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Nutritive Value of Major Browse Species in East Dembia District, Central Gondar, Ethiopia

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ABSTRACT

Background: Regardless of having ample number of farm animals, its contribution to GDP is limited due to insufficient year round livestock feed supply in terms of quantity and quality, particularly during the dry season. This study was conducted to assess the most commonly used browse species as livestock feed particularly during dry period and to determine their nutritive value from four kebeles of East Dembiya district.

Methods: Stratified random sampling was used for the selection of respondents. A total of 12 plots of 20m *20m (400m^2) were established at an interval of 200m along the transect line to identify and record the available browse species. The leaves and petioles of *A. abyssinica, C. africana, F. thonigii, F. sycomorus, V. amygdolina, M. arbutifolia* and *A. seyal* were collected for chemical analysis. General linear model procedure of SAS was used for statistical analysis.

Result: The mean CP content of the browse species ranged from 12.13% (*F. sycomorus*) to 29.74% (*V. amygdolina*). The IVDMD varied from 38.5% for *M. arbutifolia* to 71.67% for *F. sycomorus*. High gas production from immediately soluble component (a) was recorded for *C. africana*. The gas production from insoluble but potential degradable fraction (b), production potential (a+b) and organic matter digestibility were higher for *F. thounigii* but low for *V. amygdolina*. The browse species in the current study could be used as protein supplements to livestock fed on low quality feeds due to their high levels of crude protein, low fiber contents and high digestibility potentials.

Key words: Browse species, Crude protein, *In vitro* dry matter digestibility, Nutritive value.

INTRODUCTION

Background and Justification

Ethiopia's national economy mainly relay on agriculture, which shares for more than 80% of income of the population (Alemayehu, 2002). Livestock production is one of the major area in the agricultural sector providing draught power, meat, milk and other products, serves as a source of additional income both for smallholder farmers and livestock owners' (Jonah, 2004). In Ethiopia (Ahmed *et al*. 2010) indicated that regardless of having ample number of farm animals, its contribution to GDP is limited to 20% and per unit productivity is quite low. The main challenge to such low productivity is insufficient year round livestock feed supply in terms of quantity and quality, particularly during the dry season (EARO, 2000). In the mixed crop-livestock farming systems of the Ethiopian highlands, feed resources accessible for livestock production are obtained from permanent marginal pastures and seasonal pastures between cropping cycles, crop residues and crop aftermath grazing. However, these feed resources are very low in protein content and essential bioactive compounds, having high fibre, with low to moderate digestibility which adversely affects the animal health, milk and meat production (Tsige-Yohanes, 2000). This calls for an action to be taken to fill gap and serve as a bridge between the dry and wet seasons. Hence to overcome the inadequate supply of green fodder during the dry season, action to be taken to explore the new feed resources for livestock production. Thus, the use of browse species has great potential and a paramount importance to alleviate the problem of feed supply. Browse species could be used as a short-term measure when the period shifts from wet to dry seasons since they stay green (Teferi, 2006). They play a very prominent role in areas where moisture is inadequate (Gelayenew *et al*., 2016). These browse plants contain appreciable amounts of nutrients that are deficient in other feed resources such as crop residues during dry periods (Megersa *et al*., 2017). East Dembiya district, where this study was carried out, is characterized by mixed crop-livestock production, woyna-dega climatic condition and sources of ample browse species. Browse species play a key role in providing and making a large contribution to livestock nutrition as they depend on such species during dry season. In spite of the availability of the indigenous browse species as livestock feed, little research has so far been done which assessed the extent of its utilization,

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inventory of the major species and evaluation of the potential nutritive values. Therefore, this study was conducted to assess the available feed resources, identify the major browse species and to determine the chemical composition and *in vitro* gas production and digestibility of the major browse species for livestock in the study area.

MATERIALS AND METHODS

Description of the study site

East Dembiya district is situated at 37° 09′ 60.00″ E longitude and 12°39′ 59.99″ N latitude and bordered with Gondar town in the North Alefa in the west and part of Lake Tana in the south. Its altitude ranges from 1370 to 1950 meter asl and the main rainy seasons of the area occurs from June to mid of September, while the dry season spells from November to April.

Survey data collection

Data collection techniques and selection of the study site and sampling methods

Primary and secondary sources were used to collect the data. The actual household survey was conducted from September to late October 2017/2018 with a pre-tested questionnaire. East Dembiya district consists of 30 farmer kebeles, out of which 4 kebeles (Sufankara, Grargie, SaljGebeba and AtkilitTeleft) were selected purposively for the study. Those kebeles were selected based on the availability, accessibility and abundance of browse species.

Household and key informants selection

A total of 120 respondents were selected by using Yemane's sample size determination formula (Yemane, 1967).

$$n = \frac{N}{1+N\ (e2)}$$

Where,

n= sample size; N= total number of household and e= sampling error.

Identification and sampling of browse species

A reconnaissance survey of the study area was made before the actual data collection. The available browse species were listed and major browse species were ranked according to animal preference and availability at each selected kebele. Along two transects, each 1.5km in length, a total of 12 plots were established for the sampling of browse species. At 200m interval over the transect line, quadrates of 20*20m (400 m^2) were used for collecting the sample.

Browse species sample collection and preparation for chemical analysis

For chemical analysis of the browse species, the sample were hand plucked with a mixture of leaves and petiole, a combined sample of 1.5 kilogram on fresh bases from ten plants were used. Samples were first dried under shade then oven dried at 65°C to constant weight for chemical analysis. Thereafter, the samples were separately ground in a Willey mill to pass through 1mm sieve. Then, the samples were kept in air tight plastic bags pending further analysis.

Chemical analysis

Dry matter and ash contents of samples of browse species were determined according to the procedures of AOAC (2005). Kjeldahl method (AOAC, 2005) was used to determine total nitrogen (N) and crude protein (CP) was calculated as N x 6.25. Neutral detergent fiber (NDF) was analyzed using the detergent extraction method as described by Van Soest *et al*. (1991) and acid detergent fiber (ADF) and acid detergent lignin (ADL) were analyzed according to Van Soest and Robertson (1985) using Ankom fiber analyzer.

In vitro dry matter digestibility

In vitro dry matter digestibility (IVDMD) of the samples of browse species was determined by the method of Tilley and Terry (1963) as modified by Van Soest and Robertson (1985).

In vitro gas production

Samples of the browse species were incubated *in vitro* with rumen fluid in calibrated glass syringes following the same procedures as of Menke and Steingass (1988).

Statistical analyses

Survey data was analyzed by using descriptive statistics using SPSS statistical software (SPSS, version 15). Data from the chemical composition, IVDMD and gas production of most commonly utilized browses were subjected to one-way analysis of variance (ANOVA) procedure using SAS software version 9.2 (SAS, 2002). Significant differences between individual means were declared using the least significant difference (LSD). The model used for the analyses of chemical composition, *in vitro* dry matter digestibility and *in vitro* gas production was:

$$Yij = \mu + bi + eij$$

Where,

Yij= response variable; μ= overall mean; bi= browse species and eij= the random error.

RESULTS AND DISCUSSION

Dominant browse species

The browse species in order of relative dominance in the study area is presented in Table 1. The availability of browse

Table 1: Availability of dominant browse species in the study area.

Species	Index	Rank
M.arbutifolia	0.21	1
A. seyal	0.20	2
F. thoungii	0.19	3
V. amygdolina	0.13	4
A. abyssinica	0.12	5
C. Africana	0.07	7
F. sycomorus	0.08	6

Index = sum of (4 times first order + 3 times second order + 2 times third order + 1 times fourth order) for individual variables divided by the sum of (4 times first order + 3 times second order 2 times third order + 1 times fourth order) for all variables.

species used as feed for livestock was not the same throughout the study area. In a sense, *Maytenus arbutifolia*, *Acacia seyal* and *Ficus thounigii* were more dominant followed by *Vernonia amygdolina*and *Acacia abyssinica*.

Nutritive Values of Browse Species

Chemical composition and *in vitro* dry matter digestibility of browse species

The chemical composition of the major browse species (leaves and petioles) are presented in Table 2. CP content varied significantly between species (*P<0.05*).The mean crude protein content of the browse species ranged between 12.13% for *F. sycomorus* to 29.74% for *V. amygdolina*. The CP content of browse species obtained in the present study was in accordance with the range (12.5%-31.9%) reported by Getachew (2002) in Ginchi watershed Area. Most of the Ethiopian dry forages and roughages analyzed earlier had a CP content of less than 9%, which implies that the microbial requirement can hardly be met unless supplemented with protein rich feeds (Seyoum and Zinash, 1989). Thus, the high CP content in all the evaluated browse species in this study (12.13-29.74%) suggested that these species have a potential for supplementing protein to poor quality feeds.

The NDF concentration for the browse species varied (*P<0.05*) and was between 20.93% (*V. amygdolina)* to 47.51% (*C. africana)*. The observed differences in NDF content between species is probably due to the effect of species variability, ability of the soil to supply nutrients to the plant, maturity of the plant (Upreti and Shrestha, 2006), as well as the proportion of different browsed components in the harvested samples. The NDF contents of the browses in the current study lie below the critical value of 60% which was indicated by Reed and Goe (1989), hence may resulting in increased voluntary feed intake, feed conversion efficiency and shorter rumination time.

The IVDMD range varied from 38.5% for *M. arbutifolia* to 71.67% for *F. sycomorus*. The IVDMD values for *F. thoungii* (51.09%) and *F. sycomorus* (71.67%) were higher than the result obtained by Kassahun (2011). This variation might be due to various factors like harvesting regimen, season and location. The variability in IVDMD of browse species also could be partly due to the differences in CP, NDF, ADF and ADL contents.

In vitro gas production of major browse species

Fig 1 shows gas production at various incubation time (ml/ 200mg DM) of the browse species examined. *Ficus thoungii* had the highest gas production while, *Vernonia amygdolina* had the lowest. The amount of gas produced when feeds are incubated *in vitro* has been reported to be closely associated to digestibility of feed for ruminants (Mebrahtu and Tenaye, 1997). Babiyami *et al*. (2004) explained that the variation in gas production probably be due to the variability in nature and level of fibre, potency of the rumen liquor for incubation and the presence of secondary metabolites.

In vitro gas production parameters of the major browse species is presented in Table 3. Gas production from

Table 2. Mean chemical composition and *in vitro* dry matter digestibility of browse species (%LDM).

Browse species	Lab DM%	Ash (%)	CP (%)	NDF (%)	ADF (%)	ADL (%)	IVDMD (%)
V. amygdolina	91.55^{abc}	12.77^{b}	29.74^{a}	20.93^{d}	12.10^{b}	3.98^{d}	47.33^{cd}
F. thoungii	92.55^{ab}	14.79^{ab}	15.87^{ef}	44.69^{ab}	32.29^{a}	11.27^{ab}	51.09^{bc}
C. Africana	94.17^{a}	14.82^{ab}	18.13^{de}	47.51^{a}	32.35^{a}	13.38^{a}	65.65^{a}
F. sycomorus	94.61^{a}	17.03^{a}	12.13^{f}	38.76^{abc}	27.41^{a}	10.94^{abc}	71.67^{a}
A. seyal	93.67^{ab}	9.95^{c}	20.76^{cd}	36.72^{bc}	26.23^{a}	14.36^{a}	42.59^{ed}
M. arbutifolia	90.79^{bc}	7.90^{c}	27.01^{ab}	34.60^{bc}	24.91^{a}	7.31^{bcd}	38.5^{e}
A. abyssinica	89.05^{c}	14.03^{b}	24.44^{bc}	32.12^{c}	16.03^{b}	4.93^{dc}	57.14^{b}
Mean	92.34	13.04	21.15	36.48	24.48	9.45	53.42

Column means with different superscript letter is significantly different (P<0.05).

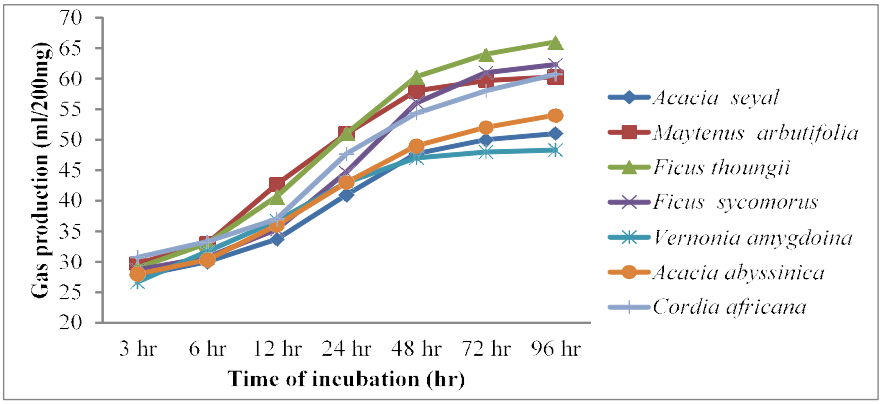


Fig 1: *In vitro* gas production (ml/200mg DM) of browse species at different incubation time.

insoluble but potential degradable portion (b) ranged between 26.1 for *V. amygdolina* and 42.17 for *F. thoungii*. Slowly fermentable fraction ('b' value) of browse species observed in this study was within the range values (18.18-64.93) reported by Mahala and Elseed (2007). The gas production potential ranged between 48.16 for *V. amygdolina* to 66.42 for *F. thoungii*. Osuga *et al*. (2006) argued that variation in potential gas production of the browse species could be attributed to difference in chemical composition, more importantly to CP and fibre components.

Organic matter digestibility, short chain fatty acids and metabolisable energy of major browse species

Metabolisable energy (ME), organic matter digestibility (OMD) and short chain fatty acids (SCFA) of the browse species are presented in Table 4. *F. thoungii* has the highest OMD (%) and the lowest was recorded for *V. amygdolina*. Similar results for OMD of browse species from Borana rangeland have been reported by Merga *et al*. (2016) which was in the range of (42.2-58.08). This inconsistency might be due to differences in fiber fraction (Van Soest, 1994) and organic matter content (Isaac *et al*., 2008) of the evaluated browse species.

The metabolizable energy content of browse species observed in this study ranged from 7.9MJ/kgDM for *A. seyal* to 9.3MJ/kgDM for *F. thoungii*. The ME of the present finding was higher than earlier report (4.53-6.48) of Okunade *et al*. (2014). This disparity probably due to differences in CP content in addition to other factors for the browse species studied.

F. thoungii has the highest while *Acacia seyal* recorded the lowest SCFA production amongst the studied browse species. The variation might be due to differences in carbohydrate content of the browse species.

Table 3. *In vitro* gas production characteristics of major browse species (%).

Browse species	a	b	a+b	C (hr^{-1})
A. abyssinica	24.66	29.50	54.15	0.04
A. seyal	24.52	27.83	52.35	0.04
C. africana	26.93	34.55	61.48	0.03
F. sycomorus	24.40	41.38	65.78	0.03
F. thoungii	24.25	42.17	66.42	0.04
M. arbutifolia	23.32	37.00	60.32	0.06
V. amygdolina	22.10	26.10	48.16	0.07

a= gas production from immediately soluble component; b=gas production from insoluble but potential degradable portion; a+b=gas production potential; c=gas production rate constant.

Table 4: Organic matter digestibility, short chain fatty acids and metabolisable energy of major browse species.

Browse species	OMD %	ME (MJ/kg DM)	SCFA (mmol/L)
A. seyal	63.4	7.9	0.9
M. arbutifolia	73.2	9.3	1.16
F. thoungii	75.1	9.3	1.17
F. sycomorus	70.9	8.3	1
V. amygdolina	63.1	8.2	0.98
A. abyssinica	64.8	8.2	0.97
C. africanA	69.6	8.8	1.1

OMD=Organic matter digestibility, ME=Metabolisable energy, SCFA=Short chain fatty acid.

OMD (%): OMD (%) = 18.53+ 0.9239 *Gas production (48 hrs) + 0.0540 *Crude protein (Menke & Steingass, 1988)

ME (KJ/gDM): ME (KJ/gDM) = 2.20+0.136 *Gas production (24 hrs) +0.0057 *Crude protein

SCFA: SCFA+0.0239 *Gas production (at 24 hrs) - 0.0601 (Bensalem *et al*. (2006).

CONCLUSION AND RECOMMENDATIONS

In general, among all the browse species evaluated for their nutritional potential, *M. arbutifolia* and *V. amygdolina* exhibited highest CP content and low fiber fraction. Consequently, the browse species can be used as a potential to supplement poor quality feeds. Furthermore, the high OMD and ME value of *F. thoungii* and *M. arbutifolia*, would make the browse species as a potential supplement of low quality roughages. We recommend further study to determine biomass yield, methane production and anti-nutritional factors for utilization as livestock supplement during critical feed shortage.

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