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**Abstract**

Twenty seven newly giving birth lactating Nubian goats were used to evaluate the effect of using fresh sweet potato vines in performance and milk yield. Experimental animals were divided into three groups that were fed three different experimental diets. Group A (control) were fed on fresh chopped Abu-70 variety of Sorghum vulgar. Group B were fed on fresh chopped sweet potato (*Ipomoea batatas*) vines and stems. Groups C were fed on fresh chopped clitoria (*Clitoria ternate*). Significant (p<0.001) difference were observed only in daily fodder intake. Group B performed a significantly (p>0.05) heavier final weight (28.45±6.67 kg) and weight gain (3.82±0.72). This group recorded a highly significant (p<0.001) fodder intake (1.88±0.35). Best feed conversion ratio was recorded by group C (6.71). Treatment effect was highly significant (p<0.01) on daily milk yield. Group B, performed the higher milk yield (0.58±0.18 liter), milk protein, milk fat and total solids compared to group A and C. According to the results obtained nutritional properties of the sweet potato leaves indicate that they have the potentiality to improve dietary protein and amino acid supply in low fibre diets for ruminants. Like other traditional fodders used in the Sudan, sweet potato can be used likewise for feeding small ruminants for milk production with marked levels of success.

**Key words:** Abu 70, Clitoria, milk fat, milk protein.
Introduction

Sweet potato is one of the five most important food crops in developing countries (Phuc et al., 2001). Traditionally, sweet potato was grown exclusively for the production of the tubers and the foliage was considered as a waste and therefore underutilized (Ruiz et al., 1980; Moat and McL Drylen, 1993). However, at present sweet potato is grown by smallholder livestock farmers as a dual-purpose crop. The vines are fed to livestock, whereas the tubers are used for human food (Karachi, 1982). Scott, 1992 reported that in developing countries sweet potato vines are mainly used as an animal feed wherever they are produced. Dry matter (DM) production potential per hectare of certain varieties of sweet potato vines can be as high as 4.3–6.0 tons per crop (Dominquez, 1992) and the forage (leaf, petiole and stem) accounts for approximately 64% of fresh biomass (Pinchinat, 1970). The forage contains 11–17% crude protein and the digestibility is >62% (Backer, 1976; Ffoulkes et al., 1997; Ruiz et al., 1980; Ruiz et al., 1981).

The value of sweet potato is attributed to high yield, palatability and crude protein content. These characteristics coupled with high moisture content, Orodho et al., (1993) make it a suitable protein supplement for animals receiving low quality forage in the dry season. Sweet potato (Ipomoea batatasL. is a common crop, and has high biomass yields of both tubers and vines. Traditionally, sweet potato is used as human food, although at present it is commonly used as feed for farm livestock. The tubers have high carbohydrate content while the leaves are rich in protein, and both tubers and vines can be used as animal feed (Woolfe 1992). The vines include the leaf and stem, with crude Protein content in the leaves of 260-330 g/kg DM compared with 100-140 g/kg DM in the stems (Woolfe 1992; Ishida et al 2000; Le Van An et al 2003). It has been shown that the leaves make up approximately half of the sweet potato vines biomass (Woolfe 1992; Le Van An et al 2003). Thus, if the leaves could be separated from the stems a considerable improvement with respect to the dietary protein and amino acid supply would be expected (Le Van An et al 2003).

In the Sudan there is an increasing interest in maximizing the utilization of crops -that can yield food both for human and livestock at the farm level- to fully integrate animal production into the cropping system. Animal production is increasing globally to meet the demands for meat and milk in human diets. However, in developing countries, there was and still, a shortage for population in both energy sources and feedstuffs. Conversely with animal production, there is an acceptable protein supply and quality for. In view of the worldwide demand for additional feed sources, the exploitation of traditional crops which often are grown with low inputs, and are largely adapted climatically, would be a step towards better resource utilization. Information about sweet potato production and, utilization and marketing in the Sudan are meager due to the socio-cultural habits of the farmers and the high cost of the production of the root and tuber crops. Sweet potato in the Sudan is a minor crop cultivated in restricted areas by the farmers in Gezira irrigated scheme; Rahad irrigated agricultural project and the river banks. The average production is 2-2.5 ton / feddan tuber and about 1-1.5 ton / feddan leaves and vines. The optimum time of planting in the country is August / September. It was produced mainly for human consumption and the vines are used as animal feed mainly ruminants (Khalid, 2005). The objective of the present study were to investigate the effects of using fresh sweet potato vines in performance and milk yield of Sudan Nubian goats,

Materials and Methods

Twenty seven newly giving birth lactating Nubian goats at an approximate age of 2 years, were used. The animals were received; rested, watered and later ear tagged and dewormed using Albendazole drench. Animals were offered ad libitium the control forage var. Abu-70 (Sorghum vulgare) for adaptation to fodder during the first two weeks and before experimental feeding. Animals were then weight-distributed and randomly allotted to three treatment groups A, B and C. Each
treatment group (nine animals) was divided into three replicates lodging three heads each.

**Housing**
The animals were housed under a shed of 8 x 10 x 2.5 m. This house was divided internally into two rows of pens, with eight pens in each row, separated by a 1.5m. corridor to facilitate movement. Nine pens only were utilized and each pen was equipped with three feeders and plastic bowl waterer.

**Experimental Forages**
Three types of forages namely Sweet Potato (*Ipomoea batatas*) vines, Abu-70 (variety of *Sorghum vulgare*) and Clitoria (*Clitoria ternate*) were sown at the Research Top Farm, Faculty of Animal Production, Managil, Gezira University, June 2004, in an area of 2.5 Feddans for each forage. Irrigation was applied every 15 days. One dose of nitrogen fertilizer was applied after three weeks from the sowing date. Forages were harvested in September '04. The forages were cut fresh and machine chopped before feeding.

**Experimental Diets**
Animals in the control group A were fed on fresh chopped Abu-70 (variety of *Sorghum vulgare*) while the animals in group B were fed on fresh chopped sweet potato (*Ipomoea batatas*) vines and stems and the animals in group C were fed on fresh chopped clitoria (*Clitoria ternate*). The analyzed proximate chemical components of experimental fodders are shown in Table 1.

A concentrate mixture (Table 2) was offered daily at 8.00 am in restriction to 250gm/head/day for all treatment groups. Fresh and clean water was always available. Experimental feeding was continued for seven days.

<table>
<thead>
<tr>
<th>Fodder</th>
<th>DM</th>
<th>CP</th>
<th>EE</th>
<th>CF</th>
<th>Ash</th>
<th>NFE</th>
<th>Mcal ME/Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abu – 70</td>
<td>96.79</td>
<td>3.05</td>
<td>1.33</td>
<td>32.54</td>
<td>5.24</td>
<td>54.63</td>
<td>3.28</td>
</tr>
<tr>
<td>Clitoria</td>
<td>96.60</td>
<td>17.15</td>
<td>2.24</td>
<td>30.26</td>
<td>6.10</td>
<td>40.85</td>
<td>3.35</td>
</tr>
<tr>
<td>Sweet potato</td>
<td>95.53</td>
<td>6.83</td>
<td>2.13</td>
<td>26.69</td>
<td>11.46</td>
<td>48.42</td>
<td>3.09</td>
</tr>
</tbody>
</table>

**Table 2:** Percent inclusion rates (as fed) and chemical composition (dry matter basis) of experimental concentrate diet.

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Sorghum</th>
<th>Groundnut meal</th>
<th>Wheat bran</th>
<th>Ca</th>
<th>Vitamins and minerals</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>50</td>
<td>25</td>
<td>20</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Component %</td>
<td>DM</td>
<td>CP</td>
<td>EE</td>
<td>CF</td>
<td>Ash</td>
</tr>
<tr>
<td></td>
<td>95.15</td>
<td>26.25</td>
<td>4.25</td>
<td>7.88</td>
<td>6.1</td>
</tr>
<tr>
<td>Meal ME/Kg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.68</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Data collection**

**Performance**
Feed intake (kg/group) was recorded on daily basis. Animal individual body weights were recorded weekly to the nearest 0.5 kg once weekly at 8:00 a.m. before feeding.

**Daily Milk Yield**
Kids were separated from their dams one week post partum allowing for colostrum consumption, and artificially reared afterwards. Goats were hand milked twice daily (morning 8:00 a.m. and evening 6:00 p.m.) and milk yield was recorded (liter) for seven days. The milking time ranged from 3-6 minutes with an average of four minutes per goat.

**Statistical Analysis**
Data in animal performance and milk yield and composition were analyzed by the one-way ANOVA. Treatment means were compared by the t-test (Snedcor and Cochran, 1978).

**Results and Discussion**

Feedlot Performance

Table (3), shows the average means of initial body weight, final body weight, weight gain, daily fodder intake, daily concentrate intake and feed conversion ratio. There were no significant difference (p>0.05) among treatments for average initial body weight, final body weight, weight gain, daily concentrate intake and feed conversion ratio while the study showed significant difference (p<0.001) among the treatments for average daily fodder intake. Differences in intake of the three forages could be explained by the differences in forage palatability; Van Soest (1987) stated that when the fibrous fraction of the forage exceeds 55-60% of the dry matter it limits the voluntary feed intake. This was not observed in this study because the three forages investigated had crude fiber content less than that limit. The most limiting factor for nutritive value of these forages was the intake. The low intake of Abu 70 and Clitoria resulted in low nutritive and low energy consumption. Differences in intake between the forages might be related to the rate of cellulose digestion in the rumen. This agrees with the suggestion of Crampton et al. (1960) who reported that the intake predictions are more sensitive to animal parameters than feed parameters. In this study individual variations in intake between animals and daily variations in the intake of each animal were observed and could be attributed to the different physiological conditions of different animals. The result of voluntary intake in this study agree with the finding of Von Soest (1982), who reported that high intake is probably related to the faster rate of fermentation in the rumen. The intake of sweet potato vines was high when compared with Clitoria and Berseem studied by ELKhider (1989), but lower than the results reported by Malavanh and Preston (2006). Group B showed the highest fodder intake (1.88±0.35), compared to groups A (1.31±0.14) and C (1.33±0.13), this result agree with result reported by Abonyi et al (2012).

Group B performed a heavier final weight gain (28.45±6.67 kg) and weight gain (3.82±0.72). Weight gain in this study higher than the result observed by Aregheore (2007); Kebede et al., (2008); Thuy and Ogle (2004) and Lam and Ledin (2004).

Best feed conversion ratio was that of group C (6.71) and group B was the lowest (8.72). The result of feed conversion in this study comparable with result observed by Lam and Ledin (2004), lower than the result reportedby Abonyi et al., (2012) and Thuy and Ogle (2004).

Table 3: Analysis of variance and average (mean±SD) performance values of treatment groups fed fresh fodders.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>A (Abu-70)</th>
<th>B (Sweet Potato vines)</th>
<th>C (Clitoria)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial weight (Kg)</td>
<td>22.95 ± 3.58</td>
<td>22.75 ± 3.50</td>
<td>22.92 ± 4.38</td>
</tr>
<tr>
<td>Final weight (Kg)</td>
<td>26.03 ± 3.47</td>
<td>28.45 ± 6.67</td>
<td>25.43 ± 4.07</td>
</tr>
<tr>
<td>Weight gain (Kg)</td>
<td>3.08 ± 0.59</td>
<td>3.82 ± 0.72</td>
<td>3.82 ± 0.71</td>
</tr>
<tr>
<td>Daily fodder intake (kg)</td>
<td>1.31b ± 0.14</td>
<td>1.88a ± 0.35</td>
<td>1.33b ± 0.13</td>
</tr>
<tr>
<td>Daily concentrate intake (kg)</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Feed conversion ratio</td>
<td>7.09</td>
<td>8.72</td>
<td>6.71</td>
</tr>
</tbody>
</table>

*** Denotes F-value significant at (p > 0.001).

Means in a row bearing the same letter subscript are similar (p > 0.05).

Figure 1 Shows average feed intake (kg) regressed on time (days). Best fit line was drawn for treatment groups fed fresh fodders for 7 days. Significant (p<0.05) regression coefficients 0.63, 0.91 and 0.95 were for groups A,B and C respectively in ascending order.

Figure 2 Shows average liveweight (kg) regressed on time (days). Line of best fit was drawn
for treatment groups fed fresh fodders for 7 days. 2.26, 2.28 and 2.29 were for groups A, C and B respectively in ascending order.

Significant (p<0.05) regression coefficients 2.26, 2.28 and 2.29 were for groups A, C and B respectively in ascending order.

Fig. 1: Average feed intake (kg) of treatment groups fed fresh fodders for 7 days.

Fig. 2: Average growth curves of treatment groups fed fresh fodders for 7 days.
Milk Yield and Composition

Table (4) shows the average values of daily milk yield and milk composition. Treatment effect was highly significant (p<0.01) on daily milk yield. Group B, recorded the higher milk yield (0.58±0.18 liter), milk protein, milk fat and total solids compared to group A and C. The total milk yield of the experimental animals in this study (47 Kg) was lower than that reported by Khallafalla and Sulieman (1990) and Peters 2008. Gonoles and Martings, (1988) reported that higher milk yield was generally associated with initial yield, persistency and lactation length. The peak milk yield in this study was earlier 3-9 weeks than the reported 5-11 weeks post kidding yield in India (Mittal and Pandy, 1971). Devendra and Mcleory, (1982) reported that milk composition is affected by the stages of lactation. Results of this study showed that the milk composition of goats was within the normal ranges stated by the latter researchers. Also the total solids were similar to those reported by them. Milk fat was higher for animals on sweet potato vines (3.87). This might be due to the higher fibre content that may affect the type of fermentation in the rumen. In this study the Milk yield increased by increasing DM intake this result agree with result reported by Dung et al 2010 milk yield was linearly related with cassava hay intake, being almost double when cassava was consumed at 25% of DM intake compared with the zero level of cassava hay. Milk quality was also improved with sweet potato used. There were associated improvements in milk quality and better growth rates this agree by finding result of Dung et al 2010.

Table 4: Analysis of variance and average (mean±SD) milk yield (liter) and percent composition values of treatment groups fed fresh fodders

<table>
<thead>
<tr>
<th>Parameters</th>
<th>F-value†</th>
<th>A (Abu-70)</th>
<th>B (Sweet Potato vines)</th>
<th>C (Clitoria)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight gain (kg)</td>
<td>3.70</td>
<td>3.08 ± 0.59</td>
<td>3.82 ± 0.72</td>
<td>3.82 ± 0.71</td>
</tr>
<tr>
<td>Daily DM intake (kg)</td>
<td>-</td>
<td>14.84</td>
<td>20.34</td>
<td>15.23</td>
</tr>
<tr>
<td>Daily milk yield (liter)</td>
<td>6.9**</td>
<td>0.45± 0.14</td>
<td>0.58± 0.18</td>
<td>0.35± 0.005</td>
</tr>
<tr>
<td>Protein %</td>
<td>-</td>
<td>3.48</td>
<td>3.82</td>
<td>3.21</td>
</tr>
<tr>
<td>Fat %</td>
<td>-</td>
<td>3.40</td>
<td>3.87</td>
<td>3.62</td>
</tr>
<tr>
<td>Total solids</td>
<td>-</td>
<td>11.80</td>
<td>12.93</td>
<td>12.60</td>
</tr>
</tbody>
</table>

† At (2, 60) d.f.
** Denotes F-value significant at (p > 0.01).
Means in a row bearing the same letter subscript are similar (p > 0.05).

Conclusion

The nutritional properties of sweet potato leaves indicate that they have the potentiality to improve dietary protein and amino acid supply in a low fibre diets for ruminants, therefore Sweet potato leaves can be used as a protein-rich feedstuff for ruminants.

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