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Preference of the main spontaneous forage herbaceous natural pastures in central west Niger

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Abstract

This study on the feeding behavior of sheep carried out at the animal park of the Faculty of Agronomy of the Abdou Moumouni University of Niamey made it possible to evaluate the preference of six spontaneous forage herbaceous plants in sheep. These are two legumes *Alysicarpus ovalifolius* and *Zornia glochidiata* and four grasses including *Cenchrus biflorus, Panicum laetum, Pennisetum pedicellatum* and *Schizachyrium* exile. These herbaceous plants were harvested at the stage of maturity in the natural pastures of Boboye (an agricultural area in western Niger). The animal material consists of 10 Fulani Bali-Bali rams aged 12 to 15 months. The study was conducted using the so-called "*cafeteria*" method. The mean voluntary ingestion was 566.67±147.49 $g^{-1}.d^{-1}.animal^{-1}$ and varied depending on the herb and the periods. The highest preference index was that of *Alysicarpus ovalifolius* and the lowest that of *Pennisetum pedicellatum*. At the end of this study, three spontaneous forage herbaceous plants *Alysicarpus ovalifolius, Zornia glochidiata* and *Schizachyrium* exile were classified as the most palatable species and should be retained as coarse feed in sheep fattening rations and in seeding and stock restoration programs degraded natural pastures.

Keywords: Rams; Preference index; Ingestion; Natural pastures; Niger

1. Introduction

Niger's natural pastures are the main source of food for more than 60 % of the country's livestock [1]. The forage species offered by these biophysical environments fluctuate inter-annually and intra-annually both quantitatively and qualitatively [2, 3]. This fluctuation is due to the combined effects of climatic hazards (drought, flooding), declining soil fertility [4], inappropriate human activities (fodder harvesting, bush fires), overgrazing and nibbling of grazing areas in favor of agricultural fields [5, 6].

In the natural pastures of central western Niger, sheep (the most demanding animal species in terms of fodder species) feed preferentially on a mixture of spontaneous fodder herbaceous plants when they are allowed to graze freely [7, 8]. These spontaneous forage herbaceous plants provide energy, proteins, vitamins and minerals that can meet the food needs of animals [9, 10].

However, this preference for spontaneous fodder grasses over natural pastures coupled with an irregular distribution of rainfall and the fraudulent collection of fodder from natural pastures can lead to the degradation of these environments, causing a chronic food deficit for livestock [11, 12, 13].

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Improving the productivity of these natural pastures in the center west of Niger and of livestock requires the optimization of the use of spontaneous fodder herbaceous plants, especially in the dry season. The general objective pursued through this study is to optimize the use of six spontaneous forage herbaceous species palatable by Fulani Bali-Bali rams from Niger. This specifically involves:

- Determining the bromatological composition of the spontaneous forage herbaceous plants tested;
- Evaluating the voluntary ingestion of these herbaceous plants in sheep;
- Evaluating the preference index of these spontaneous fodder species in fulani rams and
- To know the relationship between weight change and total dry matter intake.

2. Material and methods

2.1. Materials

2.1.1. Study site

This experiment was carried out for 28 days (from February 7 to March 6 2021), including 7 days of adaptation and 21 days of data collection at the animal park of the Faculty of Agronomy of the Abdou Moumouni University of Niamey. The park is located in the municipal district of Niamey 5. The hydrographic network of this municipal district is marked mainly by the Niger River which crosses it for about 35 km and to which are added some permanent ponds as well as numerous temporary ponds [14]. Its climate is tropical of the Sudano-Sahelian type characterized by an average temperature of 35 °C with a maximum of 45 °C in April, a minimum of 15 °C in January. The average rainfall is 500 mm/year, variable depending on the year [15]. There is generally sparse shrubby vegetation and seasonal herbaceous plants. In the lowlands, the nature of the soil and the proximity of water are conducive to the development of fairly dense natural vegetation.

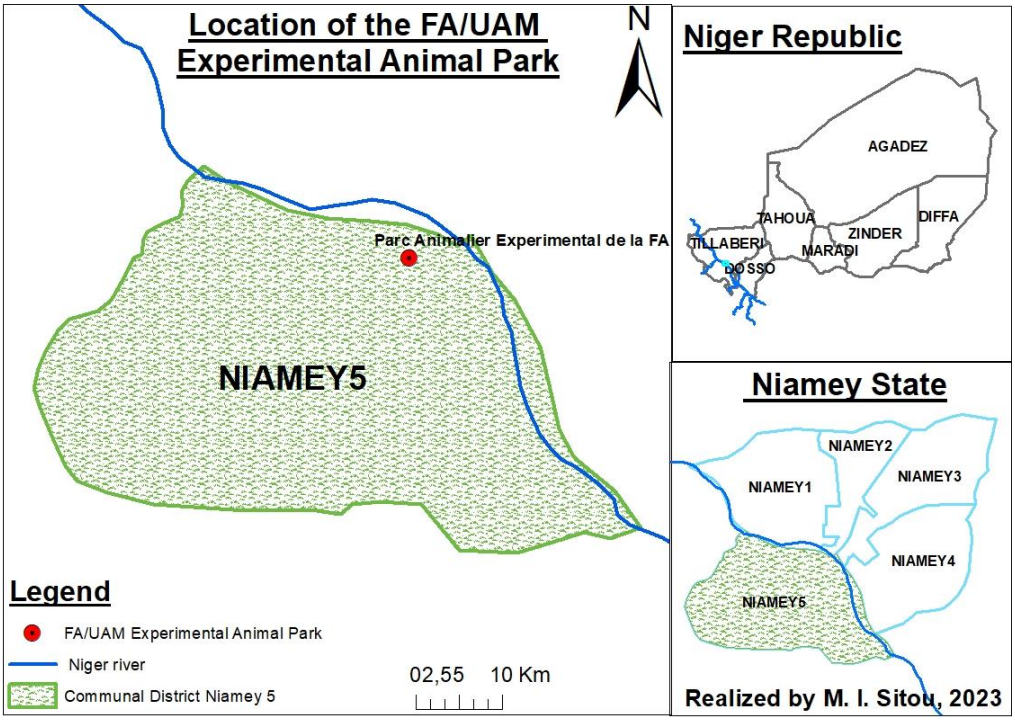

Figure 1 Location of the FA Experimental Animal Park

2.1.2. Animal material

The animal material consisting of ten (10) whole adult rams aged 12 to 15 months (presence of 2 adult claws) of the Bali-Bali breed with an average weight of 23.26 ± 1.65 kg. These animals come from the agro-pastoral zone (Dan Kassari-Allela sector) in central Niger.

Figure 2 Rams used during the experiment

2.1.3. Plant material

The plant material (spontaneous forage herbaceous plants to be tested) consisting of six species chosen on the basis of the results of surveys of pastoralists and/or agropastoralists of natural pastures in central western Niger [8]. These are two (2) legumes (*Alysicarpus ovalifolius* (Schumach.) J. Léonard, and *Zornia glochidiata* Rchb. ex DC.), and four (4) grasses (*Cenchrus biflorus* Roxb., *Panicum laetum* Kunth, *Pennisetum pedicellatum* Trin ., *Schizachyrium exile* (Hochst.) Pilg.,).

Figure 3 Sample of fodder distributed

2.1.4. Collection and drying of fodder

Fodder collection was carried out in Boboye between October-November 2020 (period of maturity of spontaneous forage herbaceous plants in Sahelian pastures). Herbaceous plants were snared using sickles. The drying was done as the fodder was harvested until the amount needed for the experiment was obtained. The fodder was spread out under the shade of a shed on newspapers in order to promote the absorption of humidity and prevent the development of fungi and possible attack by insects (termites). Once dried, they were kept by species in jute bags in a store.

2.1.5. Rations offered

During the experimental period, the rams were fed with the same quantity of forage (200 g) per grass in two meals (i.e. 100 g in the morning at 9 a.m. and 100 g in the evening at 5 p.m.). Water was given ad libitum. The fodder species were distributed for each ram randomly in six feeders so as to avoid the reflex oriented by the taste and the smell of a given

fodder. In addition, 150 g of concentrate (wheat bran) was offered per ram at each meal (i.e. 300 g/day) 30 minutes before the distribution of herbaceous plants in order to arouse the desire to consume forage [16].

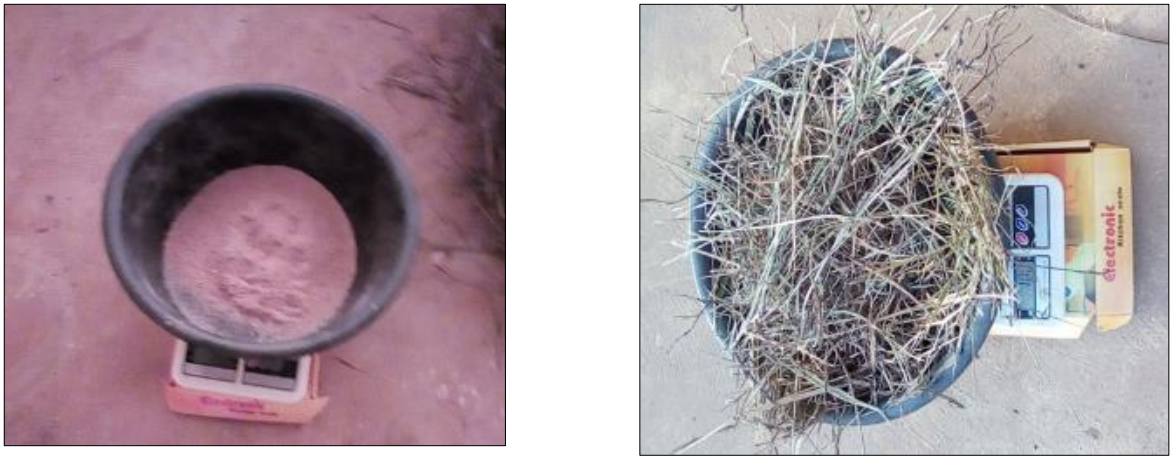

Figure 4 Weighing the quantities offered

2.1.6. Technical material

It consists of two electronic scales, one with a capacity of 10 kg and 1 g of precision for weighing the herbaceous plants tested and the other with a capacity of 40 kg and 10 g of precision for the weighing of animals). In addition, 70 containers of 10 liters capacity were used for animal fodder and watering. A Garmin *etrex* 10 GPS was used to identify the geographical coordinates of the experimental site.

2.2. Methods

2.2.1. Test device

The rams were tied to a stake in a sheepfold in the animal park of the Faculty of Agronomy of Abdou Moumouni University in Niamey. Before the start of the experiments, all the animals were numbered at random using a permanent marker on the ears before being treated with *Stress Vitam* solution for injection (anti-stress and vitamin and amino acid intake) by intramuscularly *IM* at a dose of 5 ml, with *Ivomec* (ivermectin 1 %) for injection against internal and external parasites subcutaneously *SC* at a dose of 0.5 ml and with Ferro Bloc (mineral salt intake) administered orally. Each animal had a living space of 12 m^2 where six (6) feeders were placed for feeding the six spontaneous forage herbaceous plants and a water trough. The feeders were fixed one (1 m) from the stake of each ram by a wooden tripod.

Figure 5 Distribution of rations to rams

2.2.2. Assessment of zootechnical parameters

Voluntary ingestion was calculated for a total duration of the test of 21 days divided into seven (7) equal periods of three (3) days each [17] in order to compare the quantities ingested between periods with the formula next.

$$Qi = Qo - Qr$$

With : Qi quantity ingested, Qo quantity offered and Qr quantity remaining

The periods considered are: P1 (day 1-3); P2 (day 4-6); P3 (day 7-9); P4 (day 10-12); P5 (day 13-15); P6 (day 16-18) and P7 (day 19-21).

The food preference index (PI) of the different herbaceous plants was determined according to the procedure described by [18] with the following formula.

$$PI = \ln\left(\frac{Ingestion\ species\ A}{Ingestion\ species\ B}\right)$$

With : ln = natural logarithm; Species A = left species; species B = right species. A positive PI value indicates a preference for the species on the left and a negative PI value indicates a preference for the species on the right.

NB: 1g has been added to avoid the ingestion 0 because ln (0) which is equal to ln (∞).

The average daily gain ADG of the rams during the experiment was calculated with the following formula:

$$ADG = \frac{weight2 - weight1}{age - age1}$$

2.2.3. Bromatological analysis

Samples of each forage grass offered to the rams were taken from each ration (two samples per grass per day) for analysis. A total of 252 samples (6 herbaceous plants * 2 rations * 21 days) were collected during this cafeteria test, grouped by species and stored in plastic bags. At the end of the measurements, the samples collected were mixed well then ground using a mortar mill and sieved to a mesh of 2 mm using a sieve (Cyclotec from Tecator) and packaged in boxes petri labeled before being analyzed at the Animal Feed Laboratory of the Faculty of Agronomy of Abdou Moumouni University in Niamey.

Thus, the moisture content was determined according to the official method. The MS dry matter was obtained from the water content results. The mineral matter MM was determined by incineration in an oven at 600 ° C for 4 hours. The Total Organic Matter OM was deduced from the results of the mineral matter. The determination of the crude cellulose CB was carried out according to the Weende method. Fat was determined using the Soxhlet extraction method. The total nitrogen content was determined by the Kjeldahl method. The feed value (FV) and the digestible nitrogenous matter (DNM) were determined according to the digestibility coefficient itself calculated from the crude cellulose rate of the feed and the fat content, thanks to the tables of calculation of the fodder value of compound feed.

2.2.4. Data analysis and processing

The Statistical Package for Social Sciences IBM SPSS Statistics version 20, Minitab 16 and XLSTAT software were used for statistical analyses. The one-factor analysis of variance (ANOVA) according to the General Linear Model (GLM) procedure was carried out to compare the average quantities of the herbaceous plants tested consumed per period. The separation of the means was made by Tukey's test at the 5 % threshold. Correlation analysis (linear regression) was used to establish the relationship between the average daily gain ADG and the average amounts of total dry matter intake (TDMI) per day per ram converted into metabolic weight ($g/d/kgP^{0.75}$).

3. Results

3.1. Bromatological composition of foods

The results of the bromatological composition of the spontaneous forage herbaceous plants tested during this cafeteria trial are presented in Table 1. The dry matter contents DM are between 93.62±0.30 and 95.06±0.05 %. Those in organic

matter OM varied from 77.41±0.94 % to 92.07±1.44 and are on average higher in the grasses than the legumes tested. However, regarding total nitrogenous matter TNM, digestible nitrogenous matter DNM and mineral matter MM, legumes have higher levels than grasses.

Table 1 Bromatological composition of feed distributed

Name	DM %	Composition in % of Dry Matter DM						Food value FV	
		MM	OM	TNM	MG	CB	ENA	VF (U.F/kg DM)	DNM (g/kg DM)
Alysicarpus ovalifolus	94.06±0.15	2.40±0.70	91.66±0.85	13.62±0.11	1.82±0.14	43.13±1.07	33.09	0.32	64.7
Zornia glochidiata	94.36±0.26	16.95±1.20	77.41±0.94	9.95±0.51	1.58±0.16	25.81±0.84	40.06	0.39	55.6
Cenchrus biflorus	94.56±0.35	3.84±1.35	90.72±1.70	5.93±0.20	0.99±0.01	39.93±0.53	43.87	0.33	28.5
Panicum laetum	93.62±0.30	1.55±0.05	92.07±0.35	5.79±0.23	0.93±0.11	40.28±1.00	45.07	0.33	27.7
Pennisetum pedicellatum	94.41±0.09	2.35±1.35	92.07±1.44	5.73±0.24	1.36±0.20	43.54±2.13	41.44	0.32	26.9
Schizycharium exile	95.06±0.05	4.93±1.84	90.13±1.79	3.46±0.14	1.31±0.11	36.84±2.28	48.52	0.34	17.07
Son de blé	89.95	82.54	7.41	4.08	19.26	14.89	44.31	-	129.3

DM : Dry Matter, MM : Mineral Matter, MO: Organic Matter, MAT: Total Nitrogen Matter, MG: Fatty Matter, CB: Crude Cellulose, ENA: Non-Nitrogen Extractive, FV : Feed Value, DNM : Digestible Nitrogen Matter DNM

3.2. Voluntary ingestion of spontaneous forage herbaceous plants tested

Table 2 Voluntary ingestion (in gDM.Animal^{-1}.Day^{-1}) of six spontaneous forage herbaceous plants tested

Period	Legumes		Gamines				Total
	Alysicarpus ovalifolus	***Zornia glochidiata***	***Cenchrus florus***	***Panicum laetum***	***Pennisetum pedicellatum***	***Schizachyrium exile***	
P1 (day 1-3)	128.47±34.04ab	103.03±32.85c	76.73±25.35h	67.47±33.31j	56.27±27.13n	121.53±32.26p	553.50±131.23
P2 (day 4-6)	142.47±22.11a	163.03±17.78d	68.13±20.47h	99.33±24.56k	35.27±15.27n	103.73±25.03p	611.97±59.92
P3 (day 7-9)	136.67±17.10a	125.60±22.51c	63.63±16.32h	111.03±21.12k	35.37±15.91n	115.43±25.50p	587.73±37.13
P4 (day 10-12)	146.40±24.15a	135.13±21.30cd	63.27±19.82h	90.60±23.45jk	30.50±13.09o	96.77±24.89p	562.67±51.42
P5 (day 13-15)	102.17±26.12b	126.23±24.74c	74.27±19.11h	104.27±28.54kl	49.80±17.62n	128.30±26.03p	585.47±64.40
P6 (day 16-18)	144.57±25.42a	134.60±27.76cf	68.23±24.73h	80.93±25.68jk	57.93±20.29n	118.33±25.65p	604.60±62.88
P7 (day 19-21)	119.17±26.52ab	96.23±25.09cg	48.33±20.38i	53.53±20.34jm	39.27±17.25n	104.20±31.51p	460.73±79.63
P8 (day 1-21)	131.41±25.95	126.27±26.53	66.15±21.11	86.74±27.32	43.49±18.58	112.61±28.01	566.67±147.49

NB: The values of the same column followed by the same letter are not different at the 5% threshold according to Tukey's post hoc test.

Visual observation of the animals during the ingestion measurements revealed that the leaves were consumed more than the stems. The average daily intake per herbaceous plant was between 43.49±18.58 to 131.41±25.95 g^{-1}d^{-1}animal^{-}

[1]herbaceous[-1]. Whereas the daily quantities ingested per ram varied between 460.73±79.63 and 611.97±59.92 depending on the period (Table 2).

3.3. Preference index of herbaceous plants tested

The preference index (PI) was calculated to identify herbaceous plants that are preferentially consumed by rams in order to use them in fattening programs and restore the productivity of natural pastures. Taking the amount of herbaceous plants ingested by the rams as a criterion for assessing the PI, we notice a real preference for legumes over grasses. In addition, the calculated herbaceous preference index revealed a rejection of *Pennisetum pedicellatum* compared to other grasses (Table 3).

Table 3 Preference Index PI of spontaneous forage herbaceous plants tested compared two by two

Combination No.	Spontaneous forage herbaceous plants	* PI value
1	*Alysicarpus ovalifolius* and *Zornia glochidiata*	0.07775584
2	*Alysicarpus ovalifolius* and *Cenchrus biflorus*	0.95681927
3	*Alysicarpus ovalifolius* and *Panicum laetum*	3.22376846
4	*Alysicarpus ovalifolius* and *Pennisetum pedicellatum*	1.57996746
5	*Alysicarpus ovalifolius* and *Schizachyrium exile*	0.27890862
6	*Zornia glochidiata* and *Cenchrus biflorus*	0.87906343
7	*Zornia glochidiata* and *Panicum laetum*	0.59851593
8	*Zornia glochidiata* and *Pennisetum pedicellatum*	1.50221162
9	*Zornia glochidiata* and *Schizachyrium exile*	0.20115278
10	*Cenchrus biflorus* and *Panicum laetum*	-0.28054749
11	*Cenchrus biflorus* and *Pennisetum pedicellatum*	0.62314819
12	*Cenchrus biflorus* and *Schizachyrium exile*	-0.67791064
13	*Panicum laetum* and *Pennisetum pedicellatum*	0.90369569
14	*Panicum laetum* and *Schizachyrium exile*	-0.39736315
15	*Pennisetum pedicellatum* and *Schizachyrium exile*	-1.30105884

*PI = ln (species A ingestion/species B ingestion); species A = left species; species B = right species. A positive PI value indicates a preference for the species on the left and a negative PI value indicates a preference for the species on the right.

3.4. Relationship between average daily ADG gain and average amounts of total dry matter ingested per day per ram (TDMI) gTDMI/D/P$^{0.75}$

The analysis of the relationship between the average daily weight gain (or daily weight gain) ADG and the quantities of total dry matter ingested TDMI through a regression made it possible to establish their degree of adjustment. The calculated regression equation showed an R2 coefficient of determination of 67% (Figure 6).

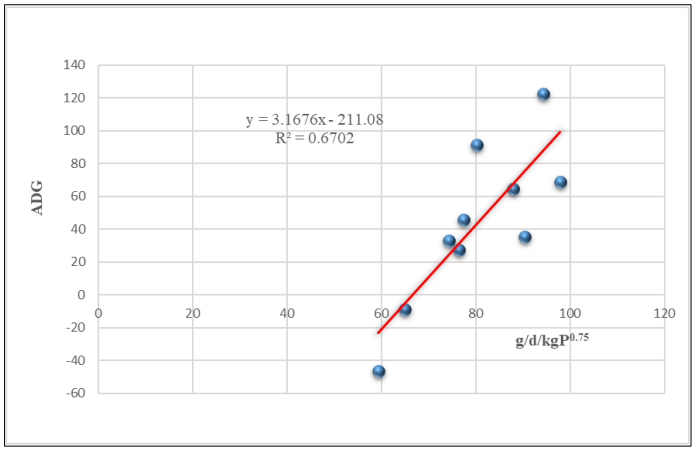

Figure 6 Relationship between ADG and TDMI in rams

4. Discussion

4.1. Bromatological composition of food

The bromatological composition of a forage varies according to the species, the stage of development, the anatomical characteristics (for example the leaves are richer in protein than the stems), the fertility of the soil and the method of conservation. The variation in the bromatological composition of forages in organic constituents (food principles) and their fate in the digestive tract of the animal is the basis of the expression of the zootechnical performances sought by breeders. The measured contents of organic matter, total nitrogenous matter, crude cellulose, mineral matter of *Alysicarpus ovalifolius, Zornia glochidiata Cenchrus biflorus* are slightly higher than those obtained by [10] in Niger. This difference may be due to the drying method (drying in the shade) and the short shelf life of the fodder during this experiment. In addition, our results of the bromatological analyzes are similar to those obtained on the main spontaneous forage herbaceous plants (grasses and legumes) eaten by livestock in natural pastures in the Sudanese areas of Benin, the province of Lubumbashi in the Democratic Republic of Congo and that of the region of Doucen wilaya of Biskra in Algeria [17, 19, 20].

4.2. Voluntary ingestion of spontaneous forage herbaceous plants tested

The ingestion of DM corresponds to the accepted norm in tropical countries, which is 2 to 3 % of their live weight in DM, according to [21]. In this study, ingestion was divided between 6 spontaneous forage herbaceous plants and wheat bran which were offered during the 21 days of data collection. The daily ingestion level of herbaceous plants in g of DM (566.67±147.49) was comparable to those obtained by [22] who obtained 643.46 g of DM. Regarding the selective behavior of animals, the results show that rams prefer leaves over stems. Similar results were obtained by [17] in Djallonké rams in Benin who state that the sheep are looking for the same plant parts and the same nutrient contents.

4.3. Preference index of herbaceous plants tested

Preference is a complex phenomenon influenced by several factors including animal species, plant (fodder to be tested) and environmental conditions [22]. To study the preferences of spontaneous forage herbaceous plants, it is important to take into account the physico-chemical characteristics of the latter but also the hedonic characteristics, i.e. linked to the pleasure of ingesting them [23]. It is to meet this requirement that the herbaceous plants tested during this cafeteria trial were collected at the same stage of development (maturity stage), dried and stored under the same conditions. Statistical analysis shows that *Alysicarpus ovalifolius, Zornia glochidiata* and *Schizachyrium exile* are the spontaneous forage herbaceous plants which respectively occupied the first, second and third place in terms of preference. These results corroborate those found by [17, 19, 22] which showed that small ruminants in general and sheep in particular prefer herbaceous legumes over grasses.

4.4. Relationship between average daily gain ADG and average amounts of total dry matter ingested per day per ram gTDMI/D/$P^{0.75}$

The positive correlation between the average daily gain ADG and the quantity of total dry matter ingested TDMI in this study confirms the fact that the voluntary ingestion of food accelerates the growth and the plumpness of rams [18]. Similar results were obtained by [24] in Oudah rams from Niger who claim that the high weight gain recorded is due to a better valuation of the feed offered. However, other authors have shown in their studies on small ruminants (sheep and goats) that the high weight gain observed was rather linked to the composition of the ration containing a certain proportion of concentrates [25, 26, 27, 28]. However, there is an urgent need to continue studies with a large number of subjects to elucidate this relationship between the ADG and the valorization of fodder and/or the bromatological composition of these.

5. Conclusion

This experiment made it possible to evaluate the preference as well as the bromatological composition of the six spontaneous forage herbaceous plants of the natural pastures of the center west of Niger. The results showed a preference for herbaceous legumes (*Alysicarpus ovalifolius* and *Zornia glochidiata*) over grasses (*Cenchrus biflorus, Panicum laetum, Pennisetum pedicellatum and Schizachyrium exile*). In addition, the digestible nitrogenous matter DNM of these legumes is much higher than that of grasses. However, *Schizycharium exile* despite its low amount of DNM was much more ingested compared to other grasses. In perspective, studies on the incorporation of these three (3) spontaneous forage herbaceous plants *Alysicarpus ovalifolius, Zornia glochidiata* and *Schizycharium exile* in sheep fattening rations and in programs for the restoration of degraded pastures must be undertaken to boost the productivity of our animals.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declare that they have no competing interests.

References

[1] Garba I. 2017. Spatial modeling of fodder production in the Nigerien pastoral zone. Thesis Doctorate in Sciences from the University of Liège, 233p.

[2] Alhassane A., Soumana I., Karim S., Chaibou I., Mahamane A. and Saadou M., 2017. Flora and vegetation of rangelands in the Maradi region, Niger. Journal of Animal & Plant Sciences, 2017. Vol .34, Issue 1: 5354-5375.

[3] Souley M. H. I., Chaibou I., Soumana I., Laouali A., Mahamane A., and Banoin M., 2018. Pastoral values and inter-decadal productivity of rangelands in the Goulbi n'kaba Valley in Niger. International Journal of Innovation and Applied Studies, 24(1): (2018) 220-239.

[4] Gouro, S. A., and Ly C., 2014. Agricultural residues and agro-industrial by-products in West Africa, State of play and prospects. FAO Regional Office for Africa Accra (2014) p 73.

[5] Djibo I., Mamman M., Issa C., Sarr O., Bakhoum A., Marichatou H., Akpo E. L., and Assane M. 2018. Vegetation characteristics of the Gadoudhé pasture, in the rural town of Fabidji (Niger). Int. J. Biol. Chem. Science. 12(3): 1151-1163.

[6] Sitou I. M., Rabiou H., Ado M. N., Ousseini M. M. M., Dan Guimbo I. and Chaibou M. 2020. Peasant perceptions of soil and biological indicators and factors of degradation of natural pasture areas in central western Niger, (Sahelian West Africa). Africa SCIENCE 17(6) (2020) 91 – 104.

[7] Moussa M.B., Soumana I., Saley K., Ambouta J-M. K. & Ali Mahamane 2018. Diversity, productivity and quality of pastures in dune ecosystems in the Department of Gouré (Niger). Geo-Eco-Trop, 2018, 42, 2: 285-296.

[8] Sitou I. M., Dan Guimbo I., Rabiou R., Moussa Mahamadou M. S., Mahaman Malam M. M. O., and Chaibou M., 2021. Analysis of peasant criteria for assessing the palatability of spontaneous forage herbaceous plants and the functioning of natural pastures in the center west of the Niger (Sahelian West Africa). Journal of Agriculture and Veterinary Science (IOSR-JAVS), 14(4), 2021, pp. 68-80.

[9] Soumana I., Ayssiwede S. B., Issa S., Guero and Missohou A., 2016. Effects of supplementation with concentrated multi-nutrient blocks based on Sida cordifolia L., an invasive plant, on the zootechnico-economic performance of antenais Balami breed in Déréki/Dosso (Niger). International Journal of Innovation and Applied Studies Vol. 15 No. 3 Apr. 2016, p. 716-730.

[10] Dan Gomma A., Chaibou I., Banoin M., and Schlecht E., 2017. Marketing and nutritional value of fodder in urban centers in Niger: the case of the cities of Maradi and Niamey. International Journal of Innovation and Applied Studies Vol. 21 No. 3 Oct. 2017, p. 508-521.

[11] Mahamane A., Saley K., Saadou M., Jauffret S., Wata I., Yacoubou B., Morou B., Diouf A., Maarouhi M., I., Zaman-Allah I., A., Ichaou A ., Aboubacar I., and Tanimoune A. 2009. "Climate variability in Niger: Potential impacts on the distribution of vegetation". Communication at the 14th International Colloquium on Environmental Assessment, 2629 May 2009 Niamey (Niger); pp1-11.

[12] Ousseina S., Fortina R., Marichatou H. and Yenikoye A., 2013. Dynamics of the herbaceous population of the experimental Sahelian station of Toukounous (Filingué – Niger). Int. J. Biol. Chem. Science. 7(2): 657-671.

[13] Sustainable Development Strategy For Livestock, (SDDEL 2013-2035), Ministry of Livestock, Volume 1, Republic of Niger/, Niamey, Niger, (2013) 61 p.

[14] Sitou I. M., Characterization of small ruminant breeding in the city of Niamey: diversity and food practices. Master's thesis in Animal Production. Faculty of Agronomy of the Abdou Moumouni University of Niamey, Niger p82.

[15] Chaibou M., Illia A. S. and Marichatou H., 2011. Management practices and performance of production in urban and peri-urban dairy cattle farms in Niamey. Bio Review Resources, Vol 1 N 2 December 2011.

[16] Zoffoun G. A., Murielle A. and Faïhun L., 2019. Palatability of eleven tropical forages in guinea pigs (Cavia porcellus) of different physiological stages in Benin. J. Anim. Plant Sci. ISSN 2071-7024) Vol.41 (2): 6916-6925. https://doi.org/10.35759/JAnmPlSci.v41-2.5.

[17] Babatounde S., Oumorou M., Tchabi I. V., Lecomte T., Houinato M. and Adandedjan C., 2010. Voluntary ingestion and food preferences in Djallonké sheep fed with grasses and tropical forage legumes grown in Benin. Int. J. Biol. Chem. Science. 4(4): 1030-1043, August 2010

[18] Hadjigeorgiou I. E., Gordon I. J., and Milne J. A., 2003. Comparative preference by sheep and goats for Graminaeae forages varying in chemical composition. Small Ruminant Research 49 (2003) 147–156.

[19] Tshibangu M. I., Kampemba M. F., Kashala K. C., Kiatoko M. H. and Hornick J. L., 2014. Chemical composition and palatability index of the leaves of Adenodolichos rhomboideus Leucaena leucocephala and Stylosanthes guianensis in local goats in Lubumbashi. Int. J. Biol. Chem. Science. 8(3): 937-945, June 2014.

[20] Djennane K., 2016. Identification and study of the nutritional value of spontaneous fodder species in the region of Doucen wilaya of Biskra. Master's degree in agronomic sciences, option Agriculture and Environment in Arid Regions, Mohamed Khider University - Biskra, Algeria, p 154.

[21] Rivière R.., 1991. Feeding of domestic ruminants in tropical environments. Ministry of Cooperation. Paris, France). 529p.

[22] Nantoumé H., Sidibé S., Cissé S., Cinq-Mars D., Kouriba A., Sanogo A., Olivier A. and Bonneville J., 2014. Food preferences of sheep: palatability of the main woody fodder species in the south -eastern Mali. Livestock Research for Rural Development 26 (12) 2014 http://www.lrrd.org/public-lrrd/proofs/lrrd2612/nant26236.htm.

[23] Dumont B., 1996. Food preferences and selection on pasture, INRA Prod. Anim., 1996, 9 (5), 359-366.

[24] Mahaman M. M. O., Chaibou M Abdou D, Abdou Ide B, Sitou I. M., and Mani M. 2017. Evaluation of the digestibility of feed pellets based on cowpea by-products used for fattening sheep. Revue des BioRessources Vol 7 N° 2 December 2017 p1-11.

[25] Kiema A., 2008. Effects of techniques for restoring and exploiting natural Sahelian pastures on the dynamics of fodder production. Unique Doctorate in Rural Development. Polytechnic University of Bobo-Dioulasso (UPB) p 189.

[26] Soumana I., Mahamane A., Gandou Z., Sani M., Wata Sama I., Karimou Ambouta J.-M., and Mahamane S. 2012. Experiences of the Uda'en Fulani of Niger in rangeland management: what implications for environmental policies? Montpellier: CIHEAM / OSS Mediterranean Options: Series B. Studies and Research; not. 68 2012 pages 129-146.

[27] Malam Abdou M., Issa S., Dan Gomma A., and Sawadogo J. G., 2017. Technical–economic analysis of densified feed on the growth performance of red goats from Maradi in Niger. Int. J. Biol. Chem. Science. 11(1): 280-292, February 2017.

[28] Barazi A. A., Chaibou M., Mouctari M. M. O. and Nouhou E. M., 2019. Effect of supplementation of rations with a feed additive on weight growth and carcass yield of Red goat kids from Maradi in Niger. Int. J. Biol. Chem. Science. 13(6): 2487-2496, October 2019.