Comparative study of the nutritive value and productivity of *Desmodium uncinatum*, *Desmodium intortum* and *Brachiaria mutica* in two periods of development, case study of RAB-Musanze

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Abstract: This study intended to compare the nutritive value and productivity of *Desmodium uncinatum*, *Desmodium intortum* and *Brachiaria mutica* in two periods of development in RAB-Musanze. It was found that the energy value for the studied forages decreases among the two periods of development due to the increase of crude fiber content as the plant matures. However, the protein value of forages depends mainly on the nitrogen content of the dry matter of forages. The study reveals that legumes forages (*D. uncinatum* and *D. intortum*) contain more nitrogen and digestible crude protein than grass forage *(B. mutica*). Regarding the mineral value, Phosphorus content decreases from 0.67 to 0.49%, 0.71 to 0.42% and 0.34 to 0.28% respectively for *D. uncinatum, D. intortum* and *B. mutica* in two periods of development and Calcium content decreases from 0.87 to 0.66%, 0.79 to 0.51% and 0.45 to 0.39% for respectively *D. uncinatum, D. intortum* and *B. mutica*. Compare to the Student Test, it showed a highly significant difference between the two periods of development for all studied species for Crude Protein content and only for Phosphorus content for *D. uncinatum*. It was found also that the productivity in tons of DM/ha of the studied species increases from 11.83 to 14.36 t/ha, 14.49 to16.23 t/ha and 9.22 to 10.50 t/ha respectively for *D. uncinatum, D. intortum* and *B. mutica*.

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1. Introduction

Rwanda is a country where 90% of the population depends on agricultural and animal husbandry activities (Mupenzi, et al., 2011ab; MINECOFIN, 2007). The agricultural sector is the base of economical growth of the country where its contribution is estimated about 45 % of the Gross Domestic Product from 2005 up to the year 2010 (MINECOFIN, 2010). It is reported that with more than 11,055,976 inhabitants for a surface of 26,338 km^2 (419.77 inhabitants/km^2), Rwanda's population density is among the highest in Africa (MINECOFIN, 2010, Mupenzi et al, 2011bcd). The country lays out sufficient land susceptible to produce forages of high quality. Rwanda had an area of agricultural lands of about 1,280,751ha which include 21,040ha (1.6%) used for forage crops and 128,008ha (10%) representing uncultivated fields and pasture (MINAGRI, 2008). The sub-sector of animal husbandry contributed for about 8.8% of the Gross Domestic Product (MINECOFIN, 2007) and the main species raised in Rwanda are cattle (991,697 heads), goats (1,270,973heads), sheep (371,766heads), pigs (211,918heads), poultry (2,482,124heads) and rabbits (489,401heads). Livestock productions doesn't satisfy the feeding requirements of the country in terms of animal productions (MINAGRI, 2008).

To satisfy the daily food need and to increase the income of the population, it is necessary to find new methods of food production throughout the intensification of agricultural and animal husbandry activities. The intensification of animal husbandry can refer to the rational respect of the standards of animal production regarding the housing, feeding, reproduction and health state of animals . When all of those factors are strictly joined and controlled, the breeding enterprises become sustainable and give sufficient productions. Therefore, when one of those factors is neglected, it leads to the harmful consequences on animal health and then decreases the productivity. Animal feeding is the largest factor in animal production which needs high skills and food of high quality fed rationally to maintain the animals in good health and to increase the productivity (REBERO *et al*., 2010). Today, animal husbandry faces many constraints especially related to nutritional quality of feedstuffs particularly forages, which become the main factor that limits the animal productivity. The animal will not highlight their genetic potential or stay in good health if the feeding is not good (MINAGRI, 2007). Therefore,

with the national program of intensification of animal husbandry through the breeding in zero-grazing or stall feeding, it seems necessary to implement forage cultures in order to satisfy animal daily need of feeds. In fact, by considering the role of crop forages in animal nutrition and their place in pastures, they constitute the main element in animal feeding. The overall objective of this study was to contribute to the increase of animal productions and provide livestock keepers with scientific advices on the good period of harvesting forages for feeding their animals by considering the nutritive value and the productivity of forages before and after flowering periods.

2. Methodology

2.1. Study area

This research was carried out in Rwanda Agriculture Board (RAB), a government institution established by the Rwandan government law No. 38/2010 on 25th November 2010 to provide research and extension services in order to improve agriculture services delivery. RAB includes the Rwanda Animal Resources Development Authority (RARDA), the Rwanda Agriculture Development Authority (RADA) and the Rwanda Agricultural Research Institute (ISAR). Its main mission is to develop agriculture and animal husbandry through their reform and using new methods in crop and animal production, research, agricultural extension, education and training of farmers in new technologies (MINARI, 2010). The study was taken in Musanze station located in Muhoza Sector, Musanze District, Nothern Province which is responsible for maintaining and increasing the productivity of cultured plants; increase the productivity of animals, ensure the rational use of ground for improved productivity and to ensure a harmonious transfer of research results to users in the region of high altitude. There are different research programs including the program of animal production in which the current research was conducted.

2.2. Materials

Plant materials

This study concerned *Desmodium intortum, Desmodium uncinatum* and *Brachiaria mutica* as biological materials. The plants were cultivated at RAB Musanze agrostological field without using any fertilizer. For laboratory analyses, the samples of forages were made of aerial parts collected before and after flowering stages of development.

Laboratory materials

Different materials were used for performing laboratory analyses of samples as follows: An analytical scale helped to weigh the milled sample needed for analyses where an overall and gloves served for protection of the body during the manipulation.It was also used other chemical products such as EDTA, H_2SO_4, HNO_3, HCl and other where the crucibles served as containers during burning the sample.

Experimental design

The experimental design consisted in 3 blocks which contain *Desmodium intortum, Desmodium uncinatum and Brachiaria mutica* respectively. Each block was sampled in two different times before and after flowering of the plant. The experimental design was made in Randomized Completely Design (RCD) with 2 replications for each plant and for each treatment either before or after flowering development stage.

Sampling

To appreciate the nutritive value and the production, forages were mowed before flowering on the date of 28/09/2011 and after flowering on15/12/2011, in interval of 77days. The sampling was done in quadrate of 50 cm x 50 cm chosen at random in 12 plots corresponding to the treatments. The mowed harvested aerial parts of forages were packaged in bags and transported immediately to the laboratory of the Higher Institute of Agriculture and Animal Husbandry (ISAE in French acronym) for analysis.

Determination of forages productivity

To determine the productivity, fresh forages moved from quadrates (measuring 0.25m^2 each) made on plot were weighed immediately before transporting to the laboratory for drying in order to determine the dry matter (DM) content. After determining the DM content in the samples, the production of fresh forages moved from two quadrates of 0.5m2 was extrapolated on a hectare (ha) and converted in tons to obtain the productivity expressed in tons of dry matter per hectare.

Estimation of Total Crude Protein (TCP)

The KJELDHAL method which consists of the hot demineralization of the sample by sulfuric acid (H_2SO_4) was used. Knowing the quantity (%) of the Nitrogen in the sample, the quantity of Crude Protein was obtained as follows:

N (%) = (T - Bl) x 0.2 x FC x FD (10) x 100/ weight of dry sample x 100, where:

T= ml of H_2S0_4 N/70 flowed to change the color of the solution;

FC=Correction Factor of H_2S0_4 N/70;

FD= Dilution Factor

0.2 mg=Equivalent to 1ml of H_2S0_4 N/70
TCP (%) = % N x 6.25
6.25: Multiplication Factor for forages.

Analysis of Calcium

The calculation of Calcium was done though EDTA method as follows:
Ca (%) = (T - Bl) x 0.2 x FC x FD x 100/ weight of dry sample x 100, where:
T=ml of EDTA flowed to change the color of the titled solution
Bl= ml of EDTA flowed to change the color of the witness solution (Considered as Zero)
FC=Correction Factor
FD= Dilution Factor
0.2 mg= mg of Ca in 1ml of EDTA

Analysis of phosphorus

The Vanado-Molybdate de Hanohiaux method was used to determine phosphorus content in forage as shown by the following formula:
P (%) = (T - Bl) x FC x FD x 100/ weight of dry sample x 100, where:
T-Bl = mg/l read on spectrophotometer at wave length of 410nm, 100% transmittance and 0 absorbance.
FC= Correction Factor of Ammonium Vanado-molybdate
FD= Dilution Factor

Data analysis

The mean value obtained from laboratory analyses of forages were subjected to the Student Test (T-Test) to find out statistically significant relationship between the results obtained before and after flowering periods of plant development for tested forages.The following formula were used:

- Sample variance: $S^2 = \sum i \frac{\left(Xi - \bar{X}\right)^2}{(n-1)}$ and $\Sigma i (Xi - \bar{X})^2$= Sum of square,

where, n is the number of observations and (n-1) is the degree of freedom

- Standard deviation:
- $S = \sqrt{S^2} = \sqrt{\sum i \frac{\left(Xi - \bar{X}\right)^2}{(n-1)}}$
- Calculated t value:
- $tc = \frac{m_1 - m_2}{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}} = \frac{m_1 - m_2}{\sqrt{\frac{n_2 S_1^2 + n_1 S_2^2}{n_1 . n_2}}}$

Where,
m_1 is mean of sample from pond 1; m_2 is mean of sample from pond 2 and; tc: the calculated t value.

The calculated t-value was compared with t-table value (appendix 2) at the significant level of 5% (P= 0.05).

In case of tc > t-table value, there is a significant different and when tc ≤ t-table value, there is no significant difference.

3. Results and discussion

3.1 Chemical composition of forages before and after flowering period

The results obtained by species in two periods, are presented in table 2 below.

The results in table 2 show a decrease of the main nutritive values (CP, Ash, Ca and P) during the flowering period except the contents of Crude Fiber and Dry Matter which increase as the plants mature.

3.2 Comparison of chemical compositions of forages before and after flowering

The comparison of chemical compositions was done using the Test of Student (T-test) that compares two means. The results of those comparisons of means from the table 2 are shown in table 2 below.

For *Desmodim uncinatum*, the results presented in table 2 shows that there is a significant difference in chemical composition for Crude Protein, Crude Fiber and Phosphorus because the calculated T-values are greater than T-table values. However, for *Desmodium intortum*, it shows that there is a significant difference for Crude Protein and Crude Fiber for the same reason as *Desmodium uncinatum*. Lastly, for *Brachiaria mutica,* the significant difference is registered for only the Crude Protein content between the two periods of development.

The figure 1 shows that for *D. uncinatum*, the DCP content is high before flowering period (144.91g/kg DM) and decreases to 56.96g/kg of DM after flowering period. The figure also shows that other values decrease after flowering period except the Dry Matter content which increases as the plant matures.

The figure 2 shows that for *D. intortum*, the DCP content is also high before flowering period (139.63g /kg DM) and decreases to 51.29g/kg DM after flowering period. The figure also shows that other values decrease after flowering period except the Dry Matter content which increases as the plant matures.

Table 1 Means values of the chemical composition of studied forages in two periods

Species	Period	Replication	DM (%)	CP (%)	Ash (%)	CF (%)	Ca (%)	P (%)
D. uncinatum	BF 28/09/2011	1	30.05	19.69	10.60	20.08	0.91	0.66
		2	29.12	19.10	9.20	19.21	0.83	0.68
		Mean	**29.58**	**19.39**	**9.90**	**19.61**	**0.87**	**0.67**
	AF 15/12/2011	1	35.14	10.38	9.11	27.84	0.69	0.49
		2	34.90	10.10	8.88	28.04	0.63	0.50
		Mean	**35.02**	**10.24**	**8.99**	**28.44**	**0.66**	**0.49**
D. intortum	BF 28/09/2011	1	38.66	18.61	12.90	18.34	0.77	0.70
		2	37.22	19.04	10.10	19.00	0.82	0.72
		Mean	**37.94**	**18.82**	**11.50**	**18.67**	**0.79**	**0.71**
	AF 15/12/2011	1	41.05	9.51	9.61	29.00	0.52	0.39
		2	40.95	9.12	9.11	29.92	0.51	0.45
		Mean	**41.00**	**9.31**	**9.36**	**29.46**	**0.51**	**0.42**
B. mutica	BF 28/09/2011	1	24.09	11.87	8.22	29.1	0.46	0.39
		2	24.67	12.05	8.00	30.05	0.45	0.30
		Mean	**24.53**	**11.96**	**8.11**	**29.57**	**0.45**	**0.34**
	AF 15/12/2011	1	26.83	5.90	7.40	35.40	0.39	0.30
		2	25.91	6.06	6.21	36.81	0.40	0.27
		Mean	**26.92**	**5.98**	**6.80**	**36.10**	**0.39**	**0.28**

Table 2: Comparisons of chemical compositions of forages in two periods

Forages	Chemical composition and Test values											
	DM		CP		TA		CF		Ca		P	
	Tc	Tt	Tc	Tt	Tc	Tt	Tc	Tt	Tc	Tt	Tc	Tt
D. uncinatum	11.33	12.71	28.067	12.71	1.15	12.71	12.79	12.71	4.2	12.71	14.69	12.71
D. intortum	3.26	12.71	32.75	12.71	1.57	12.71	14.58	12.71	10.58	12.71	9.17	12.71
B. mutica	3.85	12.71	49.66	12.71	2.16	12.71	6.66	12.71	6.0	12.71	1.25	12.71

Legend: Tc= Calculated T-value; Tt= T- table value

3 .3 Comparison of nutritional value

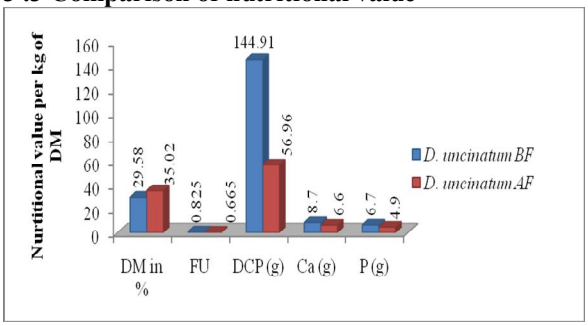

Figure 1 Comparison of nutritional value for *D. uncinatum*

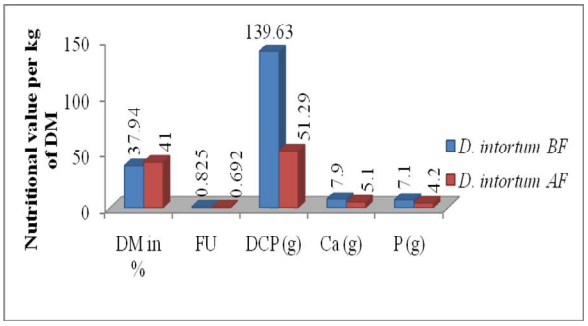

Figure 2 Comparison of nutritional value for *D. intortum*

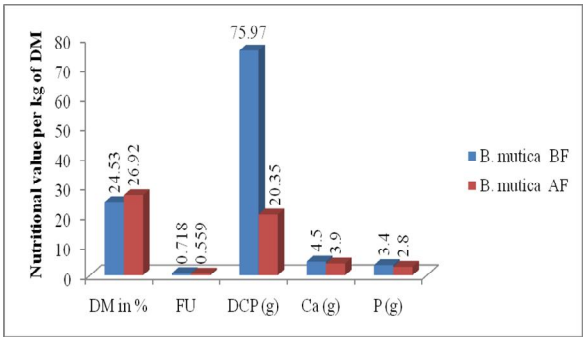

Figure 3 Comparison of nutritional value for *B. mutica*

The figure 3 above shows that for *B. mutica*, the DCP content is high before flowering period (75.97g/kg of DM) and decreases to 20.35g/kg of DM after flowering period. The figure also shows that other values decrease except for the Dry Matter content which increases as the plant matures.

3.4 Comparison of the productivity of studied forages among two periods of plant

The comparison of productivity was done by using statistical histograms. It concerns two periods of development for each forage species as shown on figures 3 and 4.

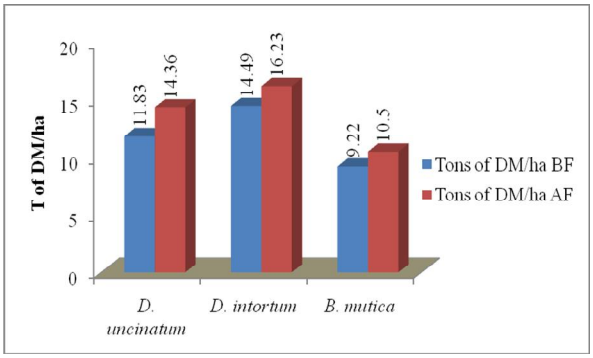

Figure 3 Comparison of the productivity in tons of DM/ha

In the two periods of development, the productivity in tons of Dry Matter per hectare increases with the maturity of the plants as shown on the figure 4.

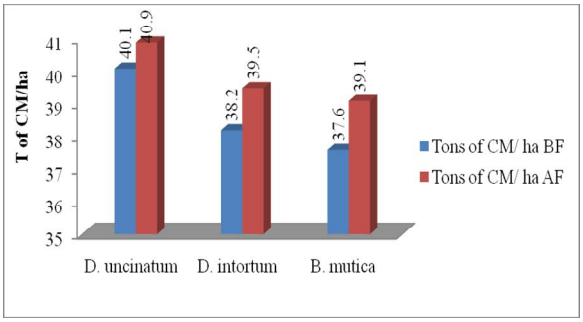

Figure 4. Comparison of the productivity in tons of CM/ha

The figure 4 shows that in the two periods of development, the productivity in tons of Crude Matter per hectare also increases with the maturity of the plants.

3.5 Nutritional value

3.5.1 Energy value

The study reveals through laboratory analyses that the energy value of the studied forages varies depending on the period of development (before and after flowering) from 0.825 to 0.665 FU, 0.825 to 0.692 FU and 0.718 to 0.559 FU respectively for *D. uncinatum, D. intortum* and *B. mutica*. These results found in the study are coherent with those of FAO (1988), which state that for the tropical forages the energy value declines with the maturity of the plants but less effect has been found in legumes. FAO (1990), also states that the study carried out on 540 tropical grasses found that the energy value decreases as the plant matures. This decrease of energy value is due the high inclusion of fiber as the plants mature. In this regard, the analysis of data on chemical composition of studied forages found that the Crude Fiber content in dry matter was increased from 19.61 to 28.44%, from 18.67 to 29.46% and from 29.57 to 36.10% respectively for *D. uncinatum, D. intortum* and *B. mutica*. However, the statistical comparison reveals a non significant difference in Crude Fiber content for the studied forages in two considered periods of development. The results of the study are reported that the crude fiber content has been determined in many tropical legumes and grasses and found the mean of 30.6% for legumes and the mean of 34.8% for grasses. According to this author, the crude fiber content of legumes tends to increase with the increasing maturity.

3.5.2. Protein value

Regarding the results of analysis of data on chemical composition before and after flowering of studied forages, the protein value determined in terms of Digestible Crude Protein (DCP) has decreased from 144.91 to 59.96 g/Kg of DM, 139.63 to 51.29 g/Kg of DM and 75.97 to 20.23 g/Kg of DM respectively for *D. uncinatum, D. intortum* and *B. mutica*. The results of this study are in close agreement with the findings registered by other researchers. FAO (1990), reported that the concentration of crude protein of tropical grasses grown and determined in different parts of the world, ranged from 2 to 27% of the dry matter according to the stage of growth and level of soil fertility with a mean of 10.6%. As grasses mature, there is usually a decrease in the crude protein percentage. This decrease is caused by an increase in the proportion of stem which has lower protein content than the leaf fraction. The crude protein content in both leaf and stem fractions decreases with age of the plant.

3.5.3. Mineral Value

The study shows that the mineral value of studied species also decreased with the maturity of the plants. The Phosphorus was decreased from 0.67 to 0.49%, 0.71 to 0.42% and 0.34 to 0.28% respectively for *D. uncinatum, D. intortum* and *B. mutica* in two considered periods of development. However, the statistical comparison revealed a non significant difference among the two periods of development for those studied species except *D. uncinatum* for which the difference detected was significant. Note that increasing maturity leads to a decrease in phosphorus content, while increasing the level of fertilization with superphosphate increases the phosphorus content in legumes. A major factor causing differences in Phosphorus content of forage is the stage of growth. The mean of Phosphorus level was 0.31% at the beginning of the wet season and fell to 0.08% during the following eight months as the forage matured. It was revealed that Calcium was

decreased from 0.87 to 0.66%, 0.79 to 0.51% and 0.45 to 0.39% respectively for *D. uncinatum, D. intortum* and *B. mutica* and the statistical comparison showed a non significant difference between the two considered periods of growth (before and after flowering) for all those above mentioned species.

3.5.4 Productivity

The results obtained during this study revealed that the productivity in tons of DM/ha of the studied species increased from 11.83 to 14.36 t/ha, 14.49 to16.23 t/ha and 9.22 to 10.50 t/ha for respectively *D. uncinatum, D. intortum* and *B. mutica*. The increase of the productivity in DM/ha is explained by the fact that the Dry Matter content in the plant tends to increase as the plant is advanced in age.

4. Conclusion

The current research was carried out on two legumes forages (*Desmodium intortum* and *Desmodium uncinatum*) and on one grass forage (*Brachiaria mutica*) in order to assess their nutritive value and productivity in two periods of development namely before and after flowering. The study should recommend to the Rwanda's livestock keepers, representing 70% of 1674687 agricultural households registered by NAS (2008), a good period to harvest forages and meet their maximum nutritional quality and productivity which allow the farmers to get from their animals the optimum production. Some farmers feed their animals without considering the nutritive value of the feeds, so that the production remains too low. For that reason, they need more information about nutritional quality of feedstuffs.

Acknowledgements

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