Nutritive value of *Cassia sturtii, Sutherlandia microphylla* and *Medicago sativa* for sheep

By

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Declaration

I **Jacqueline Tucker** declare that the thesis/dissertation, which I hereby submit for the degree **MSc (Agric) Animal Science (Nutrition science)** at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

Signature: _____

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Abbreviations

ADF	Acid detergent fibre
ADL	Acid detergent lignin
ADS	Acid detergent solution
AIDS	Acquired immune deficiency syndrome
A.nummularia	*Atriplex nummularia*
AOAC	Association of Official Analytical Chemists
Ca	Calcium
C. sturtii	*Cassia sturtii*
CF	Crude fibre
cm	Centimeters
CO_2	Carbon dioxide
CP	Crude protein
CPD	Protein rumen degradability
Cr	Chromium
CT	Condensed tannins
Cu	Copper
d	Day
DAPA	Diaminopimelic acid
df	Dilution factor
DHP	Dihydroxypyridine
DM	Dry matter
DMD	Dry matter digestibility
DOM	Digestible organic matter
DOMI	Digestible organic matter intake
DOMR	Digestible organic matter in the rumen
EE	Ether extract
Fe	Iron

g	Gram
GABA	Gamma-aminobutyric acid
GIT	Gastro-intestinal tract
h	Hour
H	Hydrogen
ha	Hectare
HCl	Hydrochloric acid
$HClO_4$	Perchloric acid
H_2SO_4	Hydrogen sulphate
HNO_3	Nitric acid
INRA	Inland Northwest Research Alliance
IVDMD	*In vitro* dry matter digestibility
IVOMD	In Vitro Organic Matter Digestibility
K	Potassium
k_d	Rate of digestion
kg	Kilogram
k_i	Rate of intake
k_p	Rate of passage
l	Litre
LW	Live weight
m	Meters
M	Molar
Mcal	Mega calorie
ME	Metabolizable energy
ml	Milliliter
mm	Millimeter
mmol	Millimol
mg	Milligram
Mg	Magnesium

MJ	Mega joule
Mn	Manganese
MRT	Mean retention time
M. sativa	*Medicago sativa*
N	Nitrogen
Na	Sodium
NaOH	Sodium hydroxide
NAN	Non-ammonia-nitrogen
NDF	Neutral detergent fibre
NDFI	Neutral detergent fibre intake
NDS	Neutral detergent solution
NE	Net energy
NH_3-N	Ammonia nitrogen
NRC	National Research Council
ºC	Degree celsius
OM	Organic matter
OMD	Organic matter degradability
OMI	Organic matter intake
%	Percent
P	Phosphorus
PD	Purine derivatives
pH	H-ion concentration
RDN	Rumen degradable nitrogen
rpm	Revolutions per minute
SD	Standard deviation
Se	Selenium
S. microphylla	*Sutherlandia microphylla*
T. sinuatum	*Tripteris sinuatum*
µg	Microgram

µl	Microlitre
µm	Micrometer
µmol	Micromole
VFA	Volatile fatty acids
$W^{0.75}$	Metabolic weight
w/v	Weight/volume
Zn	Zinc

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Abstract

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The aim of this study was to assess the potential nutritive value for sheep, of two drought tolerant leguminous shrubs (*Cassia sturtii* and *Sutherlandia microphylla*) in terms of chemical composition, degradation parameters, digestibility, rumen fermentation parameters, intake, microbial nitrogen synthesis and nitrogen balance as well as the rumen kinetics when compared to that of *Medicago sativa*.

The crude ash concentration of all three forages differs, with *S. microphylla* and *C. sturtii* lower than M*. sativa*. *M. sativa* has a crude ash concentration almost twice the amount of both *S. microphylla* and *C. sturtii.* Wilcock *et al.,* (2004) reported ash values for *C. sturtii* stems and leaves of 53 and 73 g/kg and that of *S. microphylla* at 25 and 64g/kg respectively. Values for *C. sturtii* are lower while those of *S. microphylla* compare well to the average of the whole plant.

The mean CP and CF concentration differed between species with *C. sturtii* having the lowest CP and *M. sativa* the highest. S*. microphylla* had the highest CF while *M. sativa* had the lowest.
The NDF and ADF levels of the samples varied between all three species with *S. microphylla* being the highest and *M. sativa* the lowest. Values for *C. sturtii* were in between those of the two other forages.
The ADL concentration of *S. microphylla* was higher than both *C. sturtii* and *M. sativa*. The degree of lignification in *C. sturtii* was high (23.8% of NDF was ADL). The degree of lignification of *S. microphylla* was 26.8%, which is higher than that of *C. sturtii*, while *M. sativa* is the same as *C. sturtii.*

The calcium concentrations of *C. sturtii* and *M. sativa* are similar and have a higher concentration than S. *microphylla*. *M. sativa* and *C. sturtii* had a higher phosphorus concentration than *S. microphylla*. With respect to magnesium (Mg), *C. sturtii* and *M. sativa* have a similar composition while S*. microphylla* has a lower concentration.
The iron concentration of all three plants differs, with *M. sativa* having the lowest concentration and *C. sturtii* the highest. The copper concentrations in *M. sativa* and *C. sturtii* were similar, while that of *S. microphylla* was slightly lower. The zinc concentrations in *M. sativa* and *C. sturtii* were similar, while that of *S. microphylla* was slightly higher. Manganese concentration of all three species differs, with *C sturtii* being the lowest and *S. microphylla* the highest. The plants from this trial were analysed for selenium but none or very insignificant levels were found and were not worth reporting.

The apparent DM digestibility of *S. microphylla* is significantly lower than *M. sativa* while it did not differ significantly from *C. sturtii. C. sturtii* did not differ significantly from both *M. sativa* and *S. microphylla.* The CP digestibility of all three species did not differ significantly, however that of *M. sativa* is numerically higher. With regards to the apparent NDF digestibility, *C. sturtii* and *S. microphylla* differ significantly to *M. sativa* with lower NDF digestibility values. The apparent OM digestibility followed the same trend as that of apparent DM digestibility.

The average intake was very different between species, with *C. sturtii* being the lowest and *M. sativa* the highest. The animals consuming either *C. sturtii* or *S. microphylla* tended to lose body weight during the experimental period, while those eating *M. sativa* gained body weight.
Voluntary intake parameters of *C. sturtii* and *S. microphylla* were lower and differed significantly between *M. sativa.* The DM intake of *M. sativa* was higher than both *C. sturtii* and *S. microphylla*.
The ME was the highest for *M. sativa* while *S. microphylla* was significantly different and had the lowest value. *C. sturtii* had an ME value similar to both *M. sativa* and *S. microphylla*. The ME intake of *S. microphylla* was 2.89 MJ/day compared to that of *M. sativa* of 8.57 MJ/day.
Rumen NH_3-N concentrations of *C. sturtii were* the lowest and differed significantly from *S. microphylla* and *M. sativa.*

Sheep receiving *C. sturtii* had the lowest total rumen VFA concentration and was significantly different from *M. sativa* which had the highest value. *S. microphylla* had a similar total VFA concentration to both *C. sturtii* and *M. sativa*.
C. sturtii had the lowest proportion of acetate but did not differ significantly compared to *S. microphylla,* while both were significantly different to *M. sativa,* which had the highest value. The propionate concentration for all three forages did not differ significantly. *S. microphylla* had the highest fibre concentration, therefore leading to higher acetate concentrations than *C. sturtii* but not higher than *M. sativa,* suggesting the fibre of *S. microphylla* is less digestible. This is supported by the low apparent NDF digestibility for *S. microphylla.*
Nitrogen intake was highest for *M. sativa* and was significantly different from *C. sturtii* and *S. microphylla*. The same trend followed for faecal and urinary nitrogen output as well as nitrogen retention. The nitrogen retention for all species was positive with *C. sturtii* being the lowest. These values compare well to the CP content of the three forages with *C. sturtii* the lowest and *M. sativa* the highest concentration.

The daily urinary allantoin elimination did not differ between *C. sturtii* and *S. microphylla* but was significantly different and higher for *M. sativa.*
The amount of microbial nitrogen supplied to the animal (g/day and g/kg DOMI) followed the same trend as allantoin.
M. sativa had significantly higher a-values (soluble fraction) for both DM and NDF degradation compared to the two shrub species at a rate constant of 0.02/h. *C. sturtii* had a higher b-value (potentially degradable fraction) for DM degradation compared to *S. microphylla* which shows that *S. microphylla* DM component was most readily soluble. For NDF, however, the b-values didn't differ among the species. Species had also no effect on the c-values (rate of degradation of the potentially degradable fraction b) of both DM and NDF. Therefore all species appear to have a similar potential source of energy for use by micro-organisms in the rumen. Effective DM degradability of *C. sturtii* and *S. microphylla* was similar while that of *M. sativa* was significantly higher. The effective NDF degradability for *C. sturtii* and *S. microphylla* was similar and *M. sativa* again had a significantly higher NDF degradability.

The rumen DM degradability for all three species showed a similar trend but much higher values than the apparent DM digestibility. The rumen NDF degradability values were almost identical to those reported for apparent NDF digestibility.The rate of intake and rate of digestion for *C. sturtii* and *S. microphylla* did not differ significantly, while that of *M. sativa* was the highest and significantly different. The rate of passage for all three species was similar. The percent NDF digested in the rumen differed significantly between all three species with *C. sturtii* being the lowest and *M. sativa* the highest. The percent NDF passing from the rumen also differed significantly between all three species, however this time *C. sturtii* being the highest and *M. sativa* the lowest, which corresponds well to the values for NDF digested in the rumen.

It is concluded that *C. sturtii* and *S. microphylla* are of a slightly lower nutritional value for sheep than *M. sativa.* If these two leguminous fodder species were to be used as maintenance feed, some other supporting source of energy would need to be supplied in order for these sheep to be maintained over a long period. The negative effect of all fibre related parameters (CF, NDF, ADF and ADL) in *C. sturtii* and *S. microphylla,* reduced digestibility as well as intake, leading to a forage of lower nutrient value as compared to *M. sativa*. The effect of anti-nutritional factors present in *C. sturtii* and *S. microphylla* on the digestibility of forages and nutrient contribution from forages needs to be studied to determine if these play a role in reducing the nutritional value.