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Original Research Article

Effects of supplementation of *Brachiaria brizantha* cv. Piatá and Napier grass with *Desmodium distortum* on feed intake, digesta kinetics and milk production in crossbred dairy cows

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ABSTRACT

This study was planned to analyse the basis that make *Brachiaria* species with greater feeding value than Napier grass (*Pennisetum purpureum*) for lactating dairy cows. Forty lactating crossbred cows were stall-fed on *Brachiaria brizantha* cv. Piatá or Napier grass cv. French Cameroon supplemented (mixed on fresh matter basis) or unsupplemented with *Desmodium distortum*, a forage legume. All cows were fed on fresh matter basis under small-holder farming conditions. Results showed that *B. brizantha* cv. Piatá had higher contents of dry matter (DM), crude protein (CP) and organic matter (OM), but lower contents of neutral detergent fibre (NDF) and acid detergent fibre (ADF) than Napier grass ($P < 0.001$). The legume supplementation increased intakes of CP and metabolizable energy (ME; $P < 0.001$), with higher effect on cows fed *B. brizantha* cv. Piatá than on cows fed Napier grass. Average daily milk yield was lower on diets based on Napier grass than those based on *B. brizantha* cv. Piatá ($P < 0.001$). The retention time of the particle phase of digesta in the digestive tract was longer on Napier grass (83.1 h) than on *B. brizantha* cv. Piatá (62.8 h) ($P < 0.05$). It was concluded that in dairy cows, legume supplementation of *B. brizantha* cv. Piatá increases nutrient intake, hence resulting in higher milk yields than supplementation of Napier grass.

1. Introduction

Napier grass (*Pennisetum purpureum*) has been recognised as a major fodder grass that has supported sustainable climate-smart intensified smallholder dairy farming in East Africa. It is a multi-purpose grass for feed with land sparing because it produces high biomass on small size of the land. It is also a key rotation component for control of stem-borer of maize (Pretty et al., 2011). *Brachiaria* grasses could provide similar benefits (Pickett et al., 2014) with the additional advantage of reducing nitrous oxide emission from the soil through biological nitrification reduction (Subbarao et al., 2009). Increasing ruminant livestock populations in many areas of the sub-Saharan Africa (SSA) have increased the demand for land for fodder production. Traditionally, mixed crop-livestock agriculture is feasible where the management facilitates reciprocal nutrient and energy flows between crop and livestock components with minimum demand for external nutrient supply (Andrieu et al., 2015). The mechanisms for reciprocation include the use of crop residues as animal feed, animal waste in integrated soil fertility management, animal draught in farm mechanization,

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fodder grasses and legumes for erosion control, legumes for biological nitrogen fixation and reduction of greenhouse gas emissions, and promotion of reforestation using multipurpose fodder trees. However, this synergy is compromised when farmers are confronted with competing interests between land use for food or fodder crops; and between crop wastes for mulching and livestock feed (Homann-Kee Tui et al., 2015). These accentuate the need for cultivated fodder for sustainable intensification.

Chemical analyses of *Brachiaria* grass and Napier grass have consistently ranked the two forages to be similar in their nutritional qualities (Mutimura et al., 2015). However, a few feeding trials and farmers' perceptions have indicated that animals and farmers preferred *Brachiaria* to Napier grass. There is indication that palatability and response of animal improves when fed on *Brachiaria* grass (Rao et al., 2015). These perceptions suggest that voluntary dry matter intake (DMI) in ruminants fed on *Brachiaria* grass is less constrained by gut fill than in other grasses. Gut-fill is predominantly determined by rates of physical degradation of feed particles and the outflow rates of undegraded material from the reticulo-rumen of the animal (Zebeli et al., 2012). On tropical, high-fibre grasses, the most adversely affected animals are those that had been selected (under feedlot conditions) for high milk yields (Niu et al., 2014). On systems based on tropical forages, DMI is the major limiting factor for livestock productivity, especially in dairy cattle (Hills et al., 2015). Here, we tested this phenomenon using stall-fed crossbred lactating dairy cows, to compare the nutritional superiority of *Brachiaria brizantha* cv. Piatá over Napier grass when fed with and without supplementation by *Desmodium distortum*, a tropical forage legume adapted to cut and carry system.

2. Materials and methods

2.1. Study site, animals and trial management

This study was carried out in smallholder farms in semi-arid area of Rwanda. The choice of farms was based on easy access and proximity to Karama Research Station of the Rwanda Agriculture Board (RAB) to guarantee the supply of fresh-cut forage legume.

The experimental animals were Ankole Longhorn × Holstein Friesian crossbred cows in second parity with 319 ± 14 kg of body weight and in early lactation (10 to 15 days in milk). The animals belonged to the farmers who stall-fed them in individual pens in the cowsheds at each farm.

2.2. Digesta flow markers and marker preparation

Fluid and particulate phase markers used were cobalt ethylene diamine tetraacetic acid (Co-EDTA) and ytterbium oxide (Yb_2O_3), respectively. The Co-EDTA was prepared according to Uden et al. (1980) and modified by Nsahlai (1991). It involved dissolving and gently heating (while stirring) Na-EDTA (297.2 g), $CoCl_2 \cdot 6H_2O$ (190.4 g) and NaOH (32.0 g) in distilled water (1,600 mL). Additional NaOH pellets (6.8 to 7 g) were added to ensure complete solubilisation. The solution was allowed to cool to room temperature; 160 mL hydrogen peroxide was added and allowed to stand at room temperature for 4 h before adding 95% ethanol (vol/vol; 2,400 mL). The solution was stored under refrigeration overnight for crystal formation. Crystals were filtered, repeatedly washed with 80% ethanol (vol/vol) and dried overnight at 100 °C.

2.3. Feed, experimental design and data collection

Basal diets were fresh *B. brizantha* cv. Piatá and Napier grass (*P. purpureum*) harvested at farmers' field where they were established without fertiliser application. These grasses were harvested after 90 days of establishment at a height of 15 cm from the ground. Either one of these grasses was fed with or without forage legume (*D. distortum*) used as supplement. This legume was established without fertiliser application and harvested at 90 days after regrowth from the Karama Research station of RAB. Fresh forage, water, and mineral block ([per kg forage] vitamin A: 100,000 IU; vitamin D_3: 20,000 IU; vitamin E: 40,000 IU; calcium: 40,000 mg; phosphorus: 50,000 mg; magnesium: 5,000 mg; iron: 2,000 mg; cobalt: 50 mg; iodine: 50 mg; manganese: 2,000 mg; zinc: 1,000 mg; selenium: 10 mg) were provided *ad libitum*.

Four diets (Table 1) were compared in this experiment. Ten cows corresponding to 10 farms were randomly assigned to each dietary treatment in a completely randomised block design. Fourteen days for feed adaptation were allotted to individual cows. Before feeding, fresh feed and refusals were also weighed. Feed sampling in each farm was done twice a week for a period of 17 weeks. Milk yield data were recorded daily and summarised weekly. Milking was done twice daily, in the morning between 07:00 and 08:00, and in the evening between 16:00 and 18:00 for 17 weeks. Forage grasses and legume were chopped manually at 10 cm length (using machete), before feeding. Daily feed DM, crude protein (CP) and metabolizable energy (ME) intakes were calculated as the difference between feed offered and refusal corrected for their respective contents. Initial data on body weight were recorded and used as covariates during statistical analysis of feed intake and milk yield data.

Farmers recorded data of forage on offer and refusals (fresh weight basis) twice a day (morning and evening). Data collected by farmers were validated during weekly test-day visits, when samples of forage on offer and refusals were collected for chemical analysis. Farmers also recorded daily milk yields, which were validated during the test day visits.

2.4. Markers administration, sampling and laboratory analysis

Four dairy cows in each dietary group of 10 lactating cows were selected for the administration of external markers. Since animals used were not fistulated, markers were administrated orally (pulse dose). Ytterbium oxide (600 mg) was weighed and mixed with small amount of feed and ensured total ingestion of the marker. According to Pinares-Patiño et al. (2007), ytterbium oxide can be used as a solid marker to estimate faecal output. The Co-EDTA (20 g) was dissolved in water (1 L) for the same reason (Huhtanen and Kukkonen, 1995). Faecal samples were taken from the rectum during the following times: 0, 2, 4, 8, 10, 12, 24, 27, 30, 33, 36, 48, 54, 60, 72, 96, 120 and 144 h post marker administration. Faecal samples were kept in cool box (4 °C) and delivered to the laboratory. Frozen samples of faeces were dried in forced-air oven (105 °C) for 24 h. Dried samples were ground to pass through 1 mm mesh and 1 g of each sample was ignited at 550 °C in a muffle furnace for 8 h to collect ash. Ash samples were analysed for Yb and Co concentrations using Inductively Coupled Plasma (ICP) Optical Emission Spectrometer (Varian 720-ES Series) at the University of KwaZulu-Natal, South Africa.

Table 1
Experimental details on diet composition (ratio, as-fed) and number of animals and farms used in the study.

Treatments	Diet composition[1]	Animals (farms)
1	100NG (NG)	10 cows (10 farms)
2	70NG:30DD (NGD)	10 cows (10 farms)
3	100PG (PG)	10 cows (10 farms)
4	70PG:30DD (PGD)	10 cows (10 farms)

[1] NG = Napier grass; DD = *Desmodium distortum*; NGD = Napier grass + DD; PG = *Brachiaria brizantha* cv. Piatá grass; PGD = *B. brizantha* + DD.

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