

Research note: Inclusion of lablab in maize and sorghum silages improves sheep performance

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Abstract

An experiment was conducted to determine intake and liveweight gain of sheep fed maize, sorghum, lablab-maize and lablab-sorghum silages (20 and 40% lablab) in a completely randomised design with 6 treatments. The maize and sorghum were mixed with lablab before ensiling and the silages were fed to sheep for 21 days. Silage intake increased with increase in legume inclusion level ($P < 0.05$). Intake of maize-based silages was higher than that of sorghum-based silages. While sheep fed the straight cereal diets lost weight, liveweight change improved as the level of lablab inclusion increased ($P < 0.05$). The findings confirm that legume inclusion with maize and sorghum forages when ensiling improves silage intake and enhances ruminant animal performance. Long-term feeding experiments using a combination of cereals and legumes with different ruminant species are required to validate these preliminary findings.

Introduction

In the semi-arid regions of Africa, small-scale intensive livestock systems generate a more regular income than other rural enterprises and can

alleviate poverty and food insecurity (Ngongoni *et al.* 2006). In Zimbabwe, ruminant livestock production is limited by the low quality and quantity of forage available during the dry season (Ngongoni *et al.* 2006). During this time of the year, crude protein concentration in the rangelands and dry-land pasture grasses is 20–40 g/kg DM, while neutral detergent fibre concentration is high (> 650 g/kg DM) (Topps and Oliver 1993). The decline in the quality of forages is attributed to lignification and nutrient translocation from leaf and stem to roots due to moisture and/or cold stress. The protein levels are inadequate for microbial protein synthesis in ruminants, leading to weight loss and reduced milk production during the dry season (Titterton *et al.* 2002).

With the development of small-scale intensive systems and the rising costs of concentrate feeds, conservation of forage crops should be an integral part of livestock production (Nitis 1999; Mapiye *et al.* 2007). Conserving high quality forages reduces the need to purchase protein concentrates for use in ruminant rations. Several grasses and legumes have been developed for pasture and forage production in Zimbabwe, and some can be grown and conserved as hay or silage, in the marginal rainfall areas, to provide feed during the dry season (Mapiye *et al.* 2007). Traditionally, in Zimbabwe, silage has been made predominantly from maize with little from sorghum and grasses (Titterton *et al.* 2002). Conservation of cereals produces silages of high energy but low protein concentration (Jingura 1994; Maasdorp and Titterton 1997). On the other hand, legumes alone do not ensile well owing to their high moisture content and high buffering capacity, resulting in high effluent losses and unstable silage of high pH (Titterton 1997). Incorporation of legumes in cereal silage increases protein concentration and therefore the nutritional quality of silage (Moyo 1996; Ngongoni *et al.* 2007).

In research done in Zimbabwe, lablab and cowpea increased total yield, crude protein

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concentration and fibre concentration in cereal-legume intercrops compared with sole-cropped cereals (Titterton 1997; Ngongoni *et al.* 2007). Maize and sorghum, and their combinations with lablab and/or cowpea, produce good quality silage (Titterton *et al.* 2002). Cereal-legume intercrops are recommended for improving dry season feed availability (Moyo 1996; Mapiye *et al.* 2007). However, little attention has been paid to the benefits of cereal-legume silages for smallholder ruminant livestock production (Mugweni *et al.* 2000). Therefore, the objective of this experiment was to determine intake and liveweight gain of sheep fed on maize, sorghum, lablab-maize and lablab-sorghum silages.

Materials and methods

Study site

The project was conducted at Henderson Research Station in Mazoe, about 32 km north of Harare, Zimbabwe, and 1200 m above sea level. Mean annual rainfall at the station is 880 mm and the mean annual temperature range is 20–30°C (Henderson Research Station 2005). The soils are well drained red clays with the following characteristics: pH 4.8, N 62 ppm, P 2.2 meq/100 g and total exchangeable ions 5.9 meq/100 g.

Planting

The forages used were lablab (*Lablab purpureus* cv. Highworth), maize (SC 401, short season maize hybrid) and sorghum (Jumbo, a late-flowering sorghum × sudan grass hybrid). An area of 0.8 ha was ploughed and disced during the dry season in October 1995. The area was disced again in December to incorporate lime at the rate of 600 kg/ha, as recommended after soil analysis. The forages were planted between December 27, 1995 and January 5, 1996 and fertilised with compound D (N:P:K, 8:14:7) at the rate of 400 kg/ha. The fertiliser was applied in bands along the rows with cereals in the inter-cropped plots and in all rows in the sole-crop plots.

The plot size into which cereal sole crops and cereal-legume inter-crops were planted was 10 m² and there were 10 replicates. Maize was planted in rows with 90 cm inter-row and 17 cm intra-row spacing to achieve plant populations of about 65 400 plants/ha. The sorghums were planted in

rows with 90 cm inter-row spacing to achieve a population of 250 000 to 300 000 plants/ha. The lablab was planted in rows with 30 cm inter-row spacing in the pure crop and 90 cm inter-row spacing in the intercropped plots to achieve plant populations of 300 000 and 100 000 plants/ha, respectively. Lablab seed was inoculated with the appropriate *Rhizobium* strains on the day of planting. Rows were oriented in an east-west direction to minimise legume growth retardation due to shading by the tall-growing cereal crops, as the shade should fall within the row. Supplementary irrigation was provided to aid emergence, which was being impeded by surface sealing of the soil.

Forage management and harvesting

Replanting and thinning of forages were done within the first 4 weeks. The crops were weeded at 4 weeks after emergence and fertilised with 400 kg/ha ammonium nitrate. The second weeding was done during the eighth week. The crops were inspected regularly throughout the growth phase for evidence of diseases and pests and remedial action was taken when required.

Harvesting was done when cereals were at the soft dough stage and the legume at flowering stage (13 weeks old). All the forages were harvested from a net plot of 9.0 m². In the intercrop plots, yields were determined by harvesting each component separately and combining the yields of harvested forages to get total yield from each plot. Sub-samples (250 g fresh weight) of chopped herbage were obtained in order to determine the dry matter (DM) content, yield and nutrient composition of the various forages.

Ensiling

After harvesting, the forages were chopped into 2 cm pieces using a motorised chopper and mixed so that lablab percentage was 0, 20 and 40% of the total herbage on a volumetric basis for each cereal. The forages were mixed thoroughly on plastic sheets before packing them in plastic bags to a weight of 20 kg material. Compression and air removal from the bags were achieved using a tobacco press. The silages were opened after 60 days and used in a feeding trial to evaluate the intake and liveweight change of sheep fed the various silages.

Experimental design

Six treatments [maize only, sorghum only, 80 maize:20 lablab (ML1), 80 sorghum:20 lablab (SL1), 60 maize:40 lablab (ML2) and 60 sorghum:40 lablab (SL2)] were compared in a completely randomised design.

Animals

Twenty-four sheep (8–10 months old and 10–35 kg fasted weight) were allocated to the 6 treatment combinations according to weight, so that each group had a mean weight of 19.1 kg. The sheep were dosed against endo-parasites before the commencement of the trial. Silage was offered at 3% fasted live weight of the sheep on a DM basis on the first day, and thereafter at a rate of 10% more than the previous day's intake.

Data collection

Fasted live weight was measured at the beginning and end of the experiment. Feed intake was determined as the difference between feed offered and refusals collected daily. Silage samples were collected daily in the last 7 days of the 21-day feeding period. A portion of the feed sample was dried and another was frozen for subsequent chemical analyses. These feed samples were analysed for crude protein (CP), neutral detergent fibre (NDF), acid detergent fibre (ADF), volatile ammonia nitrogen ($\text{NH}_3\text{-N}$) and pH to determine the mean nutrient composition of the silages (Goering and van Soest 1970).

Statistical analyses

The data for feed intake and liveweight gain were subjected to analysis of variance using the General Linear Model of the Statistical Analysis System (SAS 1998). Least squares means and P diff statistics were used to detect differences between means. The model fitted the effects of cereal (maize and sorghum), lablab inclusion level (0, 20 and 40%) and their interaction.

Results

Dry matter concentration in the various silages ranged from 171–208 g/kg (Table 1). The legume proportion in the mixed silages (DM basis) was similar to the volumetric proportions. Inclusion of lablab increased protein concentration of the cereal silages ($P<0.05$). The NDF concentration was higher in sorghum-based silages than in maize-based silages ($P<0.05$). ADF followed a similar trend to NDF with sorghum combinations tending to have higher ADF levels than maize silages ($P>0.05$) (Table 1). All silages had pH below 4 and low NH_3N levels ($<17\%$). For maize-based silages, NH_3N tended to increase with increasing lablab proportion, while the reverse was true for sorghum-based silages.

Daily DM intake increased as lablab proportion increased ($P<0.05$) (Table 1). Sheep on maize-based silages tended to have better intakes than those on sorghum-based silages. Some groups of sheep lost weight during the study while others gained weight (Table 1). Liveweight performance on sorghum-based silages was lower than on maize-based silages and performance

Table 1. Physical and chemical characteristics of diets fed to sheep.

Parameter	Lablab	Maize	Sorghum	ML1 ²	SL1	ML2	SL2	s.e.
DM (g/kg)	180	183	208	171	192	189	192	
Legume in DM (%)		0.0	0.0	22.4	22.7	43.5	40.0	
CP (g/kg DM)	154a ¹	113b	88c	125b	108c	144a	119b	11
NDF (g/kg DM)	549c	671ab	701a	612b	681ab	595b	654ab	19
ADF (g/kg DM)	275c	377ab	466a	375b	384ab	371b	444a	10
Hemi-cellulose (g/kg DM)	473	294	235	224	311	236	225	21
pH		3.43	3.68	3.54	3.80	3.97	3.84	
NH_3N (% of TN)		8.0	15.2	10.0	12.0	16.4	9.6	3.2
DM intake (g/d)		400c	361c	536b	462bc	691a	607a	5
Liveweight change (g/21d)		-925c	-2 133d	75b	-525c	1275a	100b	342

¹ Within rows, values followed by the same letter are not significantly different ($P>0.05$).

² ML1 = 80 maize:20 lablab; SL1 = 80 sorghum:20 lablab;
ML2 = 60 maize:40 lablab; SL2 = 60 sorghum:40 lablab.

was directly related to the level of lablab in the silage ($P < 0.05$).

Discussion

This study has confirmed earlier studies that inclusion of legumes with cereal forages when ensiling improves the quality of silage (Moyo 1996; Ngongoni *et al.* 2007). The improvement in CP concentration in the mixed silages was reflected in increased intake by sheep, presumably as a result of increased fermentation rates and digestibility. The finding that legume inclusion increased protein concentration to above the 120 g/kg DM required per day for animal growth or production is in agreement with Topps and Oliver (1993). In agreement with other work, the sorghum-based silage had high fibre content (McCormick *et al.* 1995; Titterton 1997). The lower intake and loss in weight of sole cereal-based silages may be due to the high NDF and ADF content of cereal silages (McDonald *et al.* 1991; Khorasani and Kennelly 2008).

The increase in intake with lablab inclusion is consistent with studies throughout the world that legume inclusion in grass or cereal-based diets improves DM intake. It concurs with results obtained with pangola and setaria-based legume silages (Tjandraatmadja *et al.* 1993). The observed increase in intake can be attributed to increased supply of nitrogen and branched C-skeletons whose shortage limits microbial activity (Jingura 1994; Mugweni *et al.* 2000). The increased N supply for the microflora would have increased rate of digestion, with resultant increase in rate of passage and voluntary feed intake. A reduction in fibre content in the mixed diets could have also contributed to the higher intakes. However, high moisture content in the silages (DM of 200 g/kg or less) could have contributed to the low intakes of the silages overall (McDonald *et al.* 1991).

It is significant that the pure cereal silages contained 8.8% (sorghum) and 11.3% CP (maize). While diets with these crude protein levels would be expected to at least maintain live weight in ruminants, sheep suffered significant weight loss over the 21-day feeding period. Cereals produce silages with high soluble carbohydrate but low protein concentration (Jingura 1994; Maasdorp and Titterton 1997; Ngongoni *et al.* 2007). This results in uncoupled fermentation and

consequently poor digestibility and animal performance (Titterton 1997).

These data suggest that cereal-legume intercrops to provide about 40% legume can produce good quality silages for feeding to sheep during the dry season. Maize had higher yields both in pure stands (12 250 kg/ha) and intercrop (11 150 kg/ha) than sorghum (8750, 8025 kg/ha), respectively (Ngongoni *et al.* 2007). This factor, coupled with the higher protein concentration in the maize-based silages and superior live-weight change in the sheep, suggests that maize would be the cereal of choice to plant with the legume. However, in the semi-arid regions of the tropics where most sheep production is practised (Titterton *et al.* 2002; Ngongoni *et al.* 2007), moisture stress can result in lower yields than those mentioned above. What can be grown is usually reserved for providing grain for human consumption. Cultivation of drought-tolerant maize varieties, partial substitution of maize with sorghum and use of a combination of cereals in cereal-legume silages could be viable alternatives for smallholder farmers.

Conclusion

Inclusion of lablab increased protein concentration of the cereal silages, resulting in higher intakes of feed and superior liveweight performance in sheep. Long-term feeding experiments using a combination of cereals and different ruminant species are required to validate these preliminary findings. However, a cost-benefit analysis is important to ascertain the potential of cereal-legume silages in reducing protein concentrate inputs in ruminant diets.

Acknowledgements

The authors are indebted to Danish International Development Agency (DANIDA) for financially supporting this project.

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(Received for publication March 12, 2007; accepted March 3, 2008)