



## THE CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF *Brachiaria* GRASS CULTIVARS AT KATUMANI DRYLAND RESEARCH STATION IN SOUTH EASTERN KENYA

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### ABSTRACT

The study was conducted at Kenya Agricultural and Livestock Research Organisation, Katumani, Machakos to evaluate the herbage quality of *Brachiaria* grass cultivars in semi arid regions of Eastern Kenya. *Brachiaria* cultivars namely *B. decumbens* cv. Basilisk, *Brachiaria* hybrid Mulato II, four *Brachiaria brizantha* cultivars Marandu, Xaraes, Piata, MG4 and *Brachiaria humidicola* cv Llanero were assessed with reference to their chemical and nutritive composition at 22, 24 and 28 weeks post seedling emergence. Rhodes grass (*Chloris gayana* cv KATR3) and Napier grass (*P. purpureum* cv. Kakamega I) were included as controls. There were significant differences ( $p < 0.05$ ) among the cultivars for crude protein, crude fibre (NDF, ADF and ADL), Ash, Calcium, Phosphorus, Dry Matter Digestibility and Metabolizable energy during the week 22 and 24 post seedling emergence harvest. At the week 28 harvest interval, however, ADL values for all the cultivars were similar. Only Marandu was significantly different ( $p < 0.05$ ) for values of metabolizable energy from the rest. The mean CP content of the grasses decreased from 11.1% at 6.3% from week 22 to week 28 harvest interval. MG4, Mulato II and Xaraes were the only grasses able to meet minimum CP (7.0%) requirement for rumen microbial function throughout the harvest period. Ash and phosphorus values decreased whereas Calcium content increased for all the cultivars during the harvest intervals, with Mulato II recording the highest ash (15%) content during this period. *Chloris gayana* KATR3 recorded highest average NDF (72.9%), ADF (48.1%) and ADL (6.1%) content during this period. Xaraes, Marandu and Mulato II were the only cultivars able to achieve the highest metabolizable energy of 7.0 MJ/kg DM recorded for the grass cultivars throughout the harvest intervals.

These results indicate that *Brachiaria* grasses can be a good source of forage for livestock and a boost to the forage resource base in the semi arid regions of Kenya. Further research is needed to quantify their productivity in both dry and wet periods and to assess the effect of feeding on animal production performance.

### Indexing terms/Keywords

Livestock ; *Brachiaria* ; grass ; Chemical composition ; Nutrition.

### Academic Discipline And Sub-Disciplines

Agriculture

### SUBJECT CLASSIFICATION

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## 1.0 INTRODUCTION

The world's livestock, particularly ruminants in pastoral and extensive mixed systems in many developing countries, suffer from permanent or seasonal nutritional stress [1]. Pasture is an appropriate source of food for ruminants, mainly in countries of tropical climate due to the high number of species that can be used, possibility of cultivating them throughout the year, capacity of ruminant to use fibrous foods, does not compete as food for humans and tends to be a cheap economical feed source [2]. Attention should therefore be given to ensuring a sufficient and adequate quality of this feed resource. Ruminants optimize forage consumption to meet their nutrient requirements if no physical or metabolic restrictions are imposed [3]. Forage (nutrient) intake under grazing conditions is a modified expression of voluntary intake and is influenced by forage quality, availability, harvestability, environmental stress and management [4]. The nutritive quality of forage has been defined as the product of the voluntary intake, digestibility and efficiency of nutrients that are used by the animal [5]. Animals require nutrients such as energy, protein, vitamins and minerals of which are utilized in the hierarchical order of maintenance, reproduction, lactation and storage. Energy is needed by animals for body functions. [6] reports that digestibility is a useful measure of quality because it is directly and positively related to the energy content of the pasture. Components of the diets of grazing animals can have dry matter digestibility (DMD) values from 14-85% depending on the amount of cell contents (NDS) and cell wall constituents (NDF) in the dry matter [7]. [8] and [9] report that the digestibility of the different grass species could be distinctly different, and is also influenced by area of origin, including temperature, light intensity, total rainfall, soil type, fertilization level, and by stage of maturity and preservation method. Neutral detergent fiber is used to estimate the intake potential of the forage. Forages with a high NDF content are considered to be lower in quality, and forage intake is generally lower compared to low NDF forages. Cellulose, which along with lignin forms ADF, reduces the digestion rate and extent of digestion which are related to the lignin content. Forages with a high level of ADF are less digestible, and have a lower energy value. Lignin is the indigestible plant component and has a negative impact on cellulose digestibility. As lignin content increases, digestibility of cellulose decreases thereby lowering the amount of energy potentially available to the animal. According [10], lignin concentration affects mainly the availability of cell wall polysaccharides. He further states that hemicellulose (presenting NDF along with cellulose and lignin) is closely associated with lignin, and its digestibility is directly related to that of cellulose and inversely related to lignification. Forages high in CP are considered high quality forages because little or no protein supplement is needed. In addition, high CP forages are usually more digestible and, consequently, provide more energy to the animal. According to [11] and [12], tropical grasses are relatively low in energy and protein and high in fibre content compared with species in the temperate zone. The authors further state that this has largely been as a result of their more rapid physiological growth and early maturation, as influenced by temperature and light. Sub-optimal protein supply to the microbial population in the rumen results in a lowered fermentation rate, decreased digestibility of food consumed and decreased voluntary intake [13]. Generally, crude protein (CP) is a gross measure of the nitrogen (N) contained in a feedstuff. Rumen microorganisms manufacture high-quality proteins for use by the animal from relatively low-quality feedstuffs, as long as they have an adequate supply of nitrogen and an energy source. The general rule of thumb is that forages with a CP concentration of 7% or greater are adequate to meet a mature cow's CP requirements [14]. Dry pregnant cows and even lactating cows with low levels of milk production can subsist on fairly low protein diets, i.e., less than 10% CP [15]. Minerals are necessary both for the growth and development of plants as well as for the growth, maintenance and productivity of grazing animals in the range areas. The mineral composition of range plants depends upon various environmental factors such as geographic aspects, climate, soil minerals, grazing stress, seasonal changes and the ability of plants to get them from soil [16]; [17]. Minerals deficiencies results in poor animal health, productivity and reproductive faults even if sufficient green fodder is present [18]. Calcium is the most abundant mineral in the body and is an important component for bones, teeth, membrane permeability, muscle contraction, and many other metabolic functions. Phosphorus is generally discussed with calcium because the two minerals function together in bone metabolism. Phosphorus is predominantly associated with bones and teeth, but also functions in cell growth, energy utilization, and membrane formation. According to [19], calcium (Ca) and phosphorus (P) are important major minerals which are rarely deficient in forages and their efficiency is dependent on each other. He reports that a dry cow requires 0.25% Ca and 0.16% P, while a lactating cow needs 0.31% Ca and 0.21% P. [19] further emphasizes that it is important that the ratio between Ca and P is 1.5:1 (e.g. 0.3% Ca and 0.2% P) to 4:1 (e.g. 1% Ca and 0.25% P). Phosphorus deficiency can cause reduced appetite, poor digestion of feedstuffs, poor growth rate and body condition, and low reproductive rate [20].

The nutritional value of tropical grasses has been shown to be generally low, falling rapidly with plant maturity [21]. Semi arid and arid rangelands are usually dominated by a particular forage type which provides the majority of organic matter consumed by grazing animals. The forage is relatively high in quality during early vegetative growth but quickly declines in quality as it matures. Their content of structural carbohydrates is quite high, they enter dormancy during unfavorable periods and reinitiate growth during favorable periods. Indigenous species that have evolved under the harsh climatic conditions of the ASALs in southern and central-northern rangelands of Kenya include grasses like *C. ciliaris*, *E. superba*, *E. macrostachyus*, and *C. roxburghiana* [22]. These grasses' nutritional and yield status decline with changing climatic conditions in the year. The full potential of the ASALs for livestock production can be exploited by expanding the forage resource base through introduction of climate smart forage species which will be able to boost nutrient quality and quantity hence supplying the nutritive requirements of livestock. Studies on climate smart *Brachiaria* grass species which originated from Africa and have been developed elsewhere could be the key to improvement of livestock production and could also serve as boost to the forage resource base in the ASAL regions. This study is aimed at evaluating the chemical composition and nutritive values of 7 *Brachiaria* cultivars namely *B. brizantha* cultivars Piata, Xaraes, MG4 and Marandu; *B. decumbens* cv. Basilisk; *Brachiaria* hybrid cv. Mulato II and *B. humidicola* cv. Llanero with Rhodes grass (*C. gayana* KATR3) and Napier grass (*P. purpureum* cv. Kakamega I) to serve as controls.



## 2.0 MATERIALS AND METHODS

### 2.1 Site

The study was conducted at the Kenya Agricultural and Livestock Research Organisation, Katumani, Machakos, Kenya (10 58'S, 37<sup>o</sup> 28'E). Elevation is 1600m above sea level and the mean temperature is 19.6°C [23]. The mean annual rainfall is 717mm, with a bimodal pattern, the long rains (LR) occurring from March-May and the short rains (SR) from October- December with two dry seasons (June-September; January- February). The soils are Luvisols, low in nitrogen and phosphorus with a PH of 6.5 [24].

### 2.2 Experiment: Analysis of Chemical Composition and Nutritive Value of Brachiaria Grass Cultivars harvested at 22, 24 and 28 weeks post seedling emergence.

Grass samples from a field sown in November, 2013 were harvested at week 22, 24 and 28 post seedling emergence from an area of 2m<sup>2</sup> in a split plot arrangement as in shown figure 1. The field comprised of 9 *Brachiaria* grass cultivars, namely; *B. brizantha* cultivars Marandu, Xaraes, Piata and MG4; *B. decumbens* cv. Basilisk; *B. humidicola* cv. Llanero and *Brachiaria* hybrid cv. Mulato II with Napier grass (*P. purpureum* cv Kakamega I) and *C. gayana* cv KATR3 serving as controls planted in a randomized complete block design layout with 4 replications. The individual plot sizes measured 5m x 4m with a 1m path between plots and 1m path between the replications. Prior to this, the grasses underwent standardization cuts at week 16 (onset of the March-May Long rainy season of the year 2014) post seedling emergence, marking the end of their establishment phase after which the plots were top dressed with CAN at rates of 100kg N/Ha. Napier was harvested only at week 24 post seedling emergence in an area of 4m<sup>2</sup>. A fresh weight of all the harvested material was recorded after which sub samples of these were weighed and recorded. The sub samples were dried in an oven for 72 hours at temperatures of 65°C after which the dry sample weights were recorded. These oven dried samples included the leaves and stems harvested at 5cm stubble height. The dried samples were then grinded with a hammer mill and sieved using 1mm sieves and stored in labeled plastic bags in preparation for the proximate analyses method [25] and the [26] feed analysis for feed quality assessment and chemical analysis.

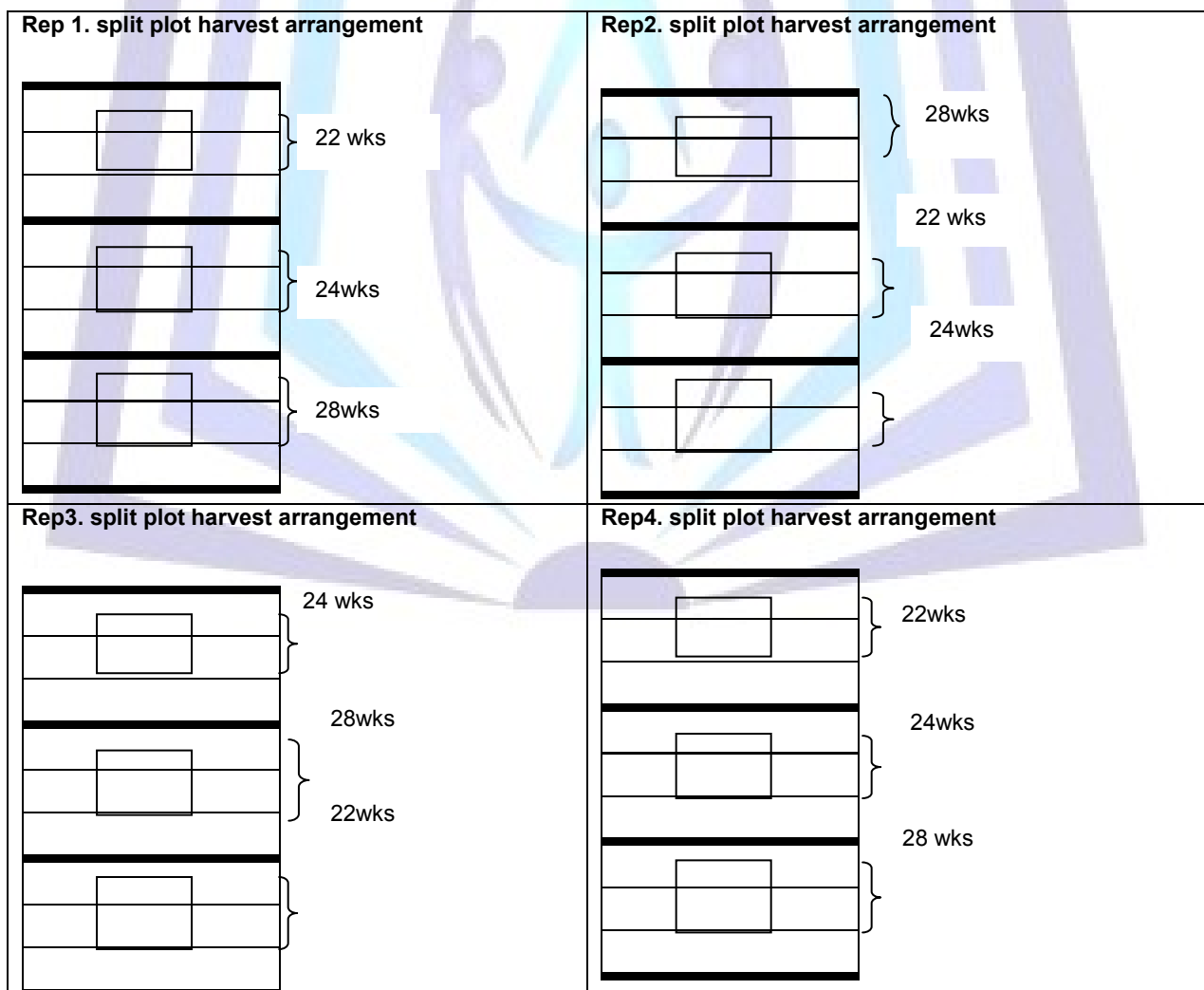


Fig 1: Sample harvest of the *Brachiaria* grass cultivars at week 22, 24 and 28 post seedling emergence

Key



- Rows of planted grass
- Border rows(also planted)
- Quadrat

Rep. 1,2,3,4 represent the 4 replications repectively

### 2.2.1 Forage Quality Analysis.

Chemical analyses were carried out at the KALRO Muguga animal nutrition laboratory. The chemical analyses were performed to determine the, crude protein (CP), *In vitro* dry matter digestibility (IVDMD), Ash, Crude fibre (neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent Lignin (ADL)). Crude protein was analyzed using Kjeldahl nitrogen determination [27]. Fibre analysis was done using the Ankom fibre method which is a modification of the [28] of forage analysis. Each sample of the extractions was done in the order of NDF (%), ADF (%) and then ADL (%). For determination of *in vitro* dry matter digestibility (IVDMD), the two stage technique for in vitro digestion of forage crops [29] was used. The ruminal fluid was obtained from one rumen cannulated steer with an average weight of 550 kg kept on Rhodes grass pasture and hay. Ash was determined by weighing the resulting inorganic residue [25]. Minerals were analyzed on a Thermo ICAP 6300 Inductively Coupled Plasma (ICP) Radial Spectrometer. Metabolizable energy was estimated on the basis of the equation described by [30].

### 2.3 Statistical analyses.

Data on chemical composition, nutritive value and dry matter yields of forage samples were subjected to ANOVA based on the model designed for a randomized complete block design (RCBD) according to [31]. To compare significant differences in response variables, ANOVA analysis was done using SAS package [32]. Duncan’s Multiple Range Test was carried out for subsequent comparison of means as described by [33].

## 3.0 RESULTS

### 3.1 Climatic Data

Rainfall data (Fig. 2) for the site during the period January 2012– June 2014 have been presented for 5 seasons: long rains (March–May), short rains (October–December), short dry season (January–February) and long dry season (June–September). Rainfall for the long rains in 2014 is given for 3 months, March– May, which was recorded toward the end of the experimental period. Rainfall during the long rains was above the short-term average (STA) in March 2013 and 2014 and May 2012. April 2012 and 2013 also recorded rains above the Short Term Average (STA). The short rains were quite variable being well above the Short-term average in November 2012 and 2013 and December 2013. The temperatures in almost all months were similar to the medium term average (Fig.3).

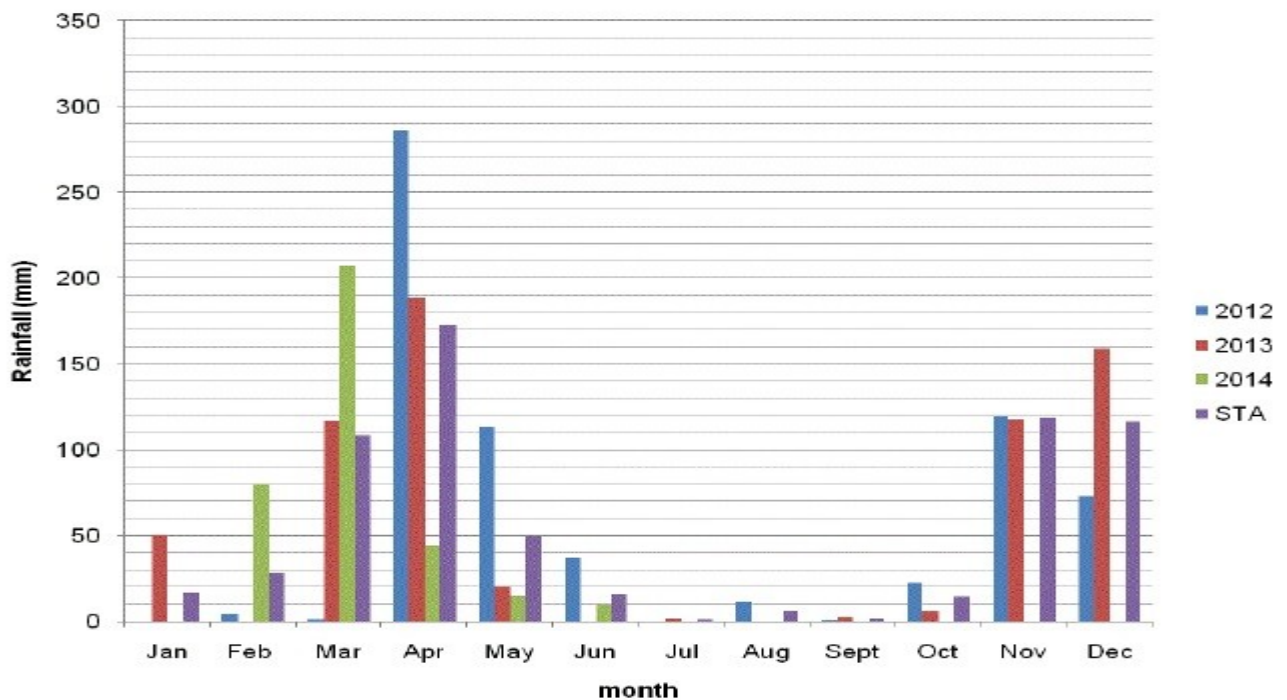


Fig 2: Monthly rainfall recorded data at experimental site from year January, 2012 to June, 2014

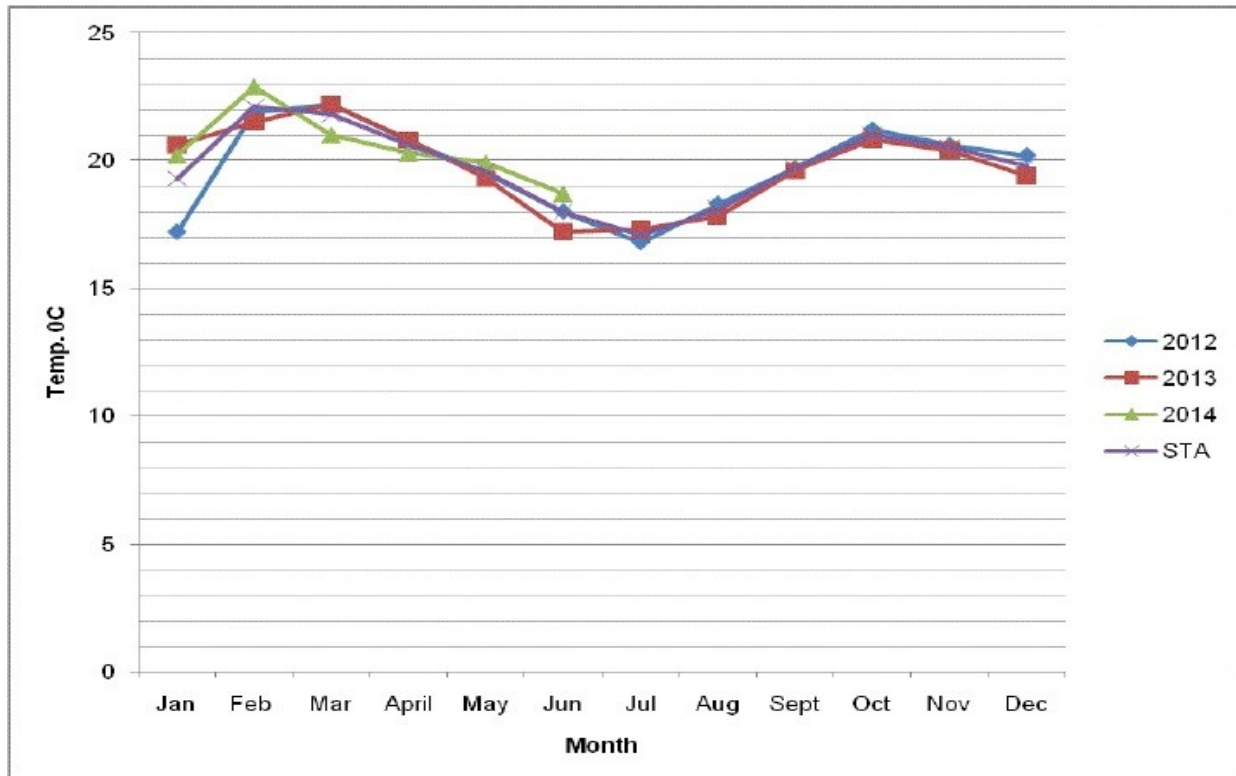


Fig 3: Mean monthly temperature at experimental site from year 2012 January to June, 2014

### 3.2 Feed Quality and Chemical analyses

Mean ash content for the cultivars was significantly different at week 22 as shown in table 1 below. *Chloris gayana* KATR3 recorded highest calcium (0.158%) but lowest ash(9.58%) and phosphorus(0.054%) content while Mulato II had the highest but similar ( $p>0.005$ ) value to Marandu for ash during this period. Mean crude protein values for all the cultivars were significantly different ( $p<0.05$ ) and moderately high (Mean CP 11.1%). Mulato II recorded highest protein content (12.8%) though this value was similar to values for MG4 (11.5%), Piata (11.5%), Xaraes (11.1%) and Marandu (11.9%). *Chloris gayana* KATR3 recorded lowest but similar CP values to Basilisk. Values for NDF, ADF and ADL were highest for *Chloris gayana* KATR3 although its ADL value was similar to those for Basilisk, Xaraes, Mulato II and Llanero. MG4 had highest but similar DMD to Piata, Xaraes, Marandu, Mulato II and Llanero. Xaraes had highest but similar metabolizable energy to MG4, Piata, Xaraes, Marandu and Mulato II.

Table 1: Table showing chemical composition and feed quality of cultivars at week 22 post seedling emergence

	Ca%	P%	Ash%	CP%	NDF%	ADF%	ADL%	DMD %	ME (MJ/kg DM)
<b>MG4</b>	0.117 <sup>bc</sup>	0.087 <sup>a</sup>	13.3 <sup>bc</sup>	11.5 <sup>bac</sup>	60.6 <sup>c</sup>	36.1 <sup>ed</sup>	3.1 <sup>b</sup>	57.5 <sup>a</sup>	6.9 <sup>ba</sup>
<b>KATR3</b>	0.158 <sup>a</sup>	0.054 <sup>c</sup>	9.5 <sup>d</sup>	9.7 <sup>c</sup>	72.5 <sup>a</sup>	45.6 <sup>a</sup>	5.2 <sup>a</sup>	48.7 <sup>b</sup>	6.1 <sup>c</sup>
<b>Basilisk</b>	0.108 <sup>c</sup>	0.63 <sup>cd</sup>	13.1 <sup>bc</sup>	9.8 <sup>c</sup>	63.9 <sup>cb</sup>	38.6 <sup>cbd</sup>	3.6 <sup>ba</sup>	37.2 <sup>c</sup>	5.3 <sup>d</sup>
<b>Piata</b>	0.123 <sup>bc</sup>	0.065 <sup>cb</sup>	13.1 <sup>bc</sup>	11.5 <sup>bac</sup>	63.6 <sup>cb</sup>	37.1 <sup>ced</sup>	2.9 <sup>b</sup>	53.2 <sup>ba</sup>	6.6 <sup>ba</sup>
<b>Xaraes</b>	0.104 <sup>dc</sup>	0.068 <sup>b</sup>	12.6 <sup>c</sup>	11.1 <sup>bac</sup>	64.7 <sup>b</sup>	39.2 <sup>cb</sup>	3.9 <sup>ba</sup>	59.1 <sup>a</sup>	7.04 <sup>a</sup>
<b>Marandu</b>	0.154 <sup>ba</sup>	0.081 <sup>a</sup>	14.6 <sup>ba</sup>	11.9 <sup>ba</sup>	60.3 <sup>c</sup>	35.3 <sup>fe</sup>	3.2 <sup>b</sup>	57.0 <sup>a</sup>	7.0 <sup>ba</sup>
<b>Mulatoll</b>	0.14 <sup>bac</sup>	0.087 <sup>a</sup>	15.0 <sup>a</sup>	12.8 <sup>a</sup>	56.1 <sup>d</sup>	32.8 <sup>f</sup>	4.4 <sup>ba</sup>	57.4 <sup>a</sup>	7.01 <sup>ba</sup>
<b>Llanero</b>	0.069 <sup>d</sup>	0.065 <sup>cb</sup>	12.3 <sup>c</sup>	10.7 <sup>bc</sup>	63.4 <sup>cb</sup>	40.0 <sup>b</sup>	5.3 <sup>a</sup>	52.5 <sup>ba</sup>	6.5 <sup>bc</sup>
<b>Napier</b>	-	-	-	-	-	-	-	-	-
<b>mean</b>	0.123	0.071	13.0	11.1	63.1	38.1	3.9	52.8	6.6
<b>SE</b>	±0.042	±0.001	±0.2	±0.2	±0.4	±0.3	±0.2	±0.7	±0.1

Column means with similar superscripts are not significantly ( $p<0.05$ ) different



At the week 24 post seedling emergence harvest, there was a general decrease in ash content for the forages although significant differences ( $p < 0.05$ ) were noted among their mean values as shown in table 2. Values for ash for Mulato II and Xaraes were the same as those recorded at week 22. Napier recorded highest ash content at 15.2% but similar values to Mulato II (15%) and Marandu (13.9%). *Chloris gayana* cv KATR3 recorded lowest ash content at 9.5%. Calcium and phosphorus content on the other hand increased except for cultivars Basilisk, Marandu and Mulato II. There were significant differences ( $p < 0.05$ ) among the cultivars for mean Calcium and phosphorus content. *Chloris gayana* cv KATR3 recorded highest calcium content (0.347%) and Marandu lowest calcium content at 0.085%. Cultivar MG4 recorded highest values for phosphorus (0.136%) and Napier lowest for the same at 0.5%. Crude protein values decreased during this harvest period although mean values for the cultivars were significantly different ( $p < 0.05$ ). Highest crude protein values were recorded for Mulato II (10.7%) yet similar to values for Xaraes (9.6%) and Llanero (9.5%). Napier recorded lowest CP (7.6%) value yet similar to *C.gayana* KATR3 (6.9%), Basilisk (8%) and MG4 (8%). Significant differences ( $p < 0.05$ ) were noted for NDF, ADF and ADL content among the cultivars. Values for NDF, ADF and ADL were highest in *C.gayana* cv KATR3. Mulato II recorded lowest NDF content at 60.6% and Marandu lowest ADF at 35.4%. Xaraes and Marandu recorded lowest ADL content at 2.3% each which was similar to values for MG4 (3.3%), Basilisk(3.4%), Piata (2.9%), Mulato II (2.6%) and Napier (3.2%). There were significant differences ( $p < 0.05$ ) for mean Dry matter digestibility among the cultivars. Dry matter digestibility decreased for all the cultivars except Basilisk and Mulato II. Mulato II had highest (57.5%) but similar DMD values to MG4 (54.4%), Basilisk (53.8%), Piata (54%), Xaraes (54.1%) and Napier (52.8%). Llanero had lowest (42.7%) though similar DMD values to *C. gayana* KATR3 (45.5%). There was a significant ( $p < 0.05$ ) difference and general decrease in metabolizable energy of the cultivars. Mean metabolizable energy dropped to 6.5 MJ/Kg DM. Mulato II (7.0 MJ/KgDM) recorded highest but similar metabolizable energy to *C. gayana* KATR3 (6.5MJ/Kg DM), Basilisk(6.6MJ/Kg DM), Piata (6.6MJ/KgDM), Xaraes (6.7MJ/Kg DM), Marandu (6.5MJ/Kg DM) and Napier (6.5MJ/Kg DM).

**Table 2: Table showing chemical composition and feed quality of cultivars at week 24 post seedling emergence**

Cultivar	Ca%	P%	Ash%	CP%	NDF%	ADF%	ADL%	DMD%	ME (MJ/Kg DM)
MG4	0.218 <sup>cb</sup>	0.136 <sup>a</sup>	12.5 <sup>bc</sup>	8.0 <sup>dc</sup>	64.7 <sup>c</sup>	38.8 <sup>cd</sup>	3.3 <sup>cb</sup>	54.4 <sup>ba</sup>	6.1 <sup>bc</sup>
KATR3	0.347 <sup>a</sup>	0.078 <sup>c</sup>	8.6 <sup>d</sup>	6.9 <sup>d</sup>	72.3 <sup>a</sup>	48.5 <sup>a</sup>	6.6 <sup>a</sup>	47.5 <sup>bc</sup>	6.5 <sup>ba</sup>
Basilisk	0.106 <sup>ed</sup>	0.05 <sup>d</sup>	12.1 <sup>bc</sup>	8.0 <sup>dc</sup>	68.1 <sup>b</sup>	42.2 <sup>bc</sup>	3.4 <sup>cb</sup>	53.8 <sup>ba</sup>	6.6 <sup>ba</sup>
Piata	0.237 <sup>b</sup>	0.096 <sup>cb</sup>	11.4 <sup>c</sup>	8.7 <sup>bc</sup>	67.0 <sup>cb</sup>	40.8 <sup>bcd</sup>	2.9 <sup>c</sup>	54.0 <sup>ba</sup>	6.6 <sup>ba</sup>
Xaraes	0.267 <sup>b</sup>	0.109 <sup>b</sup>	12.6 <sup>bc</sup>	9.6 <sup>ba</sup>	65.2 <sup>cb</sup>	35.4 <sup>d</sup>	2.3 <sup>c</sup>	54.1 <sup>ba</sup>	6.7 <sup>ba</sup>
Marandu	0.085 <sup>e</sup>	0.08 <sup>c</sup>	13.9 <sup>ba</sup>	9.2 <sup>bc</sup>	65.6 <sup>cb</sup>	38.6 <sup>cd</sup>	2.3 <sup>c</sup>	52.0 <sup>ba</sup>	6.5 <sup>ba</sup>
Mulato II	0.133 <sup>ed</sup>	0.075 <sup>c</sup>	15.0 <sup>a</sup>	10.7 <sup>a</sup>	60.6 <sup>d</sup>	36.9 <sup>cd</sup>	2.6 <sup>c</sup>	57.5 <sup>a</sup>	7.0 <sup>a</sup>
Llanero	0.168 <sup>cd</sup>	0.098 <sup>cb</sup>	11.4 <sup>c</sup>	9.5 <sup>ba</sup>	66.6 <sup>cb</sup>	40.9 <sup>bcd</sup>	4.4 <sup>b</sup>	42.7 <sup>c</sup>	5.7 <sup>c</sup>
Napier	0.110 <sup>ed</sup>	0.50 <sup>d</sup>	15.2 <sup>a</sup>	7.6 <sup>d</sup>	68.2 <sup>b</sup>	45.1 <sup>ba</sup>	3.2 <sup>cb</sup>	52.8 <sup>ba</sup>	6.7 <sup>ba</sup>
mean	0.186	0.085	12.5	8.7	66.5	40.8	3.4	52.1	6.5
SE	±0.007	±0.002		±0.1	±0.3	±0.6	±0.1	±0.9	±0.1

Column means with similar superscripts are not significantly ( $p < 0.05$ ) different

Mean ash content for the cultivars decreased at the week 28 post seedling emergence harvest. Cultivar Marandu (12%) recorded highest but similar ash content to Mulato II (11.4%), Llanero (11.1%) and Xaraes (10.6%) as shown in table 3. below. *Chloris gayana* cv KATR3 (8.3%) recorded lowest but similar ash content to basilisk (8.5%) and MG4 (9.6%); highest calcium content (0.357%) and lowest but similar phosphorus content to Piata (0.056%) and Basilisk (0.064%). Llanero recorded lowest (0.099%) but similar calcium content to Piata (0.139%). Crude protein content for all the cultivars decreased at week 28 harvest with mean CP content value being 6.3%. Xaraes recorded highest (8.0%) but similar CP content to Mulato II (7.0%), MG4 (7.0%) and Llanero (6.6%). *Chloris gayana* cv KATR3 recorded lowest CP content at 4.4% and highest NDF (73.8%), ADF (50.2%) and ADL (6.5%) values. ADL content for all the cultivars was similar. Mean DMD for the cultivars also decreased (45.1%). Piata recorded the highest, 52.3% but similar DMD to Mulato II (51.4%), Basilisk (50.1%), *Chloris gayana* cv KATR3 (46.4%), Xaraes (45.8%) and Llanero (43.6%). Marandu had the lowest DMD at 28.8%. The metabolizable energy for the cultivars also decreased at the week 28 harvest (mean ME being 5.9 MJ/KgDM). Values for ME for the cultivars were significantly different ( $p < 0.05$ ). Piata (6.4 MJ/KgDM) and Mulato II (6.4MJ/KgDM) recorded highest but similar ME values to Basilisk (6.2 MJ/KgDM), *C.gayana* KATR3 (5.9 MJ/KgDM), Xaraes (5.9 MJ/KgDM), Llanero(5.9 MJ/KgDM) and MG4(5.7 MJ/KgDM). Marandu recorded lowest ME values at 4.6 MJ/KgDM.

**Table 3: Table showing chemical composition and feed quality of cultivars at week 28 post seedling emergence**

	Ca%	P%	Ash%	CP%	NDF%	ADF%	ADL%	DMD %	ME (MJ/kg DM)
<b>MG4</b>	0.168 <sup>dc</sup>	0.082 <sup>bac</sup>	9.6 <sup>dc</sup>	7.0 <sup>ba</sup>	69.1 <sup>c</sup>	42.9 <sup>b</sup>	4.4 <sup>a</sup>	43.6 <sup>a</sup>	5.7 <sup>a</sup>
<b>KATR3</b>	0.357 <sup>a</sup>	0.048 <sup>ed</sup>	8.3 <sup>d</sup>	4.4 <sup>d</sup>	73.8 <sup>a</sup>	50.2 <sup>a</sup>	6.5 <sup>a</sup>	46.4 <sup>a</sup>	5.9 <sup>a</sup>
<b>Basilisk</b>	0.198 <sup>c</sup>	0.064 <sup>edc</sup>	8.5 <sup>d</sup>	4.9 <sup>dc</sup>	71.3 <sup>b</sup>	42.4 <sup>b</sup>	4.9 <sup>a</sup>	50.1 <sup>a</sup>	6.2 <sup>a</sup>
<b>Piata</b>	0.139 <sup>de</sup>	0.056 <sup>ed</sup>	10.2 <sup>bc</sup>	6.1 <sup>bc</sup>	69.0 <sup>c</sup>	41.1 <sup>cb</sup>	4.0 <sup>a</sup>	52.3 <sup>a</sup>	6.4 <sup>a</sup>
<b>Xaraes</b>	0.178 <sup>dc</sup>	0.072 <sup>bdc</sup>	10.6 <sup>bac</sup>	8.0 <sup>a</sup>	67.5 <sup>c</sup>	39.9 <sup>cbd</sup>	5.2 <sup>a</sup>	45.8 <sup>a</sup>	5.9 <sup>a</sup>
<b>Marandu</b>	0.267 <sup>b</sup>	0.096 <sup>a</sup>	12.0 <sup>a</sup>	6.2 <sup>bc</sup>	65.6 <sup>d</sup>	38.0 <sup>cd</sup>	3.6 <sup>a</sup>	28.8 <sup>b</sup>	4.6 <sup>b</sup>
<b>Mulato II</b>	0.277 <sup>b</sup>	0.091 <sup>ba</sup>	11.4 <sup>ba</sup>	7.0 <sup>ba</sup>	63.3 <sup>e</sup>	37.5 <sup>d</sup>	6.4 <sup>a</sup>	51.4 <sup>a</sup>	6.4 <sup>a</sup>
<b>Llanero</b>	0.099 <sup>e</sup>	0.074 <sup>bdc</sup>	11.1 <sup>ba</sup>	6.6 <sup>ba</sup>	68.7 <sup>c</sup>	40.4 <sup>cbd</sup>	4.4 <sup>a</sup>	45.5 <sup>a</sup>	5.9 <sup>a</sup>
<b>Napier</b>	-	-	-	-	-	-	-	-	-
<b>mean</b>	0.211	0.073	10.2	6.3	68.5	41.5	4.9	45.1	5.9
<b>SE</b>	±0.005	±0.002	±0.2	±0.2	±0.2	±0.4	±0.3	±1.6	±0.1

Column means with similar superscripts are not significantly ( $p < 0.05$ ) different

#### 4.0 DISCUSSION

With advancing stage of development during the harvest intervals, consistent decline in ash, phosphorus, Crude protein, IVDMD and metabolisable energy was observed. On the other hand Ca, NDF, ADF and ADL increased.

In this study, *Chloris gayana* cv KATR3 recorded highest calcium content during all the harvest intervals with Marandu and Mulato II recording highest phosphorus content. A high calcium content with increasing age can be explained on the basis of the increased amount of cellular material which is composed principally of this element [34]. [35] However reported that the late-season increases in calcium and ash may be attributed to dust accumulations. A late stage pregnant cow requires 11% of CP, 0.37% of Ca and 0.26% of P daily [36]. A dry cow requires 0.25% Ca and 0.16% P, while a lactating cow needs 0.31% Ca and 0.21% P. Among the grasses only *Chloris gayana* cv KATR3 is able to meet the calcium content of 0.37% for late stage pregnant cows. None of the grasses attained the Phosphorus content required by late pregnancy, dry and lactating cow.

For all the grasses the levels of CP in the harvested forage exceeded the minimum of 7.0% suggested as necessary for optimum rumen function by [37] at the week 22 harvest but dropped during the week 24 and 28 harvests. This trend in CP content has been reported in other studies by [38]; [39] and [40] and is mainly attributable to dilution of the CP contents of the forage crops by the rapid accumulation of cell wall carbohydrates at the latter stages of growth [37]. Comparative studies were developed by [41] who evaluated the nutritional values of Marandu palisadegrass, Xaraes palisadegrass and Piata palisadegrass and showed that regardless of the experimental year, the CP were higher during the rainy season. [42] reported that other factors like maturity of the grass can be the source of declining CP.

The *Brachiaria brizantha* cultivars had high (11.1-11.9%) and similar CP content with Mulato II (12.8%) at the week 22 harvest which can be partly attributed to the Nitrogen application of fertilizer at rates of 5.8 Kg N /Ha after standardization cuts were done on the plots. Studies carried out by [43] report that the effects of 3 cutting intervals (20, 40, 60days) and four rates of N application (0, 100,200 or 400kg N/ha) on the yield and CP content of *B. brizantha* at Morogoro Tanzania. Crude protein content of the herbage declined with longer cutting intervals, but increased from 6.9% to 12.9% when N was increased from 0 to 400kg/ha. Crude protein yield increased with increasing cutting interval up to the 40-day interval. It was concluded that at Morogoro, Tanzania *B. brizantha* should be harvested at about 6-week intervals to strike a balance between herbage yield and quality. Values for Napier (7.6%) which was cut once at week 24 were above 7.0% as recommended by [37] for rumen microbial function. In all the harvest intervals Mulato II recorded high CP levels that ranged between 7-12.8% which is almost within the range reported by [44] of 10-14% crude protein in Thailand on poor soils and 12-17 % crude protein on better soils in Florida, USA. Values for CP for Basilisk ranged between 9.8% (week 22 harvest) and 4.9% (week 28 harvest). These were lower than those found by [45] in the tropical region of Indonesia for *Brachiaria decumbens* collected in the natural grassland of Sumatra during the wet and dry seasons at CP content of 12.8 and 8.7%, respectively. Decline in nutritional quality of *Chloris gayana* with age in this study has also been reported in similar studies by other authors. [46], [47], [48] and [49] report that there is rapid decline in digestibility and protein content of *C.gayana* with advance in development. Other authors report that *C. gayana* is characterized by a particularly low nutritive value of stems compared to leaves and that it is also influenced by the season and variety [50]; [51].

The trend in NDF content due to age at cutting was similar with ADF and ADL and significantly increased ( $P < 0.05$ ) with advance in maturity confirming the results of similar studies by [52]) and [53]. NDF is relevant to the improvement of the forage nutritional value and can be an important parameter to define the forage quality, because the more fibrous pasture occupies more space for longer and limits the intake rate. For all grasses used in the study, the value of NDF was high during the third harvest (week 28) and varied between 63.3-73.8%. A high NDF that is above 72% will cause low intake of



forage [54] and as NDF percentages increase, dry-matter intake generally will decrease [55]. High NDF content can be attributed to the low development of the grasses in the dry period and to forage maturation [56]. The NDF content for *Chloris gayana* cv KATR3 was above 72% during all the harvest intervals and this according to [54] can cause low intake. Mulato II maintained lowest NDF content in all the harvest intervals ranging between 56.1% and 63.3%. The *B. brizantha* cultivars had NDF values ranging between 60.3 and 71.3% of which the highest value of NDF at 71.3% was demonstrated by Basilisk at week 28 harvest. ADF is the value that refers to the cell wall portions of the forage that are made up of cellulose and lignin. These values are important because they relate to the ability of an animal to digest the forage. The digestibility of foods is related to the fiber because the indigestible portion has a proportion of ADF, and the higher the value of ADF the lower the food digestibility [57]. Xaraes, Mulato II and Marandu maintained below 40% ADF throughout the harvest periods. [58] reports that forage with ADF content around 40%, or more, shows low intake and digestibility. Studies conducted by [59] report that intercropping annual crops eg. corn with forages is a good option for providing quality food at critical periods of drought, as from the corn harvest; there is recovery of emergence of new tillers, providing yield and forage with good digestibility. [59] further report that forages grown in integrated systems with corn were still able to attain below 40% ADF at the fourth harvest. *Chloris gayana* cv. KATR3 maintained higher values for ADF during all the harvest intervals. Acid Detergent Lignin content for all the cultivars increased with harvest interval and was in conformity with other reports by [38], [40] and [60] that showed that ADL content increases with the advance in harvesting days of forage crops. [61] has reported that the soil fertility could also influence grass lignin concentration. *Chloris gayana* KATR3 recorded higher ADL (5.2-6.5%) content in all the harvest intervals although at week 28 harvest, values for ADL for all the cultivars were similar. Mean ADL values for the grasses ranged between 3.9-4.9% which is within the range reported by [62] that the lignin contents of marginal land grasses at early bloom varied between 2.8% to 4.6% and at mature stage lignin contents ranged between 3.4 to 5.7%.

Decreasing values of DMD may possibly be explained by the advancing physiological maturity, due to the seasonality of forage production which increases the cell wall components and reduces digestibility. The age at cutting of forage crops also has an influence on DMD, which is a function of the chemical constituents of forages [63]. Dry Matter Digestibility values of the grasses ranged between 43.6-57.5% far less than the range reported by [64] for the digestibility of cultivated tropical grasses which lie between 50 and 65% and of temperate grasses which lie between 65 and 80%. Piata, Basilisk and Mulato II had higher digestibility compared to the other grasses at harvest interval week 28. Values of IVDMD in signal grass of *B. decumbens* has been found to range between 60% to 70% in immature forage, and from 50% to 60% in mature forage, higher than the average (55%) for tropical forage grasses found by [65]. The DMD values for the *Chloris gayana* cv KATR3 agree with those reported by [66] of 40 to 60% for sole Rhodes grass. Basilisk recorded digestibility values ranging between 37.2% (at week 22 harvest) to 50.1% (at week 28 harvest interval) which is almost in the range of 42.7 and 50.3%, obtained by [67]. [67], however, reports that the *Brachiaria decumbens* in his experiment was subject to the shadow of a leguminous tree.

Mean metabolisable energy during the harvest intervals decreased from 6.6-5.9 MJ/kg DM. The highest metabolisable energy values obtained in this experiment were for Xaraes, Marandu and Mulato II of 7.0 MJ/kg DM. In relation to the metabolizable energy, [68] report that pasture and forage with values exceeding 8.37 MJ/kg DM are considered of good quality.

## 5.0 CONCLUSION

The stage of maturity seems to influence forage quality with Crude protein, phosphorus, DMD and ME tending to decrease with advancing maturity. On the other hand NDF, ADF ADL and calcium increase with advancing maturity. The grass cultivars in this study vary as to digestibility and nutritive composition. The *Brachiaria* species are richer in ash and phosphorus compared to *C. gayana* KATR3 and Napier grass. *Chloris gayana* records higher calcium content than all the grasses. MG4 and Mulato II are the only grasses that meet CP requirement for microbial rumen function throughout all the harvest stages. *Chloris gayana* records high NDF, ADF and ADL and consequently lower digestibility than all the other grasses. The low energy values obtained from this study suggest that energy may be a limiting nutrient in all these grass cultivars. *Brachiaria* cultivars however, are superior to both Napier and *Chloris gayana* in CP, digestibility, and fibre and may be able to supplement these nutrients when intergrated with the indigenous forages to boost livestock feed resources in arid and semi arid regions in Kenya. Further research is needed to establish their animal production potential in these regions.

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### Biography of the fourth author



Mwobobia Royford Murangiri holds a Bachelor of Veterinary Medicine degree and is currently working as a Veterinary officer with the Kitui County Government, Kenya. He is a student at South Eastern Kenya University pursuing a Master of Science degree in Livestock Production Systems

