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The effect of *Opuntia ficus indica* and forage legumes based diets on goat productivity in smallholder sector in Zimbabwe

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ABSTRACT

Nutrition is a major component in livestock production. The use of alternative feed resources which are adaptive to long dry seasons is important. A study was conducted to establish options of improving nutrition, palatability and to determine the performance of goats fed on cactus–browse hay as dry season supplements. Sixteen castrated goats were housed in individual metabolism cages for sixty-three days in a randomised design with four replicates for the four treatment diets. The experimental and basal diet intakes were measured daily while live weights were taken weekly. Daily feed intakes measured were significantly different ($p < 0.05$) among treatments. Kids that were supplemented with Cactus-*Leucaena leucocephala* meal (CACT-LL) consumed more than those on Cactus-*Acacia angusitissima* meal (CACT-AA) and Cactus-*Macroptilium atropurpureum* meal (CACT-MA) but not significantly different from the commercial growers meal. *Pennisetum purpureum* (bana) grass hay was offered as basal diet. It was observed that all diets were readily palatable. However, the commercial diet had significantly higher basal diet intake compared to other experimental diets. Average daily weight gains were higher in CACT-LL and commercial diet. Moreover, all treatment diets led to increased growth rates and live-mass gains in goats. Animals that were given commercial diet and CACT-LL performed better than those supplemented with CACT-AA and CACT-MA. The weights were significantly different. Fresh cactus can be mixed with different browse legume hay and provide cover for dry season quality feed deficit and at the same time improve growth rate and overall weight gain.

1. Introduction

Long dry seasons, characterised by shortage of animal feed, both in quality and quantity are a major factor that affects animal production in Zimbabwe. The low nutritive value of the forage during the dry season is the main obstacle to increasing animal productivity (Gambiza and Nyama, 2000; Chakoma et al., 2004; Abidi et al., 2009). Use of non-conventional feed resources that are available and adapted in the area and use water more efficiently, can be the best option to ensure viability of livestock in these drought prone areas. Ruminants can make efficient use of non-conventional feed resources (Khanum et al., 2007) and non-conventional feed resources adapted to these areas include but not limited to *Opuntia ficus indica* (cactus) and browse legume trees such as *Acacia angusstisma* Leucaena *leucocephala* and *Macroptilium atropurpureum*.

Cacti can produce 4–5 times dry matter (DM) (Degu et al., 2009) per millimetre of rainfall than any other type of plant due their crassulacean acid metabolism (Guevara

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et al., 2011) while browse legumes also provide a very cheap protein sources for ruminants. Combining these outstanding feed ingredients should bail farmers out of the perennial feed deficit challenges. On the other hand these non-conventional feeds can boost animal performance thus leading to improved meat and animal products supply. An increase in animal performance may also translate to improved human nutrition and livelihoods.

Cactus cladodes are high in soluble carbohydrates (640–710 g/kg DM) and calcium (40–80 g/kg DM), crude protein (25–60 g/kg DM), high in calcium and β-carotene, but low in fibre (NDF, 170–280 g/kg DM) (Ben Salem and Smith, 2008; Ben Salem and Abidi, 2009; Ben Salem and Makkar, 2010). Cactus has considerable palatability, tolerance to salinity, high digestible energy content and high content of mucilage. However, it is sometimes not readily accepted by livestock mainly due to its laxative action (Menezes et al., 2010) and spines. There is need for it to be mixed with browse or other sources of protein feeds to retard its laxative effect. Inclusion of dry feed stuffs improves the DM levels and CP in the feed. This study was conducted to establish suitable options of improving its palatability and nutritive value, as well as to determine how goats perform when fed a mixture of cactus and browse hay as dry season supplements

2. Materials and methods

2.1. Study site

The experiment was conducted in Masvingo District, at Makoholi Research Institute, which is located 32 km North of Masvingo town on 19°50′ S and 30°47′ E in Zimbabwe. The research was carried out during the dry season from June to July. The area has an altitude of 1200 mm and rainfall is unreliable both within and between seasons (annual mean 565 mm and range from 133 to 1155 mm). The soils are granite-derived with typical arable topsoil, which consist of sand 96%, silt 2% and clay 2%. They are inherently infertile and plant growth is severely limited by the unavailability of nitrogen and phosphorus.

2.2. Chemical analysis of diets

Samples for each diet were collected in triplicates. Nitrogen content in the feed and in the residues was analysed by Kjeldahl method according to AOAC (1996). Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF) were analysed according to Goering and Van Soest (1970). Total ash was obtained by igniting a dried sample in a muffle furnace at 600 °C for 24 h, calcium and phosphorous were determined by the EDTA (Kaur, 2007) and spectrophotometer (Danovaro, 2009) methods, respectively. Condensed tannins were determined in the four legumes according to the method of Terrill et al. (1992).

2.3. Experimental animal management

The animals were reared in accordance to the animal welfare regulation of the country of Zimbabwe. Sixteen six-month old castrated goats weighing 16.3 ± 2.4 (mean ± SD) kg were used in the experiment. The castrated goats were of the Small East African breed. They were kept in individual metabolism cages, provided with a basal diet of low quality hay (bana grass) and then supplemented with treatment diets. Before the study, the goats were dosed for internal parasite with Albex® (Albendazole) and dipping was done monthly with Triatix® spray (Amitraz). Each goat was given the treatment diet at 8 AM for 63 days. The first 21 days were used as an adaptation period where there was no data collection during this period. From day 22, the animals were weighed weekly for six weeks. *Pennisetum purpureum* (bana grass) hay was offered *ad libitum* and was always available. Clean drinking water was available all times in the water troughs.

2.4. Treatment diets and hay production

2.4.1. Hay production

Pennisetum purpureum which was used as basal diet was harvested at 8 weeks old and about 0.80 m in height. The harvested biomass was chopped using machetes to 10 cm pieces before air drying under shade. The harvested material was dried for three days before being packed in hessian bags and stored in the feed storage room at ambient temperatures of 25 °C. It was then milled in a hammer mill without a screen or sieve.

2.4.2. Treatment diet preparation

Fresh cladodes from planted plots of cactus were also harvested and chopped using machetes to 5 cm pieces a day before feeding. The browse legume shrubs with an average height of 2 m were cut at 30 cm above ground; leaves were dried under shade for one week before being stored in hessian bags in a feed storage room. The diets were mixed as 60%: 40% fresh weight cactus to dry weight browse hay ratio with the bana grass hay serving as a basal diet since the animal were confined, to produce the following experimental feed used in the study:

Fresh cactus + *Acacia angustissima* hay (CACT-AA).
Fresh cactus + *Leuceana leucocephala* hay (CACT-LL).
Fresh cactus + *Macroptilium atropurpuriem* hay (CACT-MA).
Commercial sheep meal (14% CP).

2.5. Experimental design and measurements

The experiment was a randomised design with four treatments and four animals in each treatment group. 500 grams of experimental diet was given to each experimental animal in the morning and residues were removed at 12 noon. A weighed amount of bana grass hay was also given as a basal diet. At 5 PM the basal diet feed refuse were collected and daily intake was calculated by subtracting feed not eaten from feed offered. Animals were weighed weekly on 8 occasions until the end of the study.

2.6. Statistical analysis

The data was analysed using the PROC MIXED procedure for repeated measures of SAS (SAS Institute Cary N.C 2010) with initial weight as a covariate. In the covariance model, least square means were used and these are group means after having controlled for a covariate (*i.e.* holding it constant at some typical value of the covariate, such as its mean value).

The following model was used:

$$Y_{ijk} = \mu + \beta_1 Inwt + V_{ij} + T_{(ij)} + (V * T)_{(ijk)} + \varepsilon_{ij}$$

where:

Y_{ijk} is response variable being (Supplement intake, basal diet intake, average daily weight gain (ADWG) and weekly live weight changes);
μ is overall mean common to all observations;
$\beta_1 Inwt$ is the initial weight as a covariate;
$T_{(ij)}$ is effect of the *i*th treatment diet; (Cactus-*Leucaena leucocephala* meal, Cactus-*Acacia angustissima*, Cactus-*Macroptilium atropurpureum*, Commercial Conventional supplement);
$V_{(ij)}$ is the effect of the week;
$(V*T)_{(ijk)}$ is the treatment and time interaction;
ε_{ij} is the random error distributed as $N{\sim}(0;\sigma^2_E)$; and
PDIFF was used to compare variability among samples and across diets.

3. Results

3.1. Chemical compositional analysis

The organic matter (OM), Nitrogen (N), neutral detergent fibre (NDF) and acid detergent fibre (ADF) of the experimental diets are shown in Table 1. There were significant differences ($p < 0.05$) in N concentrations of experimental diets. The highest N level was recorded for CACT-LL (2.88) followed by CACT-AA (2.67), CACT-MA (2.26) and the least were from bana grass hay (1.64).