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Research Application Summary

An assessment of the nutritional quality of ecotypes of *Digitaria macroblephara* at different phenological stages in southern Kenya

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Abstract

Livestock production is a key economic activity in drylands all over the world. Drylands support a majority of the world's livestock population. Local and indigenous communities in these areas have for long relied on experientially acquired knowledge passed down from one generation to the next for their survival. Tapping into this knowledge base could spur advancement of restoration and pasture production technologies that could ultimately help solve the problem of inadequate pasture for livestock production. Our study determined the nutritional value of ecotypes of *Digitaria macroblephara*; a grass species perceived by agro- pastoral communities in Southern Kenya to improve body condition and milk yield. The ecotypes were harvested at the onset of flowering, at full flowering and after seed maturity for analysis of % crude protein (CP), % Acid Detergent Fiber, % Neutral Detergent Fiber, % ether extract, In-sacco dry matter digestibility (ISDMD), and % lignin. Results showed significant differences in ecotype performance for the nutritional parameters tested at the various growth stages. The Oldonyonyoike ecotype recorded a significantly lower CP content at the onset of flowering. The Olptepesi ecotype had a significantly higher CP and ISDMD at full flowering. The Oldonyonyoike ecotype recorded a significantly higher ISDMD. These differences in performance at different stages of growth provide insight into the optimal timings of harvesting or grazing of these grass ecotypes. Further research looking into their resource use efficiency and tolerance to grazing should however be done so as to come up with a high performing pasture variety that is well adapted to the drylands.

Keywords: Grass ecotypes, indigenous grasses, livestock, nutrition, Southern Kenya

Résumé

La production animale est une activité économique clé dans les zones arides du monde entier. Les zones arides abritent la majorité de la population animale du monde. Les communautés locales et autochtones de ces régions se sont longtemps appuyées sur des connaissances acquises par l'expérience transmises d'une génération à l'autre pour leur survie. L'exploitation de cette base de connaissances pourrait stimuler le progrès des technologies de restauration et de production des pâturages qui pourraient finalement aider à résoudre le problème des pâturages inadéquats pour

la production animale. Notre étude a déterminé la valeur nutritionnelle des écotypes de Digitaria macroblephara; une espèce d'herbe perçue par les communautés agro-pastorales du sud du Kenya pour améliorer l'état corporel et le rendement laitier. Les écotypes ont été récoltés au début de la floraison, à pleine floraison et après la maturité des graines pour l'analyse du % de protéines brutes (PB), du % de fibres détergentes acides, du % de fibres détergentes neutres, du % d'extrait d'éther, de la digestibilité de la matière sèche In-sacco (DMSI) et% de lignine. Les résultats ont montré des différences significatives dans la performance de l'écotype pour les paramètres nutritionnels testés aux différents stades de croissance. L'écotype Oldonyonyoike a enregistré une teneur en PB significativement plus faible au début de la floraison. L'écotype Olptepesi avait un PB et un DMSI significativement plus élevés à pleine floraison. L'écotype Oldonyonyoike a enregistré un DMSI significativement plus élevé. Ces différences de performance à différents stades de croissance donnent un aperçu des délais optimaux de récolte ou de pâturage de ces écotypes d'herbe. Des recherches plus poussées sur l'efficacité de leur utilisation des ressources et leur tolérance au pâturage devraient cependant être effectuées afin de trouver une variété de pâturage très performante et bien adaptée aux zones arides.

Mots-clés: écotypes d'herbe, graminées indigènes, bétail, nutrition, sud du Kenya

Introduction

Globally, livestock production plays a critical role in maintaining food security, more so in dryland ecosystems (Noble *et al.,* 2014). In Kenya, livestock production contributes nearly $800 million to the economy annually, translating to 10% of the country's GDP (GOK, 2015). Kenya's arid and semi arid lands (ASALs) employ 90% of the population in drylands (Benkhe and Muthani, 2011; GOK, 2015). Livestock production in drylands however faces several challenges, key amongst them being the inadequate quality and quantity of pastures (Ndathi *et al.,* 2013; Ndung'u *et al.,* 2017).

Deliberate cultivation of a number of indigenous grass and crop species for the purpose of feeding livestock and creating fodder banks has been identified as one possible solution to these challenges. There has been extensive work done in the past on various indigenous grass species in Kenya (Wasonga *et al.,* 2003; Mnene, 2006; Opiyo, 2007; Mganga *et al.,* 2010; Ogillo, 2010; Ndathi *et al.,* 2011; Machogu 2013, Mganga *et al.,* 2015; Kirwa *et al.,* 2015, Koech *et al.,* 2016), yet little work has been done on the existing ecotypes of specific grass species (Kirwa *et al.,* 2015; Njarui *et al.,* 2015). There is, therefore, little or no information on the nutritive value of these grasses differentiated by ecotypes and phenological stages. Some grass species that are important to agro-pastoral communities in Kenya such as *Digitaria macroblephara* have been little studied (Ndung'u *et al.,* 2017). In order to improve our rangeland restoration efforts and pasture productivity programmes, there is a need to improve our understanding of the indigenous pasture species naturally occurring in Kenya ASALs. This study therefore sought to determine the differences in the nutritional value of ecotypes of *Digitaria macroblephara* at different phenological stages.

Materials and Methods

Study area.The study was carried out at the Kenya Agriculture and Livestock Research Organization (KALRO) Kiboko field station in Makueni County, Southeast of Nairobi. The research station is located between latitudes of 2o 10'S and 2 o 25'S and longitudes of 37o 40' E and 37 o55'E at an elevation of 1000 m above sea level (Machogu, 2013). The site receives a bi-modal rainfall pattern with the peak during the long rains being in April and that of the short rains being in November. Average annual rainfall, evapo-transpiration and temperature are 615 mm, 26°C and 2000 mm, respectively (Mnene, 2006; Machogu, 2013).

Experimental design. The study used a completely randomized design. Land preparation was done by clearing vegetation on the identified research plot at the station and tilling was done to fine tilth. The plot was then subdivided into twenty-seven 3x3m plots allowing a 1m access lane between the plots for management. Three ecotypes of *D. macroblephara* were randomly distributed in the plots, namely, Oltepesi, Mashuru and Oldonyonyoike. Three replicates of each ecotype were established.

Planting materials were obtained from KALRO-KIBOKO and planted in the plots at a spacing of 0.5m within and between rows (Munyasi *et al.,* 2015). The plots were irrigated at a rate of about 2mm/hr/day for six weeks to enable establishment and thereafter maintained under rain-fed conditions. No fertilizers were applied. Weeding was done by hand every two weeks.

Data collection and analysis. Samples for determination of nutritive value were collected at three different phenological stages, i.e., onset of flowering, full flowering, and after seed harvesting for two seasons. Clipping was done in each plot within a 0.25 m^2 quadrat to a 2.5cm stubble height (Tarawali *et al.,* 1995). Harvested materials from each plot were sorted to ensure that they are not contaminated by soil or weeds. Crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), ether extracts (EE), and lignin, respectively, were determined in accordance to the standard procedures of AOAC (2005). In-sacco dry matter digestibility (ISDMD) was determined following protocols described by Osuji *et al.* (1993). Laboratory analysis of samples was carried out in the animal nutrition laboratory at the University of Nairobi's Department of Animal Production.

Analysis of variance (ANOVA) and General linear models (GLMs) were run using R version 3.4.1. This was done to determine the differences in performance of the ecotypes tested. Mean separation was done using Tukey's HSD test in the agricolae package in R.

Results

Significant differences ($P \leq 0.05$) were recorded for CP with little variations recorded across all other parameters for nutritional quality at the onset of flowering. The Oldonyonyoike (5.47%) ecotype had the least amount of crude protein while Mashuru (13.98%) recorded the highest amounts. The Oltepesi (13.13%) ecotype recorded the highest CP at the full flowering (Table 1). The Oltepsi ecotype also had a significantly higher digestibility (57.74%) compared to its counterparts. The Oldonyonyoike ecotype recorded a significantly higher lignin content (5.43%) compared to Oltepesi and Mashuru. After seed harvesting, the Oldonyonyoike ecotype recorded the highest digestibility (52.68%) and also had a significantly high CP (8.42%) (Table 1). There

were no significant differences among the three ecotype recorded for lignin, NDF and EE content recorded (Table 1).

Table 1. Nutritive comparison of ecotypes of *D. macroblephara* at different phenological stages

Phenological Stage	Species	Ecotype	%Cp	%Lignin	%ADF	%NDF	%EE	%ISDMD
Onset of flowering	*Digitaria macroblephara*	Oldonyonyoike	5.47^{c}	4.10^{a}	14.51^{c}	62.38^{b}	2.41^{a}	53.95^{a}
	Oltepesi		11.16^{b}	3.02^{a}	29.92^{b}	63.15^{b}	1.56^{a}	56.02^{a}
	Mashuru		13.98^{a}	3.55^{a}	31.13^{a}	66.35^{a}	2.75^{a}	51.17^{a}
Full flowering	*Digitaria macroblephara*	Oldonyonyoike	10.84c	5.43a	31.03^{b}	63.50^{b}	2.43^{a}	48.96^{b}
	Oltepesi		13.13^{a}	3.07^{b}	27.79^{b}	60.86^{c}	2.77^{a}	57.74^{a}
	Mashuru		11.41^{b}	4.01^{a}	45.62^{a}	77.06^{a}	2.01^{a}	49.77^{b}
At seed maturity	*Digitaria macroblephar*a	Oldonyonyoike	8.42a	4.16^{a}	27.67^{b}	59.21^{c}	2.16^{bc}	52.68^{a}
	Oltepesi		5.63^{a}	4.45^{a}	30.69^{a}	65.06^{ab}	1.58^{c}	39.49^{b}
	Mashuru		6.26^{a}	3.57a	29.91^{ab}	63.43^{b}	3.09^{ab}	37.42^{bc}

Means within the same columns with different superscripts are significantly different at p≤0.05. N=135

Discussion

Crude protein contents recorded across the different ecotypes of *D. macroblephara* in this study ranged from 5.47% to 13.98% (P≤0.05). This falls within the crude protein range of between 2.93% and 17.8% recorded by various researchers for rangeland grass species (Aregheore *et al.,* 2001; Machogu *et al.,* 2013; Rafay *et al.,* 2013; Rasool *et al.*, 2013; Njarui *et al.,* 2015; Ragasa *et al.,* 2015). While the dietary requirements of livestock differ depending on genetic, physiological and climatic factors, livestock generally require 7-20 % CP in their daily diet (Rafay *et al.,* 2013). Depending on age and the purpose of livestock rearing, ruminants require >7% CP under maintenance conditions, >10% when rearing them for meat production and >12% when the main purpose of livestock keeping is dairy production (Machogu *et al.,* 2013). Different studies have given different results for the optimal CP content for effective and efficient dairy production. Frank and Swensson (2002), found CP content lower than 13.5% to significantly reduce milk yield in dairy cattle. The National Research Council (2001) recommend CP contents of between 11.9% to 20% for lactating cows depending on the size and stage of lactation while Colmenero and Broderick (2006) found the optimal range of CP content in a diet to be 13.5%-16.5% for dairy cattle.

Despite the high CP content in the indigenous grass species represented in the study, their nutritional quality is however undermined by their high NDF content. Generally, grasses with NDF content lower than 50% are considered to be of good quality while those with above 60% are considered of poor quality (Machogu *et al.,* 2013). All the ecotypes in this study had a NDF content of above 58%.

The nutritive performance of indigenous grass species is a key factor in determining livestock productivity in the drylands of Kenya. An understanding of the nutritional performance of

the different ecotypes at different stages of growth provides unique opportunity to better solve the challenges of production of adequate quality and quantity feed faced by livestock keepers in the country. Such information will enable livestock keepers and pasture producers to make timely harvests and plan their grazing practices in a manner that ensures the optimization of the nutritive quality of different grasses.

The preference of livestock keepers to a given grass species is highly influenced by its tolerance to dry conditions characteristic of the drylands and its ability to improve animal performance with regard to the aims of livestock keeping. The Mashuru ecotype of *D. macrolephara* was suitable for both beef and dairy production purposes while Oltepesi ecotype was ideal only for beef production at the onset of flowering (CP >10%). At full flowering, all ecotypes of *D. macroblephara* were suitable for beef production with Oltepesi was the only ecotype with suitable CP requirements for dairy cattle (CP >12%). At seed maturity, none of the ecotypes was suitable for both beef and dairy production purposes. However, the Oldonyonyoike ecotype was found to be suitable for the purpose of animal maintenance (CP >7%).

Knowledge of the optimal time within which to harvest or graze livestock on the different ecotypes and its incorporation into pasture production and management practices has the potential to give pasture producers higher financial gains.

Conclusion and recommendations

The Mashuru ecotype recorded higher CP content than the rest at the same stage of flowering. The Oltepesi ecotype of *D. macroblephara* recorded a significantly higher CP content at full flowering and had the lowest NDF as well as the highest digestibility in the same stage of flowering. The Oldonyonyoike ecotype of *D. macroblephara* recorded the highest digestibility and the lowest NDF at seed maturity. All ecotypes were found to have a declining trend in CP and ISDMD while they showed an increasing trend in lignin values as they progressed from one phenological stage to the next.

The results of this study show that the nutritional quality of the ecotypes differed across different phenological stages. This information is important in informing grazing and pasture management practices as it provides insight on the right time to graze or harvest pastures. In addition, the choice of species and their ecotypes grown by livestock producers in the ASALs should be informed by the producer's objective as different grasses are suitable for different purposes based on their quality.

More research, however, needs to be carried out to determine the suitability of these ecotypes for drylands based on their water use efficiency and tolerance to grazing. These traits should be investigated to determine their productivity in different climatic conditions and with continued use.

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