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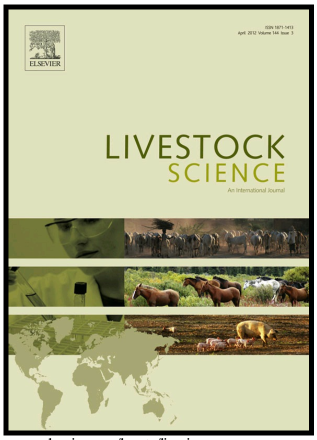

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Natural gastro properties of *Ficus natalensis, Rhuss natalensis* and *Harrisonia abyssinica* in native East African goats

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Abstract

The natural gastro properties of *Ficus natalensis*, *Rhuss natalensis* and *Harrisonia abyssinica* was evaluated with the objectives of determining the rumen degradation properties. Results showed that *H. abyssinica* presented the highest DM disappearance from the nylon bags throughout the different incubation times followed by *F. natalensis* and *R. natalensis* showed the lowest. The DM readily available soluble fraction (*a*), insoluble but degradable fraction (*b*), degradation rate (*c*), potential degradability (PD) and effective degradability (ED) differed significantly (P<0.05) across the three browse species. The CP *a*, *b*, PD and ED fractions differed significantly (P<0.05) across the three browse species. The CP c fraction was similar across the browse species. The NDF *a*, *b*, PD, and ED fractions differed significantly (P<0.05) across the browse species. The NDF *c* fraction was not different across the browse species. In conclusion, *Rhuss natalensis* subsp. *romantica* has inferior rumen degradability properties, an

indication of low nutritive value for goats compared to *Harrisonia abyssinica* subsp. *abyssinica* and *Ficus natalensis* subsp. *Natalensis.*

Keywords: Browse species; *Ficus natalensis*; *Harrisonia abyssinica*; *Rhuss natalensis;* Rumen degradability;

1. Introduction

Native browse species offer an opportunity to provide healthier meat as opposed to other feed resources (Pearce *et al.,* 2010). These browse plants are drought and disease resistant, readily available in the communities and therefore build resilience for goat small holder farming systems.

Goats are a suitable livestock for resource-poor farmers (Devendra, 2006) because they require less space, less feed and low initial cost compared to large animals. Hence they have an important role in ensuring food security, income generation and employment for the resource-poor (Peacock, 2005). Despite the positive role of goats to the socio-economic well-being of resource-poor, the productivity of goats is low (Devendra, 2010). The low productivity of goats is mainly attributed to poor nutrition, which is brought about by inadequate feed resources especially during the dry conditions (Ben Salem and Smith, 2008). Leaves of browse plants have been reported to have the potential to support goat production during periods of scarcity since they maintain sufficient levels of protein (Yayneshet *et al*., 2009; Safari *et al*., 2011) even during the dry season. This is because of their ability to remain green and hence maintain their nutritional value long in the dry season (Safari *et al*., 2011). However, information on the natural properties in the rumen of small ruminants of most locally available browse plants is inadequate.

In Uganda, several studies (Kabasa *et al*., 2004; Tabuti and Lye, 2009) have reported the availability of browse plants such as *F. natalensis, R. natalensis*, *H. abyssinica*, *Acacia* *sieberiana, Acacia senegal etc.* However, there is inadequate information on the natural gastro properties of these browse plants. The available information is from other regions and is largely limited to nutrient composition. The CP and NDF values for the browse plants reported by Abdulrazak *et al*. (2000), Rubanza *et al.* (2005a, 2005b and 2006) Kendric *et al*. (2009), Nsahlai *et al*. (2011) and Abebe *et al*. (2012) range between 53 – 238g/kg DM and 245 – 494g/kg DM, respectively. A full understanding of the natural gastro properties of these browse plants would afford the opportunity of a better and efficient utilisation of these locally available browse plants to increase goat production in Uganda. The objective of this study was to determine the natural gastro properties of *F. natalensis*, *H. abyssinica* and *R. natalensis* leaves as feed for indigenous goats, through determining their rumen degradation properties.

2. Materials and methods

All the procedures performed in this study involving animals were in accordance with the internationally accepted welfare standards for animal experimentation

2.1. Location and climate of the study area

This study was conducted in Buyende district, Uganda. The district is located between 1°14- 1°29N and 1°28- 33°16E at an altitude of 1,083 m above sea level. The area has a bimodal rainfall pattern with March to May and September to November as the first and second rain seasons respectively. The average annual rainfall is 1200 mm. The mean daily maximum and minimum temperatures of the area are about 28^{o}C and 16^{o}Crespectively.

2.2 Collection of samples of browse species

Samples of browse species were collected from Kidera sub-county. Leaves were collected from three browse speciesncn, namely *F. natalensis*, *H. abyssinica* and *R. natalensis*. The three browse species are among the most common and preferred by farmers in the area. The leaves were harvested during the dry (June - August) seasons. For each browse species, leaves were harvested from at least 5 randomly selected trees. The leaves chosen contained all the categories, since the goats eat all the leaves they come across regardless of their position (upper part, lower part, close to the stem). The harvested leaves were bulked, thoroughly mixed and thereafter two sub-samples were drawn. For each season, 4 samples were collected at intervals of 21 days. This resulted in a total of 4 samples per browse species for the season. On each day of sample collection, sampling started between 08:00 and 09:00 hours and lasted 30 minutes. After collection, the samples were placed in plastic bags, sealed, labeled pending transportation to the laboratory for weighing and oven drying. After oven drying (at 60^{o}C for 48 hours), the samples were weighed and divided into two sub-samples: one for chemical analysis and the other for rumen degradability determination.

2.2. Rumen DM degradability

The samples of each browse species from the dry season designated for rumen degradability determination were bulked and ground using a 2mm screen. Two grams of the ground samples were weighed in triplicate into labeled weighed nylon bags with a pore size of 36µ. Following the recommendations of Osuji *et al*. (1993) the nylon bags were incubated in the rumens of three fistulated mature indigenous ewes weighing 18kg (S.D. 1.0). The ewes were fitted with permanent rumen cannulae with an internal diameter of 5cm. The ewes were left to graze freely in a paddock containing mainly *Commelina benghalensis*, *Panicum maximum* and *Digitaria* *abyssinica*. The ewes also had free access to clean drinking water and mineral licks on a daily basis. The nylon bags were withdrawn at 3, 6, 12, 24, 48 and 72 hours after insertion. Using the sequential addition method, 9 bags were incubated in the rumen of each ewe at a time. The 0 hour measurement was estimated by washing triplicate bags under clean running tap water until the water squeezed out of them was colourless. Following removal from the rumen, the bags were washed as described above and then oven dried at 60^{o}C for 48 hours and weighed immediately.

Using the PROC NLIN procedure of SAS the DM degradation data was fitted to the equation $Y = a + b\,(1- e^{-c(t\text{-lag time})})$ (McDonald, 1981) to determine the degradation characteristics (*a*,*b*,*c* and lag time); where Y is the DM degradation at time *t*, *a* the soluble fraction of the feed (Zero intercept), *b* the slowly degradation, *a* + *b* the potential degradability (PD) of the feed when time is not limited and *c* the rate of degradation of the slowly degradable fraction. The effective degradability (ED) of the DM was calculated using the equation of AFRC (1993), assuming a rumen out flow rate of 0.02 per hour.

2.4. Chemical analysis

The samples designated for chemical composition were ground using a 1mm screen. The samples were analyzed for CP (AOAC, 1990). NDF was determined according to Van Soest and Robertson (1985).

2.5. Statistical analysis

All data analyses were carried out using SAS (2003). To compare rumen DM degradation parameters between the forages, the following statistical model was used: $Y_{ij} = \mu + B_i + e_{ij}$, where Y_{ij} is the dependent variable, μ is the overall mean effect, B_i is the browse effect and e_{ij} is the random error.

3. Results

Rumen DM, CP and NDF degradation

The DM readily available soluble fraction (*a*), insoluble but degradable fraction (*b*), degradation rate (*c*), potential degradability (PD) and effective degradability (ED) differed significantly (P<0.05) across the three browse species (Table 1). The DM *a* was highest (P<0.05) in *H. abyssinica* (478g/kg) followed by *R. natalensis* (418g/kg) and lowest (P<0.05) in *F. natalensis* (378g/kg).The DM *b* was highest (P<00.05) in *F. natalensis*, but not different between *H. abyssinica* and *R. natalensis*. The DM *c* was highest (P<0.05) in *H. abyssinica* but not different between *F. natalensis* and *R. natalensis.* The DM PD was highest (P<0.05) in *H. abyssinica* (848g/kg) and *F. natalensis* (793g/kg). The DM ED was highest (P<0.05) in *H. abyssinica* (743g/kg) followed by *F. natalensis* (632g/kg) and lowest (P<0.05) in *R. natalensis* (608g/kg).

The CP *a*, *b*, PD and ED fractions differed significantly (P<0.05) across the three browse species. The CP c fraction was similar across the browse species. The CP *a* fraction was highest (P<0.05) in *R. natalensis* (337g/kg) followed by *F. natalensis* (283g/kg) and lowest (P<0.05) in *H. abyssinica* (233g/kg). The CP *b*and ED fractions were highest (P<0.05) in *H. abyssinica* followed by *F. natalensis* and lowest (P<0.05) in *R. natalensis*. The NDF *a*, *b*, PD, and ED fractions differed significantly (P<0.05) across the browse species. The NDF *c* fraction was not different across the browse species. The NDF *a* fraction was highest (P<0.05) in *R. natalensis* (62g/kg) but not different between *F. natalensis* (27g/kg) and *H. abyssinica* (11g/kg). The NDF *b* fraction was lowest (P<0.05) in *H. abyssinica,* but not different between *F. natalensis* and *R. natalensis*. The NDF ED was highest (P<0.05) in *F. natalensis* (464g/kg), followed by *H. abyssinica* (410g/kg) and lowest (P<0.05) in *R. natalensis* (335g/kg).

4. Discussion

4.3. Rumen DM, CP and NDF degradation

The effective DM, CP and NDF degradabilities for *R. natalensis* were significantly lower than those of *F. natalensis* and *H. abyssinica.* This is partly attributed to the high fibre fraction (NDF, ADF and ADL) of *R. natalensis* compared to *F. natalensis* and *H. abyssinica* as well as other factors not measured in the present study, for instance the presence of condensed tannins. Condensed tannins have been reported to have a greater negative effect on degradability than NDF and ADF (Frutos *et al*., 2004, Nshahlai *et al*., 2011; Sebata *et al*., 2011). Abebe *et al.* (2012) reported up to 224.5 g/kg DM of condensed tannins in *R. natalensis* compared to the total tannin content of 60g/kg DM reported by Kendrick *et al*. (2009) in *F. natalensis*. High fibre has a negative relationship with rumen degradability (Abdulrazak *et al*., 2000; Kamalak *et al*., 2005). Similarly, Gasmi–Boubaker *et al*. (2005) reported a negative relationship between lignin concentration and extent of digestion of forages. Lignin is an indigestible fraction and inhibits the access of microbial enzymes to the structural polysaccharides (Van Soest, 1994).

Although the chemical composition was comparable to that reported by Abebe *et al*. (2012) and Bamikole *et al*. (2004) for *R. natalensis* and *Ficus species,* the degradation characteristics were different. For *R. natalensis,* Abebe *et al*. (2012) reported values lower by 20 and 26% than those observed in this study for DM *a* and ED, respectively. For *Ficus species,* Bamikole *et al*.

(2004) reported values lower by 26 and 35% than those observed in this study for DM *b* and ED respectively. The differences may be attributed to other factors not measured in the present study. Data on degradation characteristics of *H. abyssinica* are unavailable. Basing on the DM, CP and NDF degradation characteristics, *F. natalensis* and *H. abyssinica* are of a superior nutritional quality to *R. natalensis*.

5. Conclusion

In conclusion, *Rhuss natalensis* subsp. *romantica* has inferior rumen degradability properties, an indication of low nutritive value for goats compared to *Harrisonia abyssinica* subsp. *abyssinica* and *Ficus natalensis* subsp. *Natalensis*. Further research is needed to determine how best *H. abyssinica* and *F. natalensis* can be used as nitrogen supplements for goats.

Conflict of interest

The authors report that there is no conflict of interest relevant to this publication.

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Table 1. Rumen degradability parameters of the browse species

	Ficus nantalensis	*Harrisonia abyssinica*	*Rhuss nantalensis*	SE	Significance level
DM					
Readily available fraction,g/kg	378^{c}	478^{a}	418^{b}	5.4	***
Slowlydegradable fraction,g/kg	415^{a}	370^{b}	317^{b}	17.9	*
Degradation rate, per hour	0.032^{b}	0.05^{a}	0.032^{b}	0.004	*
Lag time, hours	0.92^{b}	0.21^{b}	6.71^{a}	1.05	**
Potential degradability, g/kg	793^{ab}	848^{a}	735^{b}	13.5	**
[#]Effective degradability, g/kg	632^{b}	743^{a}	608^{c}	2.2	***
CP					
Readily available fraction,g/kg	283^{b}	233^{c}	337^{a}	7.5	***
Slowlydegradable fraction,g/kg	516^{b}	664^{a}	365^{c}	32.6	**
Degradation rate, per hour	0.04	0.05	0.032	0.006	NS
Lag time, hours	0	0	0	0	-
Potential degradability, g/kg	799^{ab}	897^{a}	702^{b}	31.8	*
[#]Effective degradability, g/kg	610^{b}	708^{a}	558^{c}	3.1	***
NDF					
Readily available fraction, g/kg	27^{b}	11^{b}	62^{a}	5.03	*
Slowlydegradable fraction, g/kg	581^{a}	469^{b}	500^{ab}	14.7	*
Degradation rate, per hour	0.061	0.123	0.024	0.02	NS
Lag time, hours	1.24	3.20	3.99	1.3	NS
Potential degradability, g/kg	608^{a}	480^{b}	562^{a}	10.4	**

#Effective degradability, g/kg	464^{a}	410^{b}	335^{c}	6.6	**

#Effective degradability calculated assuming a ruminal flow rate of 0.02/h (AFRC, 1993)

^{abc}Means within rows with different superscripts are significantly different (P<0.05)

*P<0.05; **P<0.01; ***P<0.001; NS Not Significa

Research highlights.

- The natural gastro-enteric properties of *Ficus natalensis*, *Rhuss natalensis* and *Harrisonia abyssinica* leaves was evaluated.
- This was done by determining their chemical composition, rumen degradation, DM intake and digestibility.
- *Rhuss natalensis* was of an inferior nutritive value for goats compared to *Harrisonia abyssinica* and *Ficus natalensis*.