Comparison of water melon (*Citrullus vulgaris*)-seed meal, *Acacia tortilis* pods and sunflower-seed cake supplements in central Tanzania.

2. Effect on hay intake and milk yield and composition of Mwpawpa cows

C.M. SHAYO\(^1\), B. OGLE\(^2\) AND P. UDÉN\(^2\)

\(^1\)Zonal Research and Training Centre, Livestock Production Research Institute, Mwpawpa, Tanzania

\(^2\)Department of Animal Nutrition and Management, Swedish University of Agricultural Sciences, Uppsala, Sweden

Abstract

An experiment was conducted to study the effect on feed intake and milk production of supplementing lactating cows with water melon-seed meal, *Acacia tortilis* pods and sunflower-seed cake. The basal diet (control) was *Cenchrus ciliaris* hay + 1 kg maize bran/hd/d and additional supplements compared were 1.5 kg/hd/d water melon-seed meal, 1.5 kg/hd/d *Acacia tortilis* pods and 1 kg/hd/d sunflower-seed meal. All animals were fed the hay *ad libitum*. Eight Mwpawpa cows were penned and fed individually in a duplicate 4 × 4 Latin square experiment. The trial lasted for 4 months. All supplements significantly (P<0.05) increased total dry matter (DM) intake, and milk production. Milk fat was not significantly (P>0.05) affected by any of the supplements. Water melon-seed meal significantly (P<0.05) depressed the total solids and total ash in milk. The study has shown that water melon-seed meal and *Acacia* pods may be more cost-effective supplements than sunflower-seed cake for dairy farmers in remote villages in the semi-arid areas of central Tanzania.

Introduction

Economic milk production in semi-arid areas is highly dependent on the use of locally available feed resources, since most villages are located in remote areas where transportation of commercial feeds is a problem. Hence, supplementation using commercial concentrates is not feasible. Water melons (*Citrullus vulgaris*) are widely grown in the semi-arid areas of central Tanzania and are mainly for human food and water for livestock, while the seeds are used as a source of nutrients for livestock (Kusekwa *et al.* 1990; Shayo *et al.* 1996). *Acacia tortilis* trees also grow extensively in the area and are an important source of protein for grazing livestock during the dry season. Information on the nutritive value of water melon seeds and *Acacia* pods for animal production is limited. Most reports are limited to the chemical composition of these feeds, and a few on their digestibility (Coppock *et al.* 1987; Tanner *et al.* 1990; Shayo *et al.* 1997).

The purpose of this experiment was, therefore, to study the effects on dry matter (DM) intake, milk yield and milk composition of supplementing lactating Mwpawpa cows with water melon-seed meal and *Acacia tortilis* pods.

Materials and methods

This experiment was carried out at the Zonal Research and Training Centre, Mwpawpa in central Tanzania, using 8 lactating Mwpawpa cows. All cows calved between December 15, 1990 and January 15, 1991. The animals were between the second and fourth lactations. Their selection was also based on their previous milk production records, which showed total milk production ranging from 790–1082 litres in 270–305 lactation days. The initial liveweights of the animals ranged from 205–335 kg.

Feeds and feeding

The animals were penned and fed individually, each receiving 12 kg (11.24 kg DM) *Cenchrus*...
ciliaris hay and 1 kg maize bran (0.9 kg DM) per day as a basal diet plus a balanced mineral lick (Maclick super, Welcome Tanzania Ltd) (see Shayo et al. 1996). The animals were allotted in a duplicate 4 x 4 Latin square experiment with the following treatments: A — Control (Cenchrus ciliaris hay + 1.0 kg maize bran); B — Control + 1.5 kg water melon-seed meal; C — Control + 1.5 kg ground Acacia tortilis pods; and D — Control + 1.0 kg sunflower-seed cake. The amounts of water melon-seed meal, Acacia pods and sunflower-seed cake were such that they provided similar amounts of crude protein.

In order to minimise losses of hay during feeding, feeds were offered 4 times per day. Each morning after milking (at 07.30 h), the animals were provided with 3.5 kg hay, followed by 2.5, 2.5 and 3.5 kg at 11.00 h, 14.00 h and 18.00 h, respectively. The amount of hay likely to be eaten was estimated using the following equation (Conrad 1966):

\[ DMI = 5.4 \ W/500 \ F \]

Where DMI = dry matter intake (kg/d),

\[ W = \text{liveweight (kg), and} \]

\[ F = \text{proportion of undigested DM} = 0.4. \]

The digestibility of the hay was estimated to be about 60% (see Shayo et al. 1997). The average level of excess hay for each animal was about 35%. Cows were milked twice daily at 07.00 h and 16.00 h. At each milking, the animals were provided with half of the daily supplement.

**Data collection**

Initially, 12 days were allowed for the animals to become accustomed to the pens. During each experimental period, there was a preliminary period of 14 days, followed by 14 days of data collection. During the data collection period, all refusals of hay were collected at 06.30 h daily, weighed and subsampled. All subsamples for individual cows during the collection period were bulked and a further subsample taken for CP and neutral detergent fibre (NDF) analysis using procedures described by AOAC (1985) and Goering and Van Soest (1970), respectively.

The milk produced by each animal at each milking time was collected and weighed. Approximately 300 ml samples of milk from each cow were collected on 3 occasions during the data collection periods, Day 2, Day 7 and Day 12. These samples were analysed for butterfat (BF), crude protein (CP), total solids (TS) and total ash, using procedures described by AOAC (1985).

**Statistical analysis**

The data on hay and nutrient intake, feed refusals and milk yield and quality were analysed using the following model for a Latin square design:

\[ Y_{ijk} = \mu + \alpha_i + \beta_j + \tau_k + e_{ijk} \]

Where

\[ \mu = \text{overall mean response for all the treatments,} \]

\[ \alpha_i = \text{part of the mean that is due to cows,} \]

\[ \beta_j = \text{part of the mean that is due to periods,} \]

\[ \tau_k = \text{part of the mean that is due to diets, and} \]

\[ e_{ijk} = \text{residual (Error term)} \]

For the treatments which showed significant differences, the means were compared using Tukey’s procedure at P<0.05.

**Economic evaluation**

Simple calculations were performed to determine the relative economics of supplementation with water melon-seed meal, Acacia tortilis pods or sunflower-seed cake. This was based on their influence on milk yield and the prevailing prices of milk and feeds.

**Results**

**Hay selectivity and intake**

The nutrient composition of the feeds offered is presented in Table 1.

The cows tended to select the most nutritious parts of the Cenchrus ciliaris hay, as CP % of the hay was higher than that of the refusals (4.7 vs 2.6%). Also, the NDF concentration of the hay provided was lower (72.5%) than that in the refusals (75.6%). There were no significant differences between treatments for either NDF or CP concentration of the refusals (P>0.05). All of the supplements were consumed.

Table 2 presents the mean daily DM and nutrient intakes per cow, allowing for the effect of selectivity. Generally, the supplements had no significant effect on Cenchrus ciliaris hay intake (P>0.05), but all supplements significantly (P<0.05) increased total DM intake. Hay intake with water melon-seed meal was significantly
lower (P<0.05) than with the sunflower-seed cake supplement.

The average amounts of hay refused daily were 34.2, 36.7, 32.1 and 29.1 percent of the hay offered on the control, water melon-seed meal, Acacia pods, and sunflower-seed cake supplemented rations, respectively.

The rations containing water melon seeds and sunflower-seed cake had significantly (P<0.05) higher fat concentration than that containing Acacia tortilis pods and the control diet. The fat concentration in the ration containing water melon-seed meal was also significantly (P<0.05) higher than that with sunflower-seed cake.

### Table 1. Chemical composition of the feeding materials

<table>
<thead>
<tr>
<th>Feedstuff</th>
<th>CP (% DM)</th>
<th>EE (% DM)</th>
<th>NDF (% DM)</th>
<th>ADL (% DM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cenchrus ciliaris hay</td>
<td>4.7</td>
<td>1.4</td>
<td>72.5</td>
<td>8.1</td>
</tr>
<tr>
<td>Acacia tortilis pods</td>
<td>13.4</td>
<td>1.1</td>
<td>44.0</td>
<td>7.7</td>
</tr>
<tr>
<td>Water melon-seed meal</td>
<td>16.8</td>
<td>24.4</td>
<td>61.5</td>
<td>12.2</td>
</tr>
<tr>
<td>Sunflower-seed cake</td>
<td>25.8</td>
<td>13.1</td>
<td>62.3</td>
<td>12.9</td>
</tr>
</tbody>
</table>

(1) Source: Shayo et al. (1997).
(2) CP = crude protein; EE = ether extract; NDF = neutral detergent fibre; ADL = acid detergent lignin.

### Table 2. Dry matter and nutrient intakes by cows supplemented with water melon-seed meal, Acacia tortilis pods or sunflower-seed cake.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hay DM</td>
<td>7.40a</td>
<td>7.12a</td>
<td>7.63ab</td>
<td>7.97b</td>
</tr>
<tr>
<td>Total DM</td>
<td>8.30a</td>
<td>9.45b</td>
<td>9.88b</td>
<td>9.81b</td>
</tr>
<tr>
<td>EE</td>
<td>0.15a</td>
<td>0.49c</td>
<td>0.16a</td>
<td>0.28b</td>
</tr>
<tr>
<td>CP</td>
<td>0.55a</td>
<td>0.78b</td>
<td>0.73b</td>
<td>0.80b</td>
</tr>
<tr>
<td>NDF</td>
<td>5.25a</td>
<td>5.67ab</td>
<td>6.02b</td>
<td>6.23b</td>
</tr>
<tr>
<td>ADL</td>
<td>0.60a</td>
<td>0.75b</td>
<td>0.68b</td>
<td>0.76b</td>
</tr>
</tbody>
</table>

(1) A = Control; B = Control + water melon-seed meal; C = Control + Acacia tortilis pods; D = Control + sunflower-seed cake.
(2) EE = ether extract; CP = crude protein; NDF = neutral detergent fibre; ADL = acid detergent lignin.
(3) Values in the same row followed by different letters are significantly different (P<0.05).

### Milk yield and composition

Supplementation with water melon seeds, Acacia tortilis pods or sunflower-seed cake significantly (P<0.05) increased milk yield (Table 3). There were no significant differences in milk yield between the supplements (P>0.05).

There was also a significant increase (P<0.05) in milk ash and a depression (P<0.05) in milk TS with water melon-seed meal supplementation as well as a non-significant (P>0.05) depression in CP and BF levels. Butterfat levels were not significantly affected by diet composition.

At the prevailing prices for the various supplements, net returns were higher for all supplemented diets than for the controls (Table 4). The highest net return was obtained with water melon-seed meal.

### Discussion

This study provides evidence of the value of locally available protein supplements for lactating cows in central Tanzania. Both water melon-seed meal and Acacia pods proved effective in stimulating milk production. The lower price per kg for these feedstuffs made them more cost-effective than sunflower-seed cake for feeding to lactating cows.

The increased milk production was a function of an increased total dry matter intake (14–19%) on the supplemented diets. According to Preston and Leng (1987), increasing rumen NH₃-N levels up to an optimum of 15 mg/100 ml results in increasing intakes of fibrous feeds. Shayo et al. (1997) observed that supplementation raised rumen NH₃-N levels from around 10 mg/100 ml on the basal diet to 12–16 mg/100 ml (Acacia pods and water melon-seed meal) and 15–30 mg/100 ml (sunflower-seed cake), and yet, in this study, no significant effects of supplementation on intakes of the basal hay diet were found. The ration incorporating water melon-seed meal contained 5.2% fat, which was almost twice the level in the sunflower-seed meal diet and three times that on the remaining diets. High levels of fat in the diet can depress hay intake because of reduced microbial fermentation of the roughage (Palmquist and Jenkins 1980), resulting in low ruminal disappearance and eventually low intake (Balch and Campling 1961).

High dietary fat is generally associated with depression of CP (Spörndly 1989) and fat in milk, due to low production of acetate relative to propionate in the rumen, resulting from reduced fermentation of the roughage. The diet containing the highest fat levels in our study (water melon-seed meal) produced milk with the lowest milk fat, crude protein and total solids.
Table 3. Effects of daily milk yield and composition of supplementing hay-fed cows with *Acacia tortilis* pods, water melon-seed meal and sunflower-seed cake.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Milk yield</th>
<th>Milk composition (%)</th>
<th>Crude protein</th>
<th>Total solids</th>
<th>Ash</th>
<th>Butterfat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>4.59a</td>
<td>2.98ab</td>
<td>13.38b</td>
<td>0.72a</td>
<td>4.53</td>
<td></td>
</tr>
<tr>
<td>Water melon-seed meal</td>
<td>5.34b</td>
<td>2.80a</td>
<td>12.86a</td>
<td>0.75b</td>
<td>4.20</td>
<td></td>
</tr>
<tr>
<td><em>Acacia</em> pods</td>
<td>5.24b</td>
<td>3.00b</td>
<td>13.29b</td>
<td>0.71a</td>
<td>4.34</td>
<td></td>
</tr>
<tr>
<td>Sunflower-seed cake</td>
<td>5.45b</td>
<td>2.90ab</td>
<td>13.27ab</td>
<td>0.71a</td>
<td>4.41</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.150</td>
<td>0.044</td>
<td>0.106</td>
<td>0.0055</td>
<td>0.083</td>
<td></td>
</tr>
</tbody>
</table>

1 Means in the same column followed by different letters are significantly different (P<0.05).

Table 4. Economic comparison of sunflower-seed cake, water melon-seed meal and *Acacia tortilis* pod supplementation of lactating Mpwapwa cows (Tshs/hd/d). 1

<table>
<thead>
<tr>
<th>Diet</th>
<th>Total expenditure2</th>
<th>Milk production</th>
<th>Income3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Tshs)</td>
<td>(kg)</td>
<td>Total (Tshs)</td>
</tr>
<tr>
<td>Control</td>
<td>258.3</td>
<td>4.59</td>
<td>957.9</td>
</tr>
<tr>
<td>Water melon-seed meal</td>
<td>309.1</td>
<td>5.34</td>
<td>1114.4</td>
</tr>
<tr>
<td><em>Acacia</em> pods</td>
<td>325.1</td>
<td>5.24</td>
<td>1093.6</td>
</tr>
<tr>
<td>Sunflower-seed cake</td>
<td>393.9</td>
<td>5.45</td>
<td>1137.4</td>
</tr>
</tbody>
</table>

1 1 US $ = 600 Tshs.
2 Prices of the ingredients were as follows: *Cenchrus ciliaris* hay = 26 Tshs/kg; Water melon-seed meal = 39 Tshs/kg; *Acacia* pods = 39 Tshs/kg; Mineral mixture = 261 Tshs/kg; Sunflower-seed cake = 117 Tshs/kg; and Maize bran = 39 Tshs/kg.
3 Price of milk = 209 Tshs/kg.

The study indicates that 1.5 kg of water melon-seed meal or *Acacia tortilis* pods could be used to replace 1 kg of sunflower-seed cake for milk production by lactating Mpwapwa cows fed on hay and 1 kg of maize bran daily. Furthermore, it appears that, for the same amount of milk production, a farmer in areas where transport is a problem should obtain slightly higher net returns by supplementation with the locally available feeds (water melon-seed meal and *Acacia tortilis* pods) rather than sunflower-seed cake.

Acknowledgement

The financial support of the Swedish Agency for Research Cooperation with Developing Countries (SAREC) is gratefully acknowledged.

References


TANNER, J.C., REED, J.D. and OWEN, E. (1990) The nutritive value of fruits (pods with seeds) from four Acacia spp. compared with extracted noug (Goizotia Abyssinica) meal as supplements to maize stover for Ethiopian highland sheep. Animal Production, 51, 127–133.

(Received for publication May 25, 1995; accepted September 2, 1996)