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Effect of Potato Vines and Sorghum Silage on Cattle Milk Productivity

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Abstract: The study was conducted to evaluate the nutritive value and productivity of Sweet Potato Vines (SPV) and Sorghum Silage (SS) as feeds for dairy production in the dry highlands of Kenya during the years 2002 and 2003. Data on yield parameters of SPV and SS were collected. Both On-centre and on-farm work involved evaluation of milk production by dairy cattle fed on varying proportions of SPV with SS while demonstration and popularisation of SPV and SS utilization technologies were conducted on farms. Mean grain and dry matter (DM) yields of sorghum were 5.5 and 23 t ha^{-1}, respectively. The Dry Matter (DM), Crude Protein (CP), Neutral Detergent Fibre (NDF) and Acid Detergent Lignin (ADL) contents of SS were 308, 60.3, 622 and 61.6 g kg^{-1}, respectively. Corresponding values of SPV were 160, 131, 341 and 64.5 g kg^{-1}. Average daily milk yield was 3.44 l day^{-1} when SS alone was fed dairy cows and the yield was 26 l day^{-1} when a combination of SPV, SS and home made dairy meal was supplied. Improved and sustained milk production in most of the farms was observed when sorghum ratoon was fed as green chop alongside SS especially during the dry season. This showed that sorghum fed together with SPV had great potential in enhancing milk production.

Key words: Sorghum silage, sweet potato vines, dairy farms

INTRODUCTION

Smallholder farmers from high potential areas in the Kenyan highlands continue migrate towards the dry highlands due to scarcity of arable land[1,2]. Dairy farming is one of these farmers major occupations and the main source of income that offers both direct and indirect employment. Production challenges such as unreliable rainfall, poor soils and lack of adapted high yielding forage crops continue to pose challenges. Technologies that can sustain feed availability and animal productivity during dry periods are also lacking. Sweet potato vines and cold tolerant sorghum are some of the feed resources that can meet some of these challenges because of their adaptation, high yields and nutritive values[3] .

Sweet potato (*Ipomea batatas* (L) Lamb) cultivar *Musinyamu* was identified as an alternative protein rich roughage that could be used supplement sorghum[4]. This cultivar is well adapted to the dry highlands and produces dry matter and crude protein content of over 10 ton ha^{-1} and 12% respectively[5,6]. Other studies[4,7] observed that inclusion of SPV in hay diet resulted in high feed intake and increased growth of steers.

Sorghum is well known for its capacity to tolerate conditions of limited moisture and to produce a crop during periods of extended drought compared to other cereals[8]. The crop is widely grown in semi-arid environments similar to those found in the Kenyan dry highlands where annual rainfall ranges from 400 to 800 mm. Cold tolerant sorghum varieties E6518 (forage) and E1291 (dual purpose) are well adapted to the cold and dry climate that is prevalent in most parts of the highlands[8]. Yields ranged from 23.5 and 17 ton ha^{-1} of DM and 4 and 7 ton ha^{-1} of grain, respectively[9]. However lower yields of 0.5-2 ton ha^{-1} have been reported on farms indicating a technological gap between research and on farm potential of the varieties[11]. Other studies[8-10] have shown that these sorghum cultivars have high nutritive value as livestock feed. Further research[7,12] showed that although sorghum feed is rich in energy it has low protein content and may be supplemented with feeds rich in protein for sustainable dairy production. Sweet potato vines were identified as the most appropriate crops to play this role. The objective of this study therefore was to transfer sweet potato and sorghum technologies that would improve household incomes and increase feed resource production for dairy production.

MATERIALS AND METHODS

The study was carried out in Nakuru district within the Kenyan rift valley and is a representative of the Kenyan dry highlands during the years 2002 and 2003. The study areas are 1500-2500 m above sea level and receive between 600 and 800 mm rainfall annually and minimum temperature while maximum temperature 12and

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30°C. The study was conducted both on the research centre and on farm. The on-centre work was conducted at KARI, Lanet Centre (0° 30°S, 35°36°E) 1920 m above sea level (a.s.l). The annual rainfall at this site is 800 mm and is unreliable and poorly distributed. The areas have two rainfall seasons per year. The long rains season begins in March and ends in August. Short rains season begins in October and ends in December[13]. Four farmers willing to share responsibilities as partners were selected from Rongai, Mbogoine, Njoro and Gilgil divisions of Nakuru district The selected farmers were to plant at least half an acre each with sweet potatoes and sorghum and provide at least three dairy cows with potential to produce 8 kg of milk per day. Each farmer was provided with enough sorghum seed for half acre while sweet potato vines were provided to farmers who did not have them. The farmers also received fertilizer and polythene paper for covering silage in the first year. Sweet potato and sorghum cultivars *Musinya* and E1291 were planted at the onset of the long rains season. Dry matter and grain yield were determined.

Participants in the study were required to be familiar with the principles and practices of the basic ingredients of the technology. For this purpose workshops, seminars and field days were held in which cultivation and utilization packages sweet potato vines and sorghum were discussed. The training was tailored to Farming Systems Approach (FSA) where other aspects of agriculture were extended. On farm supervisory visits were conducted routinely according to the crop husbandry calendar. These visits were synchronized to coincide with at land preparation, planting, weeding, thinning, bird scaring, silage making, harvesting and ratoon crop management.

Sweet potato vines were planted on a flat seedbed, as it is the most prevalent method used by farmers in the region. Sweet potato cultivar Musinyamu was chosen because of its higher production potential. Even though Musinyamu produces tubers, vines were used for this study. All recommended agronomic practices were followed and the vines were harvested three months after sowing when the nutritive value is expected to be high. Harvesting was by cutting the vines using a sickle about an inch above the ground. Vine yield and nutritive attributes were then determined and fed to livestock in mixtures with sorghum silage.

Sorghum cultivar (E1291) was grown according to recommended agronomic practices and silage made from it was used for this study. Sorghum was harvested at the hard dough stage and ensiled without any additive.

Samples of sorghum plant and silage were collected from farmers during field visits and later analysed for chemical composition. Dried samples of whole crop and the silage were milled through 1 mm screen using Cyclotec™ mill and kept in sealed plastic bags to await proximate analyses.

Feeding and milk production: Milk production from dairy cattle fed on four rations of varying levels of SS and SPV were determined. Latin Square Design was used for the feeding trial whereby the four rations were fed in turns. Lactating dairy cows in their early to mid lactations were used. Each ration was fed for 21 days. The first 4 days were for diet changeover, the next 14 days for acclimatization and last 7 days for data collection. The rations were changed in turns according to the experimental sequence. The cows were given SPV twice daily i.e., at the milking times and half of the daily feed allowance was provided at the feeding time as a Total Mixed Ratio (TMR). Water was provided adlibitum (full feeding). They were milked at 6.30 am and 4.30 pm. daily and milk yield recorded. Rations refusals were weighed and samples collected for laboratory analysis.

Statistical analysis was done and means were separated using[14].

RESULTS AND DISCUSSION

Yield and Chemical composition of sweet potato vines and sorghum: Sweet Potato Vines normally have low DM content which in the current study ranged from 129.5-190.4 g kg^{-1}. Their CP content ranged from 83.4-179.1 g kg^{-1} with the highest values being from the farmers crops. Neutral Detergent Fibre (NDF) ranged from 300.9 to 383.9 g kg^{-1}. There was high variation in chemical composition within the feeds and among the farms. The DM content of Sorghum Silage (SS) ranged from 267.3-335.6 g kg^{-1}. The CP content of silage ranged from 50-70.6 g kg^{-1} and NDF of was 665.4 (Table 1). Mean total DM yields ranged from 17 to 29.0 ton ha^{-1} and grain yield ranged from 4 - 7 ton ha^{-1}. The present yields agreed with those reported earlier by Arkel (1979). Based on the classification[9], E1291 sorghum is regarded as early maturing dual purpose while E6518 is late maturing forage varieties[8]. The silage DM values were within the reported range[12,15] of 250-300 g kg^{-1}. The fact that correct DM content could be attained at the time of harvesting without any costly conditioning or additive is an advantage to farmers. Thus it is important that farmers are advised to strictly adhere to correct stage of growth for silage making i.e., at grain hard dough stage. Like maize, no additive is required because at this stage there is enough readily fermentable carbohydrates for microbial activities necessary in silage conservation.

Table 1: Dry Mater (DM) intake (kg) and milk yield by cows fed on sorghum silage and sweet potato vines on center and on farm

On-centre feeding trial				On-farm	
Ration SS:SPV (%)	DM intake (kg)	DM intake/live weight (g kg^{-1})	Milk yield (kg day^{-1})	Feed resource	Milk yield (kg day^{-1})
100	6.7^{c}	1.9^{b}	3.44^{b}	SS+SPV	10
80:20	7.5^{b}	2.1^{a}	4.52^{a}	SS+SPV	14
70:30	8.2^{a}	2.2^{a}	4.65^{a}	SS+SPV+dm*	20
60:40	8.2^{a}	2.2^{a}	4.67^{a}	SS+SPV+ hmd**	26

Values in a column with same letter superscripts are statistically similar p>0.001, *dm = commercial dairy meal, **hmd = home made dairy meal

The lower CP content of SS as comparison to SPV was expected and is the main reason for supplementing of SS diet with protein rich SPV. As exemplified by high NDF and ADL contents, SS can be regarded as energy rich feed. The high variation in CP content observed in SPV was most likely as a result of differences in management. Highest CP contents were from young vines and where farmyard manure was applied (Fig. 1). The low NDF, ADL and ash contents of SPV indicates high nutritive values[11].

Feed intake and milk yield: In the dairy cattle performance trial, the mean DM intake per cow between 7.45 kg day^{-1} and 2.05 kg^{-1} live weight. Feed intakes were significantly ($p<0.001$) influenced by ration composition where addition of SPV increased intake of SS basal diet (Table 1). The milk yields were 3.44 l day^{-1} in sole SS diet fed on-centre, 10 and 14 l day^{-1} in the diet of SS: SPV combination fed by farmers and 26 l day^{-1} when SS, SPV^{-1} and home made dairy meal were fed by a farmer. The on-centre results showed that inclusion of the SPV^{-1} in the SS diet was significant ($p<0.001$) in increasing the yield. The study focused on the use of sorghum and sweet potato vines in dairy production and the dual purpose nature of sorghum was however highly essential and had to be addressed. For this reason demonstrations were conducted to expose farmers and stakeholders to different food recipes that are prepared from the crops. For sorghums the recipes included cakes, porridge, *ugali, pilau, mandazi* and biscuits. With regard to sweet potatoes, it emerged that for human use, the tubers had to be removed right from the first harvest of vines. This is because the tubers removed after re-growth do not 'cook' to normal taste and texture hence are inedible. Important factors for adoption of these technologies for livestock production include climate, production system, land size, silage quality/intake and level of income. Those farmers who are commercial oriented, have smaller land sizes, capable of making high quality silage and with higher incomes tend to adopt the technology more. Feeding SPV and sorghum as basal diets was such that milk deliveries in some instances increased tremendously and production was higher when the same diet is supplemented with dairy meal.

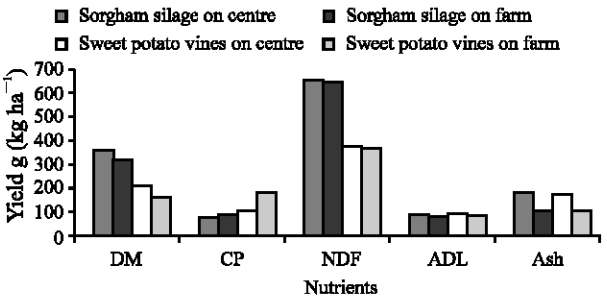

Fig. 1: Nutrients in Sorghum Silage (SS) and Sweet Potato Vines (SPV)

The improvement of feed intake due to increased proportion of SPV in SS basal diet agreed with the findings of Irungu *et al.*[7]. However these authors observed digestive upset when SS: SPV was above 30:70. This ratio can therefore be regarded as the upper limit of SPV addition. Milk yields on center were lower compared to those of farmers and what has been realized from grazing dairy cows without supplementary feeding reported by Irungu and Mbugua[15] where daily milk yield of 10 kg day^{-1} was realized from Holstein Friesian cattle grazing Rhodes grass. The low milk yields on Centre can be largely attributed to two aspects. One, the of SS and SPV used had poor nutritive value especially in terms of CP content which was only 50 and 83.4 g kg^{-1}. A high potential dairy cow would need a diet containing at least 120 g kg^{-1} of crude protein to produce 10 kg day^{-1} and above. Secondly the genetic potential of the cows was poorer as compared to those used by Irungu and Mbugua[15] as well as the farmers in the current study. However, the results indicate that life and milk production, which are crucial in smallholder systems can be sustained by feeding conserved silage especially during dry season when feeds are scarce. The current results further show that high feed value and genetic merit of cattle are important considerations for achieving high productivity when SS and SPV are to be conserved and used in dairy production. The dual-purpose nature of these crops is acknowledged and can play an important role in enhancing food security[16].

The study demonstrated that Sweet Potato Vines (SPV) and Sorghum Silage (SS) have the potential to produce sustainable yield in the cold dry highlands. They also have high nutritive value for ruminants as demonstrated by their chemical composition. For dairy production, the present work clearly shows that sorghum silage and sweet potato vines have high potential of improving productivity in the tropical dry highlands. But the nutritive quality of these feeds can be highly varied as a result of management. A lot of emphasis

should be put particularly on the production and conservation efficiency of sorghum silage. The use of green chop of sorghum and sweet potato vines in feeding dairy cattle should also be encouraged.

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