Evaluating the Chemical Composition, Feed Intake and Rumen Digesta Kinetics of *Brachiaria brizantha* cv Toledo and *Brachiaria decumbens* cv Basilisk Grasses

Progress Report

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BACKGROUND INFORMATION

Naturally occurring pastures inform the diets of ruminant livestock and donkeys in SSA with little emphasis on pasture production. This is because the immediate need of the communities is food for human with livestock food needs priorities being less considered despite the knowledge that they too have to be fed. The result is that the main feed source of these animals is rain generated pastures and crop residues after harvesting. Poor animal condition and productivity will then lead to a lower yield in livestock and livestock products as well poor market prices for the animals (Thornton, 2010). Arid and semi-arid areas are most affected despite having large tracts of non-arable land that can be converted to pasture production. Continued emphasis, however on the need to grow pastures for their animals is contributing to the increasing demand for pasture seed by farmers and hence the acreages under pasture cover are increasing steadily. Some of the pasture species growing in these areas and are utilized by livestock include the Maasai Love grass (*Eragrostis superba*), the African foxtail grass (*Cenchrus ciliaris*), the Horsetail grass (*Chloris roxburghiana*), the Bush rye (*Enteropogon macrostachyus*) and the star grass (*Cynodon dactylon*) (Kidake *et al*., 2016) among others. However the nutritional quality of the grasses decline faster as the wet season fades away compared to grasses growing in the highlands. These grasses also have high stem to leaf ratio (Kidake *et al*., 2016) making them less able to provide digestible nutrients as compared to other highland grasses like the Kikuyu grass (*Pennisetum clandestinum*) .

The *Brachiaria* grass species are native to Africa but have been developed elsewhere to come up with climate smart varieties that can establish and grow well in the semi-arid areas (Njarui *et al*., 2016). In particular these include *Brachiaria brizantha* cultivars Xaraes (also known as Toledo), Piata, MG4 and Marandu; *Brachiaria decumbens* cultivar Basilisk and *Brachiaria* hybrid Mulato II (Nguku, 2016). Compared to the grasses found growing in the semi-arid South Eastern Kenya mentioned earlier these grasses are leafier, i.e. the leaf stem ratio is higher; they acquire greater plant heights, spread, cover, tillering ability and plant population when sown and retain higher nutrient digestibility for a lengthier period than the indigenous grasses in the ASALs (Nguku, 2016). The grasses therefore are a potential boost to the forage resource base in these regions and their adoption should be encouraged. Not much documentation has been done on the animal production potential of these grasses compared to the indigenous grasses and therefore there is need to evaluate their potential to livestock for growth and productivity.

INTRODUCTION

The nutritional value of a feed depends on its nutrient contents, the extent of rumen degradation and the digestibility of undegraded feed components, especially protein, passing to the small intestine. Diets high in fibre are more slowly digested and will therefore decrease the overall feed intake because the animal remains full longer (Mohamed and Chaudhry, 2008; Mc Donalds *et al*., 1987). Nutrients required by animals are water, carbohydrates, protein, vitamins and minerals. In ruminant animals these are supplied mainly by grasses, herbs and shrubs. Animals at different stages of growth have varying nutritional needs. Factors that influence the effect of a feed on animal production include the voluntary intake of the particular feed source, its digestibility and passage rate across the reticulorumen.

Voluntary intake of forage is the amount consumed by the animal when its accessibility to forage is unrestricted (Huston and Pinchak, 1991). The knowledge of intake level and diets quality for grazing ruminants is however essential to improve herd management in balancing sward availability to animal needs (Decruyenaere *et al*., 2009). Allison (1985) documents that factors that affect voluntary intake as body size, with younger animals consuming more due to their smaller rumen and faster turnover rate of ingesta; physiological status such that lactating animals consuming more than pregnant animals and body condition whereby animals compensate for periods of under nutrition by eating more. Other factors include forage factors which are availability, nutrient requirements and nutrient concentrations in forages (Decruyenaere *et al*., 2009). Voluntary intake can be estimated by direct measurements which involve feeding the animals with a known amount of feed and determining the amount left after the feeding period (Osuji *et al*., 1993). Intake of grazing ruminants can be estimated by indirect methods such as the markers techniques, ratio techniques, the recording of animal behavior and other empirical models (Decruyenaere *et al*., 2009).

The digestive system of ruminants comprising four compartments (rumen, reticulum, omasum and abomasum) and is well adapted to the utilisation of cell walls by microbial fermentation and the specialised ruminant stomach (Van Soest, 1994). Fermentation of cell walls occurs in the first three compartments in a complex ecosystem influenced by interactions between feeds, microbial populations and the host animal (Van Soest, 1994). The rumen and reticulum form a large fermentation chamber (up to 20% of body weight) containing an active and diverse microbial population (Ahvenjärvi *et al*., 2000). An optimal pH for microbial fermentation of cell wall carbohydrates is maintained by continuous salivary flow and absorption of VFA's produced during fermentation (Van Soest, 1994). Microbial fermentation of carbohydrates is completed in the large intestine. The nutrient content of a feed does not assure certain animal performance levels, as productive responses depend on the quantity of nutrients available to the animal, which in turn is determined by fermentation processes which take place in the reticulo-rumen (Hackmann *et al*., 2010). Important characteristics of digestion in the rumen with regard to forages are effective degradability, rate of digestion, and the amount of digestible fibre (Larbi *et al*., 1988). Rumen degradation is crucial in the supply of dietary nutrients to meet the nutrient demands of the anaerobic microbes and body tissues of ruminant animals (Mohamed and Chaudhry, 2008). Knowledge of ruminal particulate kinetics enhances understanding of roughage utilization by ruminant animals (Grovum, 1983). Methods used for measuring degradability (digestibility) of feed include; the nylon bag technique (*in sacco* techniques), in vivo techniques involving the use of internal and external markers, in vitro techniques e.g. the Menke gas-production technique (Osuji *et al*.,1993) and in vitro organic matter degradation techniques (Tilly and Terry, 1963).

Passage rate or flow rate is the rate at which digesta leaves a part of the digestive tract and it is the reciprocal of retention time (Adesogan, 2000). Factors affecting rate of passage include; feeding level, animal species, diet composition (forages vs concentrates), feed particle size / physical form and moisture in feeds (Adesogan, 2000). Passage rates can be measured by rumen evacuation method or by the marker method.

It is on this basis that the study seeks to evaluate the animal production potential of two *Brachiaria* grass species; *Brachiaria decumbens* cv Basilisk and *Brachiaria brizantha* cv Toledo (Xaraes) with *Eragrostis superba* to serve as controls.

Statement of the problem

Ruminant livestock feed continues to be a challenge in the livestock production systems worldwide with the unfolding arena of climate changing patterns that lead to low and erratic rainfall patterns. The effect is limited pasture and other forage resources in rain fed production systems which are not adequate to provide nutrients to livestock. Attempts have been made to mitigate this uncertainty through interventions and technologies like livestock insurance schemes in which policyholders are paid in response to 'trigger events', such as abnormal rainfall or high local animal mortality rates, when preventative measures fail (FAO, 2016); fodder production through hydroponics (Wanzala, 2018) and as FAO (2016) further documents; putting in place early warning systems to assist rural communities in managing the risks associated with rainfall variability and altering forage species composition as a selective increase in biodiversity and intensification of pasture production though fertilization, cutting regimes and irrigation practices have been made. Increase in biodiversity of climate smart forage species like the *Brachiaria* grasses are a boost to the forage resource base in pastoral, agro-pastoral and mixed crop and animal production systems. The animal production potential of the species in these regions however needs to be investigated and the feedback shared among the livestock development stakeholders in order to impact further on its adoption. It is on this basis that voluntary intake, rumen degradation profiles and passage rates of *Brachiaria brizantha*; cv Toledo (Xaraes) and *Brachiaria decumbens* cv Basilisk which are among the climate smart grasses selected through farmer participation at KALRO Katumani Kenya (Gatheru *et al*., 2017) for the south eastern Kenya region need to be investigated.

Objectives of the study

General objectives

To evaluate the nutitive potential of *Brachiaria* grass cultivars; *B. brizantha* cv. Toledo, *B. decumbens* cv. Basilisk as a livestock forage resource in the semi-arid regions of Kenya.

Specific objectives

1. To evaluate the voluntary feed intake in Dorper sheep offered hay of *B. brizantha* cv. Toledo, *B. decumbens* cv. Basilisk and *Eragrostis superba*.
2. To evaluate the rumen digesta degradability and passage rates of *B. brizantha* cv. Toledo, *B. decumbens* cv. Basilisk and *Eragrostis superba* in Dorper sheep.
3. To evaluate the chemical composition of *B. brizantha* cv. Toledo, *B. decumbens* cv. Basilisk and *Eragrostis superba* hay fed to Dorper sheep.

Research hypothesis

1. There is no significant difference in voluntary feed intake in Dorper sheep offered diets of *B. brizantha* cv. Toledo, *B. decumbens* cv. Basilisk and *Eragrostis superba* hay.
2. There is no significant difference in rumen digesta degradability and passage rates of *B. brizantha* cv. Toledo, *B. decumbens* cv. Basilisk and *Eragrostissuperba diets* offered to Dorper sheep .
3. There is no significant difference in the chemical composition and nutritive value of *B. brizantha* cv. Toledo, *B. decumbens* cv. Basilisk and *Eragrostis superba* hay offered to Dorper sheep.

Justification of study

Ruminant animals are the main providers of protein to humans. The diet of these animals consists mainly of vegetation which is in the form of grass (green, standing hay, conserved hay or silage), shrubs, herbs and forbs. The nutritive content of the diet is important as it informs the production potential to the animal in products like meat, milk and other desired animal products. To be able to document this, studies in voluntary intake of the diets offered; degradation parameters and passage rates need to be undertaken.

Scope of the study

The study was limited to small ruminant stock whose average intake is less compared to large ruminant stock. This is mainly because of the limited acreages under *Brachiaria* pastures. Currently the grass is still under research in Kenya.

Materials and methods

Experimental Site

Field data for this study was collected at South Eastern Kenya University, located at Yatta Kwa Vonza Ward in Kitui County, Kenya. The university is situated between 01.313580 S, 037.755460 E and 01.314220 S, 037.755760 E at an elevation of 1173m a.s.l.

Climate

South Eastern Kenya University is in semi-arid Kenya characterized by two rainy seasons; short rains October-January and long rains march –May with the short rains being more reliable than the long rains.

Animal welfare

Three weeks before the study, the animals were brought to the shed and housed in individual pens of measurement 2m length by 1.25m width by 1.5 m height. The sheep were sprayed with Ectomin acaricide to clear them of ectoparasites and then dewormed using albendazole 10% solution. On day 1 of confinement they were weighed and fed *Eragrostis superba* hay for 2 weeks prior to start of experiment using the trial feeds. This was to ensure that they get accustomed to being confined permanently in a house and feeding in a confined environment. The sheep were also provided water adlib and a mineral block within each individual pen.

Plate 1: Dorper sheep house showing the individual pens and sheep being led to the pens

Nine male sheep of the Dorper breed were used in the study. These sheep were registered, given identification numbers and cared for according to guidelines in the Prevention of Cruelty to Animals ACT,1983 (KSPCA, 1983) approved by the Society for the Protection and Care of Animals.

The study was conducted in accordance with the laws and regulations controlling experiments performed on live animals in Kenya. All surgical and animal care procedures were approved by the Ethics Committee of the Chuka University that was registered under the protocol number NACOSTI/NBC/AC-0812.

Plate 2: Weighing and tagging of the sheep

Forage source

Brachiaria brizantha cv Toledo hay and *Brachiaria decumbens* cv basilisk hay was purchased from farmers in Kagundo Sub county, Machakos county. The area is in AEZ-UM 2- main coffee zone, and UM 3-marginal coffee zone, located at an altitude of 1544m a.s.l., at longitude 37°20′49″ E and latitude: 1°17′52″ S. The average annual temperature and rainfall in Kagundo sub-county is 19.3 °C and 958 mm respectively. The soils types are Alfisols, Acrisols, Ferralsols and Andosols. *Eragrostis superba* hay was purchased from Kibwezi West at Nyayo market coordinates -2°24'59.99'' S 37°57'59.99'' E. All the grasses (*Brachiaria* and Eragrostis were established in 2015 OND (October, November December) short rains in their respective origins.

Plate 3: Hay of *Eragrostis superba* and *Brachiaria*

Study 1. The Voluntary feed intake of *B. brizantha* cv Toledo, *B. decumbens* cv basilisk and *Eragrostis superba* hay offered to Dorper sheep.

Trials to determine intake were carried out using procedures outlined by Osuji *et al*. (1993). Nine Dorper sheep were fed *ad libitum* diets of the *Brachiaria brizantha* cv Toledo, *Brachiaria decumbens* cv Basilisk and *Eragrostis superba* in a randomized complete block design with 3 rows of feeding block with each of the diets allocated randomly to the sheep. The sheep were initially brought into the shed and their individual weights recorded before allowing them to randomly occupy individual pens which measured 1.33m x 1.03m x 0.9m each having a feed trough and water trough inside. This was to allow them to adjust to being housed and stall fed which took a period of 2 weeks before being introduced to the trial diets. At the start of feeding on the trial diets to the sheep their weights were taken again after which they were fed for 21 days at *adlib* supplied with water and 2kg mineral block supplement whose composition was Ca 2.1%; NaCl 85%; Mg 1%; P ; Fe 0.045%, Iodine 0.02%; Cu 0.15%; Co 0.05%; Mn 0.4%; Se 0.02%; Zn 0.4%. Feed to be given to the animals was milled to pass through a 5cm sieve screen and weighed each day prior to feeding after emptying the feed troughs of the orts from the previous day feed offered.

Plate 4: Milling of hay diet and a ram feeding on the diet offered

Data collection began on day 15 where only feed offered for each sheep was weighed and recorded for each of the animals. On day 16 feed offered and orts for each sheep from the previous day's feed was weighed and recorded. On day 17 the weight of feed offered, orts from feed offered on day 16, urine volume and faeces weights were recorded. This also happened for the rest of the days up to day 22. On day 22 the individual weights of the sheep were recorded. During each of the intake measurement days, a sample (5–10%) of the feed offered was collected and saved in a paper bag. The orts were also collected and their weight recorded each morning for individual animals. Total fecal output was measured daily and samples from each animal pooled for analysis. Fecal subsamples were dried at 100^{o}C and then ground through be frozen and freeze dried, then ground through a Wiley Mill using a 2-mm screen. Individual, daily ground samples will be composited by sheep by period. The DM content of feed and faecal samples were then determined as described by Undersander *et al*. (1993) where part of the sub sample from each day will be dried in triplicate in a 60°C force air oven for 72 hours to determine fecal dry matter. The feed samples, orts and faeces were analysed for their chemical composition through the proximate analyses for CP, ash, DM and for NDF, ADF and ADL.

Study 2 a. A study of the rumen degradation profiles for grass hays of *B. brizantha* cv Toledo, *B. decumbens* cv Basilsk and *E. superba*

The study aimed at incubating samples of feeds in the rumen of fistulated dorper sheep for periods of from 6 to 120 hours and subsequent determination of the disappearance of the different feed components. Three rumen-fistulated dorper sheep were used in a 3 x 3 latin square design. The samples, which were prepared in duplicate for each diet and each incubation hour, were incubated in each of the experimental animals in the same way. Nylon bags 6.5 x 14 cm with a pore size of 53 µm were oven dried at 60°C for 30 minutes and their empty weights measured after allowing them to cool to room temperature in a desiccator. The bags were then labelled according to the treatment and incubation period. Two (2) g/bag of dried forage samples of the treatments (AOAC, 2005) were milled to pass through a 2-mm sieve screen and put in the into the nylon bags. Prior to this, the nylon bags were weighed and their weight recorded. They nylon bag +feed sample was also weighed and recorded. The bags were then tied tightly using nylon string resistant to rumen micro-organisms and then anchored with 20 cm of nylon cord to the cannula top. They were placed deep into the rumen of the fistulated animal and the forage samples incubated for 0, 6, 12, 24, 48, 72, 96 and 120 hours. The 120-hour samples were placed first and the 6 hour samples placed in the rumen 6 hours before all the incubated bags were removed such that on day 1 at 6am, the 120 hour samples were placed in the rumen. On day 2, the 96 hour samples were placed. This continued until the samples of 6 hour incubation were placed. After 120 hours all the samples were removed from the rumen and rinsed thoroughly before drying in forced air oven at 60^{o}C for 24 hours. The bags were then cooled in a desiccator and their weights recorded.

Plate 5: Inserting feed samples into the rumen for degradation (L) and incubated bags with samples being rinsed (R)

Study 2b Rate of passage of digesta from the reticulo-rumen

The study was study was conducted using a 3x3 Latin Square Design in which in which each period lasted 15 days. During the first 7 days animals were allowed to adapt to the diets. The last 8 days were used to evaluate the passage rate of the solid phase (chromium marker mordanted hays of the 3 grasses). From the 8th to the 15th day of each period, faeces were collected to estimate the curve of excretion of the marker and consequently from the data generated, the particle passage kinetics was determined, utilizing chromium (Cr mordant) as marker, attached to the cell wall of the forage of the respective treatment (compaction level), by adapting the procedures described by Udén et al. (1980).

Each period of testing involved feeding animals with hay of grass species (either *B. decumbens* cv Basilisk, *B. Brizantha* cv Toledo or *E. superba*). Two hundred grams of marked fiber for the grass under treatment was supplied through a rumen cannula into the rumen 30 – 60 minutes before feeding time at the beginning of the experimental period. This was done using a plastic funnel to introduce marker material into the dorsal rumen via the rumen fistula. Particles left in the funnel were washed into the rumen with water. Individual collections of faeces was performed, beginning at time zero, along with administration of the mordanted fiber, resuming at pre-determined times until 120 hours (0, 6, 12, 24, 27, 30, 33, 36, 48, 60, 84, 96, 108,120, 144 h) after administration. Fecal samples were collected by inducing defecation by rubbing the dorsal rectal wall and saving the final 150 to 300 g of faeces excreted (Hartnell and Satter 1979). To remove the faecal sample, a gloved lubricated hand was gently passed through the anus to withdraw any material present.

SUMMARY OF RESULTS

Results from study 1 and 2 have been obtained but due to a breakdown of some equipment in the University of Nairobi laboratory, data from study 2b has not been chemically analysed.

Study1a: Chemical composition of the *B. brizantha* cv Toledo, *B. decumbens* cv Basilisk and *E. superba* hay offered to Dorper sheep

Significant differences ($p<0.05$) were observed in the grass hays for dry matter (DM), organic matter (OM), crude protein (CP), Ash and Calcium (Ca) content, Metabolizable energy (ME), in vitro dry matter digestibility (IVDMD) and in vitro organic matter digestibility (IVOMD) in the diets offered to the sheep. *Brachiaria brizantha* cv Toledo was superior in DM content of 96.2% though similar to similar to the dry matter for E. superba, (96.08%), ash content at (8.68%), NDF content (65.59%), ADL (3.9967%), ME (2154.30 MJ/kg) and IVDMD (54.02%). *Eragrostis superba* was superior in organic matter (OM 92.53%), calcium content (0.33%) and crude protein (CP 5.68%). *Brachiaria decumbens* cv Basilisk was superior only in ADF (44.33%) and IVOMD (49.89%). Differences in phosphorus content of the three diets offered to the sheep were not significant ($p> 0.05$).

Study 1 b: Voluntary intake of *B. brizantha* cv Toledo, *B. decumbens* cv Basilisk and *E. superba* hay offered to Dorper sheep

There were significant differences ($p<0.05$) in Voluntary intake for the *Brachiaria brizantha* cv Toledo, *Brachiaria decumbens* cv Basilisk and *Eragrostis superba* hay. Voluntary intake for Toledo and Eragrostis was similar as shown in table 2 although Eragrostis recorded the highest mean voluntary dry matter intake (2.8% of the body weight). Basilisk recorded lowest average intake per body weight (2.19%) of sheep.

Study 2a

Data from study 2a is currently being analysed statistically

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