

# Evaluation of nutritive value and *in-vitro* degradation of selected indigenous browses from Semi-Arid areas of Kenya

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## Abstract

The feeding value of five browse foliages (*Balanites aegyptiaca*, *Maerua angolensis*, *Acacia brevispica*, *Grewia hostii* and *Berchemia discolor*) from the semi-arid area were evaluated to check their potential as supplements. Rhodes grass (*Chloris gayana*) hay *ad-libitum* supplemented with browse foliage was used as the control. Chemical composition including polyphenols and *in-vitro* gas production characteristics were determined.

The CP content ranged from 41.4 gkg<sup>-1</sup>DM in Rhodes grass and 162 gkg<sup>-1</sup>DM to *Berchemia discolor*. The relative high CP content range (112 to 162 gkg<sup>-1</sup>DM) of *Balanites aegyptiaca*, *Maerua angolensis*, *Berchemia discolor*, *Acacia brevispica* and *Grewia hostii* show the possible contribution as protein source important for the utilization of the growing goats especially in the arid and semi-arid regions. The EE content range was from 17.7 gkg<sup>-1</sup>DM in *Grewia hostii* and 53.4 gkg<sup>-1</sup>DM for *Acacia brevispica*. *Chloris gayana*, *Grewia hostii*, *Acacia brevispica*, *Balanites aegyptiaca* and *Berchemia discolor* had the highest NDF, ADF and ADL contents, respectively. *Maerua angolensis* had the lowest fiber content among the species. TEPH and CT contents ranged from 6.11 to 52.3 gkg<sup>-1</sup>DM and 1.98 to 43.8 gkg<sup>-1</sup>DM, respectively. The major mineral P, K, Ca and Mg were in the ranges of 1.77-3.37, 9.11-24.8, 2.49-20.5 and 1.29-13.1 gkg<sup>-1</sup>DM, respectively. Trace elements (mg kg<sup>-1</sup>DM) varied in the range of Co (3224-5397), Cu (81.3-160), Zn (69.1-134), Mn (0.04-65.4) and Fe (20.2-86.9). *Berchemia discolor* had the highest CP content (162 gkg<sup>-1</sup>DM) with *Grewia hostii* having the lowest CP content (112 gkg<sup>-1</sup>DM). It is concluded that these browses can be used in dry season to supplement poor quality natural pasture or fibrous crop residues to improve animal performance in semi-arid areas.

**Keywords:** *Acacia brevispica*, *Balanites aegyptiaca*, *Berchemia discolor*, crude protein, goats, *Grewia hostii*, *Maerua angolensis*, Rhodes grass

## Introduction

The performance of animals maintained in resource-poor surroundings are usually low due to seasonal fluctuations in the quality and supply of animal feeds especially in the arid and semi-arid regions, which could be overcome by using locally available natural resources such as the different indigenous browse species (Aregawi et al 2008). When accessible even in limited quantities, the fibrous feeds such as cereal crop residues and poor quality mature grasses cannot maintain animals during much of the year (Osuga et al 2008).

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The browse fodder is generally rich in protein and minerals and can be used in dry season to supplement poor quality natural pasture or fibrous crop residue to improve animal performance (Devendra et al 1990). However, the presence of tannins in shrubs and tree leaves hampers their utilization as animal feeds by exhibiting antinutritional effects or positive nutritional merits (Osuga et al 2008). Goats can tolerate condensed tannins better than cattle and sheep during feeding.

It is possible and most appropriate to supplement grazing with indigenous browse such as *Grewia hostii*, *Balanites aegyptiaca*, *Acacia brevispica*, *Berchemia discolor* and *Maerua angolensis* to make up for deficiency of some nutritional component and to improve performance.

## **Materials and methods**

### **Browse foliages**

Leaves from five browse species (*Grewia hostii*, *Acacia brevispica*, *Balanites aegyptiaca*, *Berchemia discolor* and *Maerua angolensis*) that grow in semi-arid region of Kenya were harvested by hand stripping from the trees on communal grazing ranges in Marigat sub-county of Baringo county during the dry season. The browse forages were selected based on local farmers' knowledge of the species consumed by animals in the region. The area is located at an altitude of 1080m above sea level with an average annual rainfall and temperature of 700mm and 24°C, respectively.

### **Experimental procedures**

Leaves of indigenous browses were collected by hand stripping and spread on a sheet and air dried under the shade for 2 to 4 days. The dried foliages was put in sacks and stored in well-ventilated shade. The basal diet consisted of Rhodes grass (*Chloris gayana*) hay that was purchased from a reputable farm. The forages were milled to pass through 1mm sieve for chemical analysis, mineral assay, and *in-vitro* digestibility.

### **Chemical analysis**

Chemical analysis procedure was used in the determination of dry matter (DM), Nitrogen, Ether extract (EE) and ash according to the standard methods of AOAC (1900). The crude protein (CP) was calculated as  $N \times 6.25$ . Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) was analyzed according to the procedure described by Van Soest et al (1991). Phenolics was extracted using 70% aqueous acetone following the procedures described by Makkar (2003). Total extractable phenolics (TEPH) were determined using Folin-ciocalteu reagent and tannic acid as the standard. The concentration of TEPH was calculated using regression equation of tannic acid standard. Condensed tannins was determined according to the method described by Porter et al (1986). Butanol-HCL (Butanol-HCl 95:5 V/V) and ferric reagent (2% ferric ammonium sulphate in 2N HCl) mixture was shaken by vortex and then placed on a heating block adjusted at 70 to 80°C for 60 minutes. Macro-elements- potassium(K), calcium (Ca), magnesium (Mg), phosphorous (P) and micro-elements- cobalt (Co), copper (Cu), zinc (Zn), manganese (Mn), iron (Fe) was analyzed using atomic absorption spectrophotometer (AAS). Samples were prepared by wet digestion using 1:1 nitric acid and 1:4 HCL for 30 minutes for ions dissociation.

### ***In-vitro* gas production**

The milled browse forage sample weighing 200mg DM was placed in 100ml glass syringes in duplicate. The fermentative activity of the mixed microbial population was determined using the gas production technique described by Menke and Steingass (1988). The rumen fluid and buffer medium

were mixed in the ratio of 1:2 (v/v). Then 30 ml of buffer -rumen fluid mixture was passed into triplicate syringes holding samples and incubated in a thermostatically controlled water bath at 39°C for 0-96 hours. Both the samples and blank (rumen fluid +buffer) was run in triplicates. Then the volume of gas produced was determined at 0, 3, 6, 9, 12, 18, 36, 48, 72, and 96 hours by reading the calibration of the piston. The gas produced was the total increase in volume minus the mean blank value from the recorded gas production of all samples to give the net gas production. The calculated values of gas production were fitted into the model of Årskov and McDonald (1979) to determine the degradability of the feed:

$$Y = a + b (1 - e^{-ct}) \text{ where:}$$

Y=the volume of gas produced with time (t)

a=initial gas production

b=gas produced during incubation

c= gas production rate constant (fraction /hour), and

a+b represents the potential extent of the gas production.

## Results and discussion

### Chemical composition

Table 1 indicates variations in the foliage proximate components analyzed and their potential as supplements for feeding ruminants. The OM content ranged from 873 gkg<sup>-1</sup>DM in *Maerua angolensis* and 945 gkg<sup>-1</sup>DM to *Berchemia discolor*. The CP content ranged from 41.4 gkg<sup>-1</sup>DM in Rhodes grass and 162 gkg<sup>-1</sup>DM to *Berchemia discolor*. The relative high CP content range (112 to 162 gkg<sup>-1</sup>DM) of *Balanites aegyptiaca*, *Maerua angolensis*, *Berchemia discolor*, *Acacia brevispica* and *Grewia hostii* show the possible contribution as protein source important for the utilization of the growing goats especially in the arid and semi-arid regions. The EE content range was from 17.7 gkg<sup>-1</sup>DM in *Grewia hostii* and 53.4 gkg<sup>-1</sup>DM for *Acacia brevispica*. Rhode grass, *Grewia hostii*, *Acacia brevispica*, *Balanites aegyptiaca* and *Berchemia discolor* had the highest ADF and ADL contents, respectively.

**Table 1.** Chemical composition (gkg<sup>-1</sup>DM) of five browse species and Rhodes grass ( *Chloris gayana*) as control

| Sample                      | DM  | OM  | CP  | EE   | NDF | ADF  | ADL  | TEPD |
|-----------------------------|-----|-----|-----|------|-----|------|------|------|
| <i>Balanites aegyptiaca</i> | 915 | 874 | 114 | 48.8 | 279 | 218  | 243  | 16.4 |
| <i>Maerua angolensis</i>    | 871 | 873 | 123 | 43.0 | 103 | 80.2 | 88.8 | 27.3 |

|                           |     |     |      |      |     |     |     |      |
|---------------------------|-----|-----|------|------|-----|-----|-----|------|
| <i>Berchemia discolor</i> | 918 | 945 | 162  | 21.3 | 171 | 155 | 144 | 49.2 |
| <i>Rhodes grass</i>       | 920 | 921 | 41.4 | 21.0 | 693 | 503 | 478 | 6.11 |
| <i>Acacia brevispica</i>  | 926 | 938 | 132  | 53.4 | 295 | 216 | 254 | 37.6 |
| <i>Grewia hostii</i>      | 929 | 914 | 112  | 17.7 | 299 | 253 | 336 | 52.3 |

*Maerua angolensis* had the lowest fiber content among the species. Osuga et al (2008) also reported *Maerua angolensis* to be lowest in fiber. TEPH and CT contents ranged from 6.11 to 52.3 gkg<sup>-1</sup>DM and 1.98 to 43.8 gkg<sup>-1</sup>DM, respectively. Abdulrazak et al (2000), reported high total extractable condensed tannins(100-480mgkg<sup>-1</sup> DM) and total extractable phenolics(104-512mgkg<sup>-1</sup>kgDM) for *Acacia nilotica*, *Acacia tortolis* and *Acacia seyal* used as livestock browse in the arid and semi-arid regions.

To improve performance, animals consuming basal diets containing less than 7% crude protein (CP) will require supplementation to achieve maximum production, (Ondiek et al 2000).

According to Abdulrazak et al (2000) some *Acacia* species including *Acacia brevispica*, *Acacia nubica* and *Acacia mellifera* have shown to contain appreciable crude protein. The relative high crude protein content of the browse (150-249 g/kg DM) provides adequate ground for the use of the browse leaves to supplement crop residues such as straw and low-quality natural pastures (Osuga et al 2006). The NDF content of the browse species was low to moderate, which indicates that the browses have high cell content, that is related with high digestibility (Osuga et al 2005). Browse fiber has been shown to be digestible more than crop residue and mature grass hence can be utilized by animal easily (El Hassan et al 2000).

The major and microelement composition of the forages and Rhodes grass is shown in table 2.

**Table 2.** Major and trace elements in five Kenyan indigenous browse and Rhodes grass

| Sample                      | Major elements, (gkg <sup>-1</sup> DM) |      |      |      | Trace elements, (mgkg <sup>-1</sup> DM) |      |      |     |
|-----------------------------|--|------|------|------|---|------|------|-----|
|                             | P                                      | K    | Ca   | Mg   | Co                                      | Cu   | Zn   | Mn  |
| <i>Balanites aegyptiaca</i> | 2.11                                   | 22.0 | 20.5 | 9.20 | 3224                                    | 86.0 | 69.1 | 1.0 |

|                           |      |      |      |      |      |      |      |    |
|---------------------------|------|------|------|------|------|------|------|----|
| <i>Maerua angolensis</i>  | 1.77 | 24.8 | 18.4 | 13.1 | 3940 | 123  | 94.9 | 32 |
| <i>Berchemia discolor</i> | 3.37 | 12.5 | 10.8 | 5.73 | 4528 | 114  | 104  | 2  |
| <i>Rhodes grass</i>       | 3.27 | 22.1 | 2.49 | 1.29 | 4504 | 141  | 134  | 0  |
| <i>Acacia brevispica</i>  | 2.68 | 9.11 | 13.6 | 6.23 | 5397 | 81.3 | 84.6 | 6  |
| <i>Grewia hostii</i>      | 3.11 | 13.7 | 15.5 | 6.51 | 4680 | 160  | 96.2 | 2  |

The major minerals P, K, Ca and Mg were in the ranges of 1.77-3.37, 9.11-24.8, 2.49-20.5, and 1.29-13.1gkg<sup>-1</sup>DM, respectively. Trace elements (mgkg<sup>-1</sup>DM) varied in the range of Co (3224-5397), Cu (81.3-160), Zn (69.1-134), Mn (0.04-65.4) and Fe (20.2-86.9). Earlier studies on the mineral content of the indigenous tree browses vary from moderate to high as reported by Abdulrazak et al (2000). The authors found that although *Acacia* species was rich in the micro-elements Mn, Mo, Zn, Co, Cu, Fe and Se, the level of P and Ca showed variability with the tree browses, suggesting that animals may consume adequate amounts and may only require specific supplementation in the diet. The current study reported the highest levels for major elements P, K, Ca and Mg at 3.37, 24.8, 20.5 and 13.1 gkg<sup>-1</sup>DM and lowest level at 1.77, 9.11, 2.49, 1.29gkg<sup>-1</sup>DM respectively. This is similar to results of McDowell, (1985) who reported the highest mineral levels for the major elements Ca, P and Mg at 28, 3.2 and 8.7 gkg<sup>-1</sup>DM and lowest levels at 7, 0.8 and 0.4 gkg<sup>-1</sup>DM, respectively. The values are adequate to meet the requirement for growth to improve the animal performance especially during the dry periods when the availability of pasture is limited in the arid and semi-arid regions.

The in-vitro degradation characteristics of the browse DM varied widely among the 5 selected indigenous species. The total gas production (ml/200mg DM) at 24hrs and 48hrs shown in table 3 point variations in the digestibility potential and forage degradability with *Balanites aegyptiaca* (14.1) and *Grewia hostii* (13.5) being the highest and *Acacia brevispica* (8.15) being the lowest at 48hrs. The degradation of some of the forages improved from 24 to 48 hours indicating that they require more time for effective degradation.

**Table 3.** *In-vitro* gas production (ml/200mg DM) of 5 indigenous browses and Rhodes grass as control

| Sample | Fermentation Characteristics |    |   |   |   |     |
|--------|------------------------------|----|---|---|---|-----|
|        | 24                           | 48 | A | B | C | A+B |

|                             |      |      |        |      |        |      |
|-----------------------------|------|------|--------|------|--------|------|
| <i>Balanites aegyptiaca</i> | 6.01 | 14.1 | 3.63   | 3.65 | 0.395  | 7.28 |
| <i>Maerua angolensis</i>    | 12.0 | 10.9 | -0.536 | 7.81 | 48.9   | 7.27 |
| <i>Berchemia discolor</i>   | 16.2 | 10.3 | 0.461  | 8.05 | 0.196  | 8.51 |
| <i>Rhodes grass</i>         | 8.61 | 13.5 | 0.0    | 4.58 | 13.6   | 4.58 |
| <i>Acacia brevispica</i>    | 9.24 | 8.15 | 0.0    | 4.21 | 12.6   | 4.21 |
| <i>Grewia hostii</i>        | 11.9 | 13.5 | -0.721 | 8.44 | 0.0921 | 7.72 |

*A, B, C are constants ( Årskov and McDonald, 1979)*

*Maerua angolensis*, *Berchemia discolor* and *Acacia brevispica* were highly degraded at the 24 hours compared to the 48hours. The variations in gas production between the indigenous browse species could be due to the amount of substrate fermented. The gas is produced by the fermentation of organic matter (OM) in the feed (BIA¼mmel and Fernandez-Rivera 2002).

This indicates that these indigenous browses are potentially degradable and can become potential supplements in improving low quality feeds fed especially to goats. The phenolic compound present in the browses could have contributed towards the low gas production under study especially *Acacia brevispica*, *Berchemia discolor* and *Maerua angolensis* at 48 hours. This was similar to the results of Osuga et al (2008) who reported all the browse foliages with generally high gas production potential except *Maerua angolensis*. These browses contain low to moderate phenolic constituents, rich in protein and are highly fermented in the rumen from the study with *Balanites aegyptiaca* and *Grewia hostii* showing high potential degradability at the 48 hour.

## Conclusion

- From the results of chemical composition and *in-vitro* gas production, the indigenous browse fodder is generally rich in protein (112 to 162 gkg<sup>-1</sup>DM) and moderate to high minerals which can be used in dry season to supplement poor quality natural pasture with low crude protein or fibrous crop residue, especially in the arid and semi-arid areas.

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