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Nutrient Characteristics of Six Cold Tolerant Sorghum (*Sorghum bicolour* (L) Moench) Genotypes Across Different Ecozones

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Abstract: The study was carried out at three locations using six sorghum genotypes in Bomet district, Kenya during the long rains of the years 2001, 2002 and 2003. The objective was to determine the nutrient composition of six sorghum (*Sorghum bicolour* (L) Moench) varieties across agro-ecological zones. The sorghum varieties selected at KARI-Lanet included E1291, Ikinyaruka, Lan-1, BJ28, E6518 and a local variety. The samples collected were analyzed for DM, OM, CP, NDF and ADF. There were significant differences ($p< 0.001$) in OM, CP, NDF and ADF at all locations. There were also significant differences ($p< 0.001$) in nutrient composition among the six varieties. Ikinyaruka had the highest OM across the locations. Mulot had the highest CP while Kapliyo gave the highest amount of ADF among all the varieties. E6518 and Ikinyaruka showed the highest OM, NDF and ADF and were lowest in CP, respectively. Mulot was the best location for all the varieties while BJ28 was the most stable variety with the highest CP and moderate amounts of fibre across all the three locations.

Key words: Sorghum, genotypes, nutrients, forage, Bomet district

INTRODUCTION

Kenya, a developing country is faced by a myriad problems including an upsurge in population, increasing poverty and declining agricultural productivity[1,2]. Declining land sizes and unfavorable weather conditions have partly contributed to these problems. The reducing land sizes have led to the shortening of fallow periods that used to restore soil fertility in many traditional farming systems[3]. Agricultural output in the 1970s in Sub-Saharan Africa (SSA) decreased by 1.3%, while population rose by 2.7%[1]. Kenya's population growth rate was 4% per annum (p.a) in 1979[4], but by 1999 it had reduced significantly to 2.9% p.a.[5]. Achieving food security and eradicating extreme poverty and hunger in Kenya calls for growth in the agricultural sector through research that targets increased productivity.

The livestock sub-sector of the Kenyan economy contributes about 10% of the GDP[2] despite the widespread use of traditional production methods particularly in the Arid and Semi-arid Land (ASAL) where about 50% of livestock are found. Sorghum is one of the food security cereals grown in the marginal areas of the world and is ranked third among cereals in Kenya. Various varieties have been grown but little is known about the environmental effect on their nutritional composition[6,7]. Technological innovative interventions, particularly targeting increased feed availability could increase animal production. The target should be to avail quantity and quality balanced feed diets the year round to guarantee high stable production continuously. This is particularly useful in areas where dairy production forms the main livestock activity.

Studies carried out at KARI-Lanet[8] demonstrated the suitability of cold tolerant sorghum as a feed source for ruminants due to its high DM yields, lower risks and easy to harvest. Sorghum (*Sorghum bicolor* (L) Moench) is widely grown in Kenya where it is ranked third after maize and wheat[2]. The crop is adapted to drought prone environments that receive 300 - 760 mm annual rainfall. Cold tolerant sorghum has a great potential for expansion in 75% of the Kenyan semi-arid and arid lands that are characterized by low and unreliable rainfall. KARI[2] in its medium term plan aims at disseminating livestock production technologies to support profitable Crop-livestock based enterprises. The high yields that most forages produce is attributed to the high plant population and high biomass (DM) produced per unit area[8,9]. In areas where rainfall is above 1000 mm, forage sorghum produces similar DM yield to maize, however under low rainfall regimes, the dual-purpose varieties yield more[6,10]. The current study was meant to transfer the research station sorghum technology to farming communities. The objective of the study was to determine the nutrient

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compositions stability of six cold tolerant sorghum varieties across agro-ecological zones.

MATERIALS AND METHODS

The study was carried out at three locations using six sorghum genotypes in Bomet district, Kenya during the rainy season of 2001, 2002 and 2003 respectively. Experiments were conducted on farms at Kapliyo, Kiplabotwo and Mulot locations (0°N37'S, 35°N28'E), mean rainfall 1000 mm pa and minimum temperature 12°C while maximum temperature 30°C[12]. These are dry highland trial locations within the Kenyan Rift Valley Province. A plot for each entry measured 4 meters long with 4 rows. Five dual-purpose sorghum genotypes E1291, Ikinyaruka, Lan1, BJ28; local entry and E6518 (forage) were used for this study. The dual-purpose sorghum varieties were spaced at (60×20) cm while forage sorghum was spaced at (75×10) cm in a Randomized Complete Block Design and replicated four times. Recommended agronomic practices were followed at all sites. Harvesting was carried out at hard dough stage by cutting whole stalks of two middle rows. The stalks and heads were chopped into small pieces from which a sub sample was collected for laboratory analysis.

Laboratory analyses were done for Dry Matter (DM), Organic Matter (OM), Crude Protein (CP), Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF) according to a methods described by AOAC[13].

The data obtained from feed analyses was subjected to an Analysis of Variance (ANOVA) and GENSTAT[14]. Fishers protected Least Significant Difference (LSD) at the 5% level of probability was used to separate treatment means.

RESULTS AND DISCUSSION

The nutrient components of the sorghum varieties were significantly ($p<0.001$) different for OM, CP, NDF and ADF but were similar ($p>0.05$) for DM as shown in Table 1.

Table 1: Mean nutrient composition of the six sorghum varieties (%)

Variety/Nutrients	DM	OM	CP	NDF	ADF
E6518	30	89.9^{a}	5.5^{c}	67.2^{a}	46.4^{a}
Lan-1	29.3	88.7^{b}	6.7^{b}	62.8^{b}	39.9^{d}
E1291	31.4	88.4^{b}	6.4^{b}	65.9^{b}	43.5^{b}
Ikinyaruka	31.4	89.7^{a}	5.5^{c}	65.9^{a}	43.7^{b}
BJ28	31.1	85.2^{c}	7.7^{a}	63.3^{b}	43.4^{b}
Local variety	30.3	88.5^{b}	6.5^{b}	62.6^{b}	43.4^{b}
SEM	1.3	0.3	0.15	0.84	0.16
LSD	3.7	0.69	0.43	1.7	0.46

Columns with different superscript are significantly different ($p<0.001$)

The differences in nutrient components of the various sorghum varieties (Table 1) were similar for each nutrient across the varieties. There were chemical composition similarities among E6518 and Ikinyaruka and Lan-1, E1291 and local variety. However, E6518 was significantly ($p<0.001$) high in ADF while Lan-1 and local variety manifested combinations of high CP and low ADF. BJ28 stood out as a peculiar variety with low OM but highest ($p<0.001$) CP to the level that is just sufficient for animal maintenance[15]. The values reported in the current study were higher than those reported for brown mid-rib genotypes except for DM and OM[16]. These compared well with species evaluated at the Kenyan coastal lowland[17].

Organic Matter (OM) levels were significantly high ($p<0.001$) for Ikinyaruka at both Kiplabotwo and

Table 2: Means of OM showing variety/location interaction (%)

Variety/Location	Kaplabotwo	Mulot	Kapliyo
E6518	90.1^{b}	89.5^{b}	90.1^{b}
Lan-1	88.3^{c}	89.9^{b}	88.0^{c}
E1291	89.3^{b}	89.2^{b}	86.7^{d}
Ikinyaruka	90.8^{a}	90.7^{a}	87.7^{c}
BJ28	84.4^{f}	88.0^{c}	83.2^{g}
Local variety	89.9^{b}	90.6^{a}	86.0^{e}

Means with different superscript are highly significant ($p<0.001$)
SEM - 0.24, LSD - 0.5, CV% - 0.8

Table 3: Means of CP showing variety/location interactions (%)

Variety/Location	Kaplabotwo	Mulot	Kapliyo
E6518	5.3^{g}	8.1^{a}	3.1^{j}
Lan-1	6.7^{d}	8.2^{a}	5.3^{g}
E1291	6.6^{d}	7.5^{b}	4.9^{h}
Ikinyaruka	5.2^{g}	7.0^{c}	4.4^{h}
BJ28	8.1^{a}	9.3^{a}	5.8^{f}
Local variety	6.3^{e}	9.4^{a}	3.8^{i}

Means with different superscript are highly significant ($p<0.001$)
SEM - 0.15, LSD - 0.3, CV% - 7

Table 4: Means of NDF showing variety/location interactions (%)

Variety/Location	Kaplabotwo	Mulot	Kapliyo
E6518	66.7^{c}	63.2^{c}	71.6^{a}
Lan-1	65.3^{c}	58.9^{d}	64.2^{c}
E1291	68.2^{b}	62.5^{c}	64.4^{c}
Ikinyaruka	69.3^{c}	64.3^{c}	64.0^{c}
BJ28	63.5^{c}	60.3^{d}	66.2^{c}
Local variety	66.4^{c}	59.5^{d}	61.9^{c}

Means with different superscript are highly significant ($p<0.001$)
SEM - 0.4, LSD - 1.2, CV% - 2.8

Table 5: Means of ADF showing variety/location interaction (%)

Variety/Location	Kaplabotwo	Mulot	Kapliyo
E6518	48.6^{b}	39.3^{k}	51.4^{a}
Lan-1	41.6^{h}	37.5^{l}	40.5^{i}
E1291	47.4^{d}	41.9^{h}	41.4^{h}
Ikinyaruka	48.1^{c}	39.9^{j}	43.0^{g}
BJ28	46.3^{e}	39.5^{k}	44.4^{f}
Local variety	46.2^{e}	36.5^{m}	41.6^{h}

Means with different superscript are highly significant ($p<0.001$)
SEM - 0.11, LSD - 0.33, CV% - 1.1

Mulot (Table 2). Only the local variety had similar ($p<0.001$) yields of this component at Mulot. Both E6518 and E1291 were second to Ikinyaruka at Kiplabotwo, Mulot and Kapliyo although E1291 gave significantly lower ($p<0.001$) yields at Kapliyo. BJ 28 had consistently ($p<0.001$) lower yields at all the locations with its trend being similar to that of Lan-1 and the local variety. The most stable variety across all the locations for OM was E6518. The most significant ($p<0.001$) variety/location interactions for this component could be attributed to varietal responses to different microclimates and management systems. However, BJ28 performed as well also at Kiplabotwo (Table 3). The varieties had also significant differences ($p<0.001$) of low CP contents at Kapliyo. BJ28 had significant differences ($p<0.001$) of higher amounts CP supplementation to support animal survival. The most stable varieties across locations for CP component were BJ28 and Lan-1.

The results showed consistently high ($p<0.001$) levels of NDF for E6518, E1291 and Ikinyaruka across the three locations (Table 4). However, there was a highly significant ($p<0.001$) interaction between E6518 and Kapliyo location followed by that of E1291 and Ikinyaruka at Kiplabotwo. Generally the NDF content was lower at Mulot than the other two locations for all the varieties. Three varieties (Lan-1, BJ28 and the local variety) were had significantly ($p<0.001$) low NDF values. A look at Table 3 showed the same varieties were high in CP at the same location.

Table 5 shows the results of the interactions between varieties and location for ADF. The significant outcomes of the results were not different from those of NDF given in Table 4. Highly significant ($p<0.001$) levels of ADF were obtained for E6518 at Kapliyo followed by those of the same variety at Kiplabotwo. High values were also recorded for Ikinyaruka and E1291 at Kiplabotwo location. Significantly ($p<0.001$) low ADF results were recorded for all the varieties at Mulot (Table 5).

Dry matter yields are directly correlated to rainfall[11] or differences in temperature, which is expected to occur at temperature changes of about 6.5°C or at altitude change of 1000 m. The non- significant differences in DM imply minor differences in the microclimate between the locations. Differences among some of the chemical components however, imply a possible difference in rainfall and/or soil temperature Arkel *et al.*[8] found forage sorghums to be more vulnerable to drought than the dual-purpose varieties. This trait was not however observed in the current study particularly on nutrient levels.

CONCLUSIONS AND RECOMMENDATIONS

The nutrient components have grouped E6518 and Ikinyaruka as varieties with high amounts of OM, NDF and ADF but low CP contents. All the varieties had high CP and low ADF contents at Mulot but were very low in CP at Kapliyo location. BJ 28 was found to be the most stable variety with high CP and moderate levels of fibre across the tree locations. Close similarities were observed among Lan-1, E1291 and the local variety, which was not inferior in performance despite its being used as control. Further work should involve more locations, fermentation trials to study their performance as silage and productivity of dairy cattle fed on these forages.

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