Effect of supplementing a tanniniferous shrub legume on milk yield and composition of dual purpose cattle grazing *Paspalum notatum*

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**Introduction**

Domesticated ruminants are a major source of income for the rural population of countries located in the tropics and subtropics. However, low availability and poor quality of forage for livestock are major constraints for satisfactory animal productivity in many regions. This is particularly relevant in regions with low-fertility soils and extended dry seasons. It was shown for many parts of the tropics that shrub legumes might present alternative dry season sources of protein supply in forage-based diets for ruminants due to their deep root system and their ability to fix nitrogen, associated with a relatively high crude protein (CP) content (Dzowela et al., 1997). At the same time, the high condensed tannin (CT) content of many such species adapted to acidic soils with low fertility is a major constraint for their use in ruminant’s diets as CT are known to reduce protein digestibility.

The International Centre for Tropical Agriculture (CIAT) in Colombia, pre-selected promising legume species on basis of a sufficient agronomic performance under unfavourable conditions and a satisfactory nutritional value for ruminant nutrition as tested \textit{in vitro} in mixtures with non-tanniniferous legumes (Stürm et al., 2006). This practice to use CT-legumes as supplements to low quality tropical grasses would be particularly suited for feeding in the dry season as it would allow small-scale farmers to cultivate, apart from forage grass, only small plots of care intensive, high-quality annual herbaceous legumes such as *Vigna unguiculata*, and supplement this diet type with a considerable proportion of perennial tanniniferous shrub legumes which are easier to grow and more productive under these conditions. At the same time, such strategies could contribute to methane mitigation (e.g. Woodward et al., 2001) and healthier animals with respect to reduced parasitism (Min and Hart, 2003) and bloat (Lees, 1992).

*Calliandra calothyrsus* is a shrub or tree legume of the subhumid and humid tropics, characterized by having high tannin contents (>50 g/kg). Particularly one accession of *C. calothyrsus* (CIAT 22310) showed auspicious potential regarding ruminal fermentation dynamics \textit{in vitro} and was therefore tested for its suitability as a supplement to grazing cattle. The objective of the present study was, therefore, to define the extent to which a high quality legume could be replaced by *C. calothyrsus* without reducing significantly milk yields in dairy cattle.

**Material and Methods**

The experiment was carried out at the research station of CIAT in Santander de Quilichao, in the Cauca district, Colombia, South America (3°06’N and 76°31’W, 990 m a.s.l.). Soils in the region are characterized by Ultisols with excellent physical properties, low pH (~4.2), low phosphorus
content (~2 ppm) as well as high contents of organic matter (70 g/kg soil dry matter (DM)) and aluminum (80%). Average temperature is 24°C and annual precipitation is 1700 mm in two rainy seasons. The total precipitation in the 56 days of the experiment from August to October was 1 mm.

In a duplicated 4x4 Latin Square design, eight dual purpose cows (Holstein × Zebu, average body weight of 432 kg) in the second third of their lactation were kept on two Paspalum notatum pastures (983 kg TS/ha) with a size of 1.5 ha. Cows were supplemented with either Vigna unguiculata or Calliandra calothyrsus San Ramón (CIAT 22310) or mixtures of the two at proportions 1:2 and 2:1. Allowance for supplementation was set to 1 kg of DM per 100 kg of body weight and given in two meals. Cows were additionally given 120 g of mineralised salt per day. To increase palatability, 100 g of molasses were distributed over the supplemented legumes. Cows were allowed to adapt for 7 days on one pasture, followed by 7 days of measurement on the other. Milk yield was measured daily. On days 1, 4 and 7, milk was analyzed for urea-N (MUN) using a commercial kit. On the last day of the measurement period, extra milk samples were taken to be analyzed for contents of dry matter and fat (Babcock-test).

Forage availability and quality on the pasture was measured at the beginning of every period, taking samples from 9 areas of 0.5 m² each. In the measurement period, samples were plucked randomly thus simulating animal grazing. Forage was analyzed for in vitro dry matter digestibility (IVDMD), neutral and acid detergent fibre (NDF, ADF) and crude protein (CP).

**Results and Discussion**

*Paspalum notatum* is a tropical grass species of the dry tropics which is used in many parts of Latin America as basic forage for dairy and meat producing cattle. It is characterized by medium to low CP content, high fibre content and a relatively constant mineral composition. Although it is adapted to tolerate drought, biomass production as well as CP content in the dry season is clearly reduced. The data analyzed in the present experiment (Table 1) support this.

### Table 1: Availability, digestibility and composition of *Paspalum notatum* throughout the experiment.

<table>
<thead>
<tr>
<th>Period</th>
<th>BMA¹ (kg DM/ha)</th>
<th>IVDMD (g/kg)</th>
<th>NDF (g/kg)</th>
<th>ADF (g/kg)</th>
<th>CP (g/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>586</td>
<td>590</td>
<td>722</td>
<td>336</td>
<td>73</td>
</tr>
<tr>
<td>2</td>
<td>358</td>
<td>572</td>
<td>733</td>
<td>339</td>
<td>71</td>
</tr>
<tr>
<td>3</td>
<td>205</td>
<td>584</td>
<td>742</td>
<td>335</td>
<td>66</td>
</tr>
<tr>
<td>4</td>
<td>115</td>
<td>580</td>
<td>735</td>
<td>328</td>
<td>64</td>
</tr>
</tbody>
</table>

¹BMA, biomass availability

Concerning the supplements, IVDMD was high with Vigna-only supplementation and decreased clearly with inclusion of Calliandra in the diet (Table 2). The CP contents were equal in all diets. This apparent inconsistency can be explained by the high CT content of Calliandra (measured: 230 g/kg DM), which also tends to result in much lower fibre content, compared to non CT-plants (e.g. Mueller-Harvey, 2006).

### Table 2: Ingredient composition and digestibility of the supplements offered

<table>
<thead>
<tr>
<th>Supplement</th>
<th>IVDMD (g/kg)</th>
<th>NDF (g/kg)</th>
<th>ADF (g/kg)</th>
<th>CP (g/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vigna</td>
<td>706</td>
<td>626</td>
<td>320</td>
<td>151</td>
</tr>
<tr>
<td>Vigna/Calliandra 2:1</td>
<td>599</td>
<td>558</td>
<td>326</td>
<td>153</td>
</tr>
<tr>
<td>Vigna/Calliandra 1:2</td>
<td>442</td>
<td>469</td>
<td>336</td>
<td>154</td>
</tr>
<tr>
<td>Calliandra</td>
<td>217</td>
<td>376</td>
<td>326</td>
<td>155</td>
</tr>
</tbody>
</table>
Voluntary DM intake is known to decrease with inclusion of CT-plants and did so notably when Calliandra exceeded one third of the total supplement. Intake of supplement with Calliandra alone was only one third of that found with pure Vigna.

The highest milk yields were, as expected, observed with the pure Vigna supplement, while Calliandra alone resulted in the lowest yields (P< 0.05) (Table 3). The mixtures of 2:1 and 1:2 did not differ statistically but showed numerically the same trend. The reduction in yield correlates with the amount of Calliandra in the diet (R=0.98) and accounted for up to 32% compared to the pure Vigna supplement.

This does not confirm the results of Paterson et al (1999), who reported for livestock systems in Kenya that 3 kg of DM of Calliandra would have the same effect as 1 kg of commercial dairy meal. In milk solids (119-120 g/kg), fat (36.6-38.5 g/kg) and solids-non-fat (80.5-83.1g/kg) contents there were no significant differences (P > 0.05) between legume supplements. The MUN was clearly higher with Vigna than with Calliandra supplementation (P < 0.05) and supplementation with the low proportion (1/3) of Calliandra decreased MUN numerically by one forth, but this change was not statistically significant. However, supplementation with 2/3 of Calliandra led already to the same concentration of MUN as with Calliandra alone. These low MUN values indicate low protein availability in the rumen, due to the formation of undegradable CT-Protein complexes.
Conclusions
Even a partial replacement of *Vigna unguiculata* by the tanniniferous shrub legume *Calliandra calothyrsus* reduced milk yields in dairy cows in Colombia. This seems to be largely an effect of refusal, due to low palatability of high CT-plants, but is also clearly affected by CT itself as is obvious from the reduction in MUN content. As far as analyzed, milk quality was not influenced. Thus, *C. calothyrsus* San Ramón, cultivated on an acidic low-fertility soil in Colombia, can not be recommended as protein supplement for dairy cattle in amounts which would help to save considerable quantities of the scarce high-quality legume.

References


