

Research Note

Nutritional quality of *Calobota sericea* fodders. A preliminary assessment

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This study aimed to provide preliminary information regarding the nutritional quality of *Calobota sericea*, a preferred perennial legume forage species from the water-limited rangelands of South Africa. *Calobota sericea* plant samples were collected from the Namaqualand rangelands in the wet and dry season and analysed for secondary compounds, fibre, protein and mineral nutrient content. The results from the fibre analyses were used to determine the digestibility and energy content of fodders. Preliminary results indicate that *C. sericea* fodders are of better nutritional quality in the wet season and that protein content, digestibility and energy content is sufficient for maintenance of lambs and dry ewes. The energy content, however, was not sufficient for maintenance of pregnant and lactating ewes. Furthermore, certain mineral nutrients (Na, P and K) were not found in sufficient concentrations in this species, and it was thus suggested that further investigation is needed into whether fertilisation could potentially improve the protein, digestibility and mineral nutrient content of *C. sericea* fodders.

Keywords: crude protein, digestibility, forage energy, legume fodders

Calobota sericea (Thunb.) Boatwr. & B-E van Wyk is a native South African legume species primarily found within the winter rainfall regions of the Western and Northern Cape provinces of South Africa (Boatwright et al. 2018). The species was prioritised as a potential alternative forage for the water-limited agro-ecological areas of South Africa, and other areas experiencing similar bioclimatic conditions (Müller et al. 2017). Samuels et al. (2016) conducted a diet selection study in the Leliefontein communal rangelands of Namaqualand and indicated that during the late summer months, when there is usually a feed shortage within the rangelands, the dry foliage of native *C. sericea* populations contribute approximately 16% of small stock (goat and sheep) diets. Within these rangelands, it has also been noted that livestock seldom browsed the green foliage of *C. sericea* in the wet season when other, presumably more palatable fodders are available within the rangelands (Samuels et al. 2016; Müller et al. 2017). This, however, allows the plant to accumulate a substantial amount of biomass throughout the wet season, allowing for its copious biomass to be used during the dry season. Therefore, if developed and managed properly, *C. sericea* has the potential to contribute significantly to the alleviation and filling of the dry season feed gaps experienced within these semi-arid agro-ecosystems.

There is, however, a lack of information regarding the nutritional quality of *C. sericea* in Namaqualand thereby limiting our understanding of its importance to livestock production and the development of the species into a potential alternative fodder crop for these areas. Therefore, this study aimed to determine the nutritional quality of

C. sericea from samples collected during the Samuels et al. (2016) study. These results are interpreted as baseline results for future research into the nutritional quality of *C. sericea* fodders and to develop strategies to include the species into fodder flow programs in these rangelands.

Plant material of *C. sericea* was collected from the Namaqualand Granite Renosterveld vegetation in the Leliefontein communal area. Plant material of *C. sericea*, which had the potential to be consumed by livestock (leaves, twigs and flowers), was harvested from 14 individual plants throughout the rangeland and grouped to form one composite sample. Samples were collected only from populations from locations where livestock were followed during the diet selection study (Samuels et al. 2016). A composite sample, rather than individual plants, was collected to reduce the variability that may exist due to differences in soil conditions between where individual plants were harvested from the natural populations. Sampling was performed during the wet season (October 2012) and replicated during the dry season (March 2013). In the dry season, dry plant material was collected directly from the plants and from litter directly underneath the plants. After collection, all plant material was oven dried at 60 °C until a constant mass was achieved. Thereafter, the dried plant material was milled using a Wiley mill with a sieve size of 0.5 mm and stored for chemical analyses.

Neutral detergent fibres (NDF) and acid detergent fibres (ADF) were determined using an ANKOM 220 Fiber Analyzer, using NDF method 6 and ADF method 5 (Ankom Technology). The NDF and ADF values obtained were used to calculate the digestible dry matter (DDM),

metabolisable energy (ME), total digestible nutrients (TDN), digestible forage energy (DFE), digestible organic matter (DOM), net energy for lactation (NE_L), net energy for maintenance (NE_M) and net energy for gain/growth (NE_G) using Equations 1 to 8.

1. DDM (%) = $88.9 - (ADF \times 0.779)$ (Rasby et al. 2008)
2. ME (Mcal kg^{-1} DM) = $(1.01 \times DFE) - 0.45$ (Meissner et al. 2000)
3. TDN (%) = $87.84 - (0.7 \times ADF)$ (Schroeder 2009)
4. DFE (Mcal kg^{-1} DM) = $0.04409 \times TDN$ (Meissner et al. 2000)
5. DOM (%) = $TDN \div 1.05$ (Meissner et al. 2000)
6. NE_L (Mcal kg^{-1} DM) = $1.044 - (0.0119 \times \%ADF)$ (Rasby et al. 2008)
7. NE_M (Mcal kg^{-1} DM) = $((1.37 \times ME) - (0.3042 \times ME) + (0.051 \times ME)) - 0.508$ (Rasby et al. 2008)
8. NE_G (Mcal kg^{-1} DM) = $((1.42 \times ME) - (0.3836 \times ME) + (0.0593 \times ME)) - 0.7484$ (Rasby et al. 2008)

Total phenolics and condensed tannins were quantified by extracting 0.2–0.3 g of *C. sericea* plant material in 3 ml of aqueous 70% Acetone (Hagerman 2002). Total phenolic concentration in plant samples were quantified using the Prussian blue assay (Price and Butler 1977) as modified by Hagerman (2002), using gallic acid as standard. Condensed tannin concentration in the samples were quantified using the Acid-butanol assay (Porter et al. 1986) as modified by Hagerman (2002), using sorghum tannin extracted from *Sorghum bicolor* seeds as the standard (Hattas and Julkunen-Tiitto 2012). All reagents used were analytical grade. For mineral nutrient analyses, a 0.4 g sample of the dry milled plant material was digested using a sulphuric-peroxide digestion mixture in a heating block (Moore and Chapman 1986). Thereafter, the aqueous solution was filtered through Whatman no. 1 filter paper into a 100 ml volumetric flask and diluted to volume. Concentrations of Ca, Mg, Na and K were determined using atomic absorption spectrophotometry (Unicam Unlimited, Cambridge, UK) using certified standards for these elements (Merck Millipore (Pty) Ltd). The phosphorus (P) concentration in the digest was determined using a Spectroquant pharo (Model 300-M) spectrophotometer (Merck Millipore (Pty) Ltd). Total nitrogen concentrations in the digest was determined by direct titration with 0.01 N HCl after Kjeldahl distillation using a Büchi Nitrogen Distillation Unit (model K-300, Labotec, Büchi Switzerland). The N (%) content in the samples obtained was multiplied by a factor of 6.25 to obtain the percentage crude protein (McDonald et al. 2011).

Results from this preliminary analysis indicated that the total phenolics, condensed tannins, protein, digestibility, energy content and mineral nutrients (except for Na and Ca) generally decreased from the wet to dry season (Table 1). These results correspond to the findings on other forage species in that the nutritional quality of forages decreases as the plants mature (Horrocks and Valentine 1999; Reinehart 2008). In the wet season, CP content was found to be 8% (Table 1), which is sufficient for maintenance of small stock (Meissner et al. 2000). This result also indicates that *C. sericea* is one of the better quality fodders available for the livestock within the Namaqualand rangelands, compared with other forages, which had a CP content ranging between 3 and 8% in the wet season (Müller et al.

2019). The 6% CP found in *C. sericea* fodders in the dry season is below the recommended 7–8% levels required to meet small ruminant needs (Meissner et al. 2000). However, this amount is still higher than the 4–4.7% reported as the average of all forages evaluated in the dry season by Müller et al. (2019) for Namaqualand rangelands. It is known that nitrogen fertilisation could improve CP concentration in forages (Dasci and Comakli 2011; Kering et al. 2011; Coblenz et al. 2017). Since *C. sericea* fodders were collected from native, unfertilised stands, it indicates that CP could still be significantly improved if an additional nitrogen source is supplied to the soils if the species were planted as cultivated pastures.

The fibre content (NDF and ADF) in the *C. sericea* fodders increased from the wet to the dry season (Table 1). Although fibre is necessary for proper rumen function, high levels of fibre in the diet decreases forage intake. In this study, the higher fibre content in the dry season could limit the intake of these fodders by livestock, and is indicated by the reduced digestibility of the dry season fodders (Reinehart 2008; McDonald et al. 2011). Forages with a DDM of 60–69% are considered high quality forages from an energy perspective (Reinehart 2008). The DDM, DOM and TDN of *C. sericea* fodders were greater than 60% in the wet season indicating that these fodders are good quality fodders for livestock. However, the increase in fibre content in the dry season resulted in a significant reduction in these variables to below 40%. This, in turn, also resulted in a reduction in all energy parameters evaluated (DFE, ME, NE_L , NE_M and NE_G) from the wet to dry season (Table 1). Lambs up to 20 kg have a metabolisable energy requirement ranging between 3.9 and 10.5 mJ kg^{-1} DM, whereas dry ewes 40–60 kg have an energy requirement of 7.6–10.2 mJ kg^{-1} DM (Meissner et al. 2000). In the wet season, *C. sericea* fodder has a ME of 10 mJ kg^{-1} DM, whereas in the dry season it only has 5.8 mJ kg^{-1} DM (1 Mcal = 4.184 MJ) (Meissner et al. 2000). This indicates that *C. sericea* fodders can fulfil the energy requirements of lambs and dry ewes during the wet season, but only lambs during the dry season. Furthermore, ewes in their last six weeks of pregnancy have energy requirements of 14.5–17.7 mJ kg^{-1} DM, and ewes during their first eight weeks of lactation have an energy requirement of 15.5–19.4 mJ kg^{-1} DM (Meissner et al. 2000). This means that *C. sericea* fodders in both wet and dry seasons are not sufficient for pregnant or lactating ewes. Other studies, for example, Dasci and Comakli (2011) and Kering et al. (2011), however, indicate that N-fertilisation may lead to decreased ADF concentrations. Acid detergent fibre is comprised of the least digestible plant components, including cellulose and lignin, and these values are inversely related to digestibility of forages, and lower digestibility forages contains lower energy (Rasby et al. 2008). Therefore, strategies to improve the CP content of *C. sericea* fodders may also result in higher energy fodders that would be used to supplement even pregnant and lactating ewes.

Results from the mineral nutrient analyses indicated that Na and P concentrations in the wet season was below the recommended concentrations of 0.4–1.8 g kg^{-1} and 1.6–3.7 g kg^{-1} , respectively (Meissner 2000). Furthermore,

Table 1: Nutritional quality of *Calobota sericea* fodders harvested in the wet and dry season.

	Wet season	Dry season
Condensed Tannins (mg STE g ⁻¹)	1.1	0.2
Total Phenolics (mg GAE g ⁻¹)	9.8	4.9
Neutral Detergent Fibre (%DM)	43.2	73.7
Acid Detergent Fibre (%DM)	34.5	66.4
Hemicellulose (%DM)	8.7	7.3
Crude Protein (%)	8.0	6.0
Dry Matter Digestibility (%)	62.0	37.2
Digestible Organic Matter (%)	60.7	39.4
Total Digestible Nutrients (%)	63.7	41.4
Digestible Forage Energy (Mcal kg ⁻¹ DM)	2.8	1.8
Metabolisable Energy (Mcal kg ⁻¹ DM)	2.4	1.4
Net Energy for Maintenance (Mcal kg ⁻¹ DM)	2.2	1.0
Net Energy for Gain/Growth (Mcal kg ⁻¹ DM)	1.9	0.8
Net Energy for Lactation (Mcal kg ⁻¹ DM)	0.6	0.3
Sodium (g kg ⁻¹)	0.1	0.4
Calcium (g kg ⁻¹)	5.0	8.6
Magnesium (g kg ⁻¹)	1.7	1.6
Potassium (g kg ⁻¹)	5.6	2.6
Phosphorus (mg kg ⁻¹)	0.9	0.3

STE: sorghum tannin equivalent; GAE: gallic acid equivalents; DM: dry matter

in the dry season, P and K concentrations were also below the recommended concentrations of 1.6–3.7 g kg⁻¹ and 5–8 g kg⁻¹, respectively (Meissner 2000). The low P concentrations observed in *C. sericea* corresponds to results from Müller et al. (2019) in which very low P concentrations in all available forages in the Namaqualand rangelands, on average ranging between 0.7 and 1.2 mg kg⁻¹ across all species consumed are reported. This could be attributed to the fact that *C. sericea* plants generally occur on well-drained sandy loam soils, rocky sand, sandy dunes and granite soils (Boatwright et al. 2018), characterised by low total soil phosphate content ranging between 5 and 35 mg kg⁻¹ (Trytsman et al. 2016). Although these deficiencies are of concern, due to the importance of these mineral nutrients to livestock production, mineral nutrient content in forages can be improved through fertilisation if the species were planted as cultivated pastures. Interestingly, both Na and Ca concentrations were found to increase from the wet to dry season. Similar accumulation of mineral nutrients in plant litter was observed by Mitchell et al. (1986) who indicated that certain mineral nutrients increased over time in decomposing leaf litter of *Leucospermum parile*. In the current study, this could potentially be attributed to dust transfer from the soil onto the litter that were collected from below the plants.

In conclusion, *Calobota sericea* provides an ideal opportunity for farmers to utilise a native legume species that is well adapted to the poor edaphic and bioclimatic conditions of the rangelands to maintain their livestock condition throughout the dry summer months. However, this is only possible if *C. sericea* fodders are harvested and stored during the wet season when the nutritional quality of the species is higher. However, additional research is needed on when the best time would be to harvest the *C.*

sericea fodders as it is well known from other forages that the phenological stage at which the forages are harvested has an impact on the nutritional quality of the fodders produced. Investigations into the application of fertilisers to improve the nutritional quality (increased CP, digestibility and energy) of *C. sericea* cultivated fodders is also needed. Additionally, further research into the preservation of forages harvested in the wet season is needed to ensure that the quality of fodders given to livestock in the dry season is still sufficiently high to meet the requirements of the livestock.

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