could be explained by the fact that climate is more favorable (rainfall, hydromorphy, soil types) to these species in the south than in the north of the country. In addition, anthropogenic pressure (overexploitation and woodcutting) and the climatic impact (drought) observed in the study area could be at the origin of these lower densities.

The inverted "J" distribution of diameter analyses showed that the population of *A. raddiana* presented a large number of young plants inside of the population studied. This population was dominated by individuals belonging to the first classes [10-15] with an average of 165 individuals/ha. However, the inverted "J" structure of the diameter classes is an indicator of good regeneration [14]. However, the steep slope in the extreme of the curve reflects an under-representation of young plants and adult individuals. This indicates that the transition from juvenile to adult phase is relatively low [11]. This situation could be due to the slow evolution of the juveniles plants or their mortality caused by biotic or abiotic factors. For the population of *A. nilotica*, the graph presented a small proportion of young plants and individuals superior to 50 cm. The class of distributions observed in our study was similar to those found by Diallo et *al.* [15] in Senegal on *Acacia senegal* population at Widou Thiengoly and Tessékéré. According to these authors, the presence of disseminated individuals shows that populations develop under difficult climatic conditions, aggravated by intense anthropogenic action through the increasing of livestock pressure and woodcutting.

Survey results revealed that 100% of breeders use pods of both species in livestock feeding and the treatment of diseases. The pods and leaves constitute the parts commonly use in small ruminant livestock. According to Nacoulma-Ouédraogo [16], these parts contain secondary metabolites that play an important role in nutrition and traditional pharmacopoeia. It is known that the absence of a large number of seedlings would be linked to the use of seeds and fruits in livestock feeding [15]. This pressure of the cattle and woodcutting was more visible in *A. nilotica* than *A. raddiana*. It would explain the low density of adult plants and the lack of regeneration reflecting the current and future availability of two both plants in the area. According to Weber et *al.* [17], excessive harvesting of *Prosopis africana* pods was seriously reduced natural regeneration in the Sahelian area of West Africa. Added to this, there are the selections of young plants by grazing [15]. Otherwise, densities and regeneration seem to be more important for *A. raddiana* than *A. nilotica* because the leaves and pods are mainly used for livestock feeding according to the questioned breeders. In general, the rate of tree cover was low for both species. Also, *Acacia* plants with large circumferences (greater than 100 cm) are unusual in Dori area. This rarity reflects the inability of the trees to grow normally in thickness due to the water deficits [18]. Thus, one could say that the *A. raddiana* population presents a good regeneration with an anthropogenic pressure on the intermediate classes. For *A. nilotica*, the regeneration was poor and most of adult plants are more or less the same size. In traditional therapy, only the *A. nilotica* plant is used for the treatment of various diseases or symptoms presented by small ruminants according to the allegations of the breeders surveyed. However, in other countries, the *A. raddiana* plant is used in the treatment of skin allergies, diabetes, diuresis and hypertension [19] in addition to fodder interest for goats and dromedaries [20]. It is also used as a dewormer and against skin diseases [21]. As for *A. nilotica*, authors report that all parts of the plant are used in traditional medicine [22]. The bark would have anti-diarrheal and anti-dysentery effects and the leaves would treat eye inflammation [23]. The internal bleeding reported by our surveyed farmers are probably related to the sanguinolent diarrhoea observed in the animals, and which could be due to a strong infestation of the *H. contortu*s [24, 25]. According to Menzies [26], an adult worm of *H. contortus* alone can cause flow loss of 0.05 ml of blood per day at the abomasum of the infected host.

5. Conclusion

The results of the surveys carried out on the two species of *Acacia* (*A. nilotica* and *A. raddiana*) showed that farmers have a good knowledge of these plants and regularly use them for food and the treatment of small ruminant diseases. The low numbers of feet and the small regenerations of *A. nilotica* reflect the anthropic pressures that this species undergoes through the abusive cuts and the harmful effect of overgrazing. This suggests that the specie *A. nilotica* is not very available and appears to be vulnerable in the region. However, studies on vulnerability indices should be conducted to confirm this hypothesis. In addition, they show that the combination of floristic inventories and ethno-veterinary surveys is an interesting approach to better characterize overexploited and endangered natural plant species. In our study environment, it is imperative to carry out measures to protect and restore *A. nilotica* species threatened with extinction due to the negative impact of anthropogenic actions compared to *A. raddiana*. In addition, validation studies of the use of extracts of these plants could be envisaged to better advise the farmers in their traditional therapies on livestock.

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