Peer-reviewed paper: Proc. 43rd Congress of the South African Society for Animal Science

Effects of sun-dried *Opuntia ficus-indica* on feed and water intake and excretion of urine and faeces by Dorper sheep

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Abstract

The effects of incremental levels (0, 24 and 36%) of sun-dried and coarsely ground *Opuntia* cladodes in balanced diets on feed and water intake and excretion of urine and faeces were investigated. Nine Dorper wethers (mean live weight 45.3 ± 1.9 kg) were stratified according to body weight in three treatment groups and a diet randomly allocated to each group. The wethers were housed indoors in individual metabolic cages and fed the diets during a 7-day trial period. Feed and water intake and urine and faeces excretions were monitored and sampled for chemical analysis. The daily intake of feed (1096.3 ± 84.8, 1295.6 ± 80.9 and 1086.9 ± 95.8 g/day) and water (1993.3 ± 75.1, 2430.5 ± 265.3, 2295.2 ± 273.8 mL/day) for diets T0, T24 and T36 respectively, were not significantly influenced by including sun-dried *Opuntia* cladodes. Daily urine excretion showed no significant differences between treatments T0, T24 and T36. Inclusion of *Opuntia* cladodes in the diets resulted in the production of wet faeces within days, due to the presence of mucilage. Despite aesthetical aspects no detrimental effects were noted in the sheep. On the contrary, diet T36 had a significantly higher digestibility than diet T0, particularly for DM (digestibility coefficients = 0.723 ± 0.01 and 0.653 ± 0.01, respectively) and excreted less faecal DM (250.0 ± 21.1 *vs*. 345.2 ± 20.1 g/day).

Keywords: Cactus pear, mucilage, digestibility, wet faeces, sheep diets
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Introduction

Seasonal feed shortages and frequent droughts are major constraints to livestock production in the tropical and subtropical arid regions and ruminant livestock grazing natural pastures (veld) lose weight during these periods (De Waal *et al.*, 2006). Therefore, alternative feeds such as the cactus pear (*Opuntia* spp.) that are more adapted to arid conditions and use water more efficiently should be evaluated.

Cactus pear cladodes are used to feed livestock (Felker, 1995; Ben Salem *et al.*, 2002; Tegegne, 2002; De Waal *et al*., 2006). These plants have high biomass yields and are palatable, tolerant to salinity and have high digestible energy content (Nobel, 1995). *Opuntia* has a high water content [about 150 g dry matter (DM)/kg fresh material] and also serves as a source of water for livestock in dry regions (Ben Salem *et al*., 1996).

When feeding cactus pear cladodes to ruminants, a concern is the laxative effect (De Kock, 2001), and the wet faeces is often mistaken for diarrhoea. In addition to aesthetical concerns it is also perceived to increase the risk of blowfly strike and reduce digestibility (Nefzaoui & Ben Salem, 2000; Ben Salem *et al*., 2002). However, studies (Zeeman 2005; Einkamerer, 2008) indicated that sun-dried *Opuntia* cladodes can partially replace lucerne in sheep diets without negative changes in feed intake and digestibility in young Dorper wethers.

The objective of this study was to evaluate the effects of incremental levels of sun-dried and coarsely ground *Opuntia ficus-indica* var. Algerian cladodes in balanced diets on feed and water intake and urine and faecal excretion, as well the apparent digestibility of diets by young Dorper wethers.

Materials and Methods

This trial was conducted at the University of the Free State in Bloemfontein, South Africa. Nine Dorper wethers (mean live weight 45.3 ± 1.9 kg) were stratified according to body weight in three groups and treatment diets randomly allocated to each group.

The three treatment diets (T0, T24 and T36) comprised respectively (air dry basis) 0, 240 and 360 g/kg sun-dried and coarsely ground *Opuntia* cladodes; 660, 410 and 285 g/kg coarsely ground lucerne hay; 300 g/kg yellow maize meal; 0, 10 and 15 g/kg feed grade urea; and 40 g/kg molasses meal (Calori 3000).

The fresh cladodes were cut with a cladode cutter (multiple blades 15 mm apart) and dried in the sun (Zeeman, 2005; Einkamerer, 2008). The sun-dried cladode strips were ground in a small hammer mill (20 mm sieve) and dried further in the sun for two to three days on a dry and clean cement surface before mixed in the diets. The lucerne hay was also ground to pass the 20 mm sieve, while the other feed sources were included in the form in which it was purchased. The chemical composition of the three treatment diets are shown in Table 1.

Table 1 Chemical composition of the treatments diets containing incremental levels of sun-dried and coarsely ground *Opuntia* cladodes

Chemical constituent	Treatment diets*		
	T0	T24	T36
Dry matter (g DM/kg feed)	876.3	886.4	815.5
Crude protein (g/kg DM)	163.9	157.7	161.0
Acid-detergent fibre (g/kg DM)	338.1	231.8	199.8
Neutral-detergent fibre (g/kg DM)	516.3	368.2	365.0
Lipid (g/kg DM)	16.9	24.2	22.2
Organic matter (g/kg DM)	906.3	884.4	871.2

*Inclusion levels of sun-dried and coarsely ground *Opuntia* cladodes: T0 - 0%; T24 - 24%; T36 - 36%.

The wethers were housed indoors in individual metabolic cages and fed the diets during a 7-day trial period. They were fed three times a day (08:00, 12:00, and 16:00) at a 15% refusal level based on a 3-day moving average feed intake (De Waal *et al*., 2006). Water was provided *ad libitum* and water consumption recorded. The cages allowed for the separate collection of faeces and urine. Feed refusals and total faeces excreted were collected and weighed daily in paper bags and dried in a force draught oven at 100 °C. The urine excreted was collected via sheet metal chutes at the base of the metabolic cages and the volumes recorded. Dried feed refusals and faeces were pooled for each wether and representative samples collected. These samples and oven dried composite samples from each treatment diet were ground in a hammer mill (1 mm sieve) and stored in plastic bottles with sealed screw tops pending chemical analysis.

Organic matter (OM) content of feed and faeces were determined by incineration in a muffle furnace at 550 °C (AOAC, 2000). Nitrogen (N) content was determined in a Leco Nitrogen analyzer (Leco, 2001); crude protein (CP) was calculated by multiplying the N content by a factor of 6.25. Lipid content was determined as described by AOAC (2000), while neutral-detergent fibre (NDF) and acid-detergent fibre (ADF) were determined as described by Goering & Van Soest (1970) and Robertson & Van Soest (1981). The data were subject to statistical analysis using GLM procedures for repeated measured analysis of variance of SAS (2004).

Results and Discussion

The daily feed and water intake (Table 2) were not influenced by *Opuntia* cladodes in the diets. This is in agreement with the reports by Zeeman (2005) and Einkamerer (2008) for feed intake. However, these authors found water consumption to increase significantly and in proportion to the level of *Opuntia* in the diet. In the present study there was a non-significant tendency for water consumption to increase with the inclusion of *Opuntia* in the diets (Table 2). Cárdenas *et al.* (1997) and Tegegne (2002) ascribed this tendency to the fact that *Opuntia* cladodes contain a complex carbohydrate, mucilage, which has a great capacity to retain water. Consequently feeding animals with cactus pear may increase their water intake.

Total daily urine excretion showed no significant differences between treatments T0, T24 and T36 (Table 2). Nevertheless, a tendency to increase urinary excretion with the addition of *Opuntia* cladodes was observed. This is in agreement with the results published by Zeeman (2005) and Einkamerer (2008).

The inclusion of sun-dried and coarsely ground *Opuntia* cladodes in sheep diets resulted in the production of visibly wetter faeces, presumed to be caused by mucilage in the *Opuntia*. The production of wetter faeces started between two and three days after ingesting the diets. Differences were noted in the amount of faeces excreted daily on a DM basis. Wethers on treatment diets T0 and T24 produced more faeces than those fed diet T36. No differences were noted between diets T0 and T24 (Table 2). This is in agreement with the results of De Waal *et al*. (2006) and could be explained by the increased apparent digestibility with inclusion of *Opuntia* cladodes (Table 2). *Opuntia* is low in fibre with a high digestibility. Thus, when lucerne is replaced by *Opuntia* the relatively low fibre in diets T24 and T36 resulted in a significant reduction in faeces (on a DM basis) despite more faeces being excreted.

Inclusion of sun-dried *Opuntia* cladodes in diets increased the apparent digestibility (Table 3) of DM, CP and lipids. The apparent digestibility of DM of diets T24 and T36 were higher than diet T0. However, no significant differences were noted between diets T24 and T36 (Table 3). Similar results were reported by Zeeman (2005) and Einkamerer (2008). Ben Salem *et al*. (1996) concluded that the apparent DM digestibility increases with addition of *Opuntia* cladodes due to its higher easily digestible carbohydrate content.

The apparent CP and lipid digestibilities were also not different between diets T24 and T36, but were higher for T36 compared to T0. A higher apparent digestibility of CP with incremental levels of *Opuntia* cladodes was reported by Zeeman (2005) and Einkamerer (2008). The apparent NDF digestibility coefficients were similar for diets T0 and T24 as well as for diets T0 and T36. Wethers fed diet T36 showed a higher coefficient of digestibility for NDF compared to those fed diet T24. However, similar apparent digestibility coefficients for diets T0, T24, and T36 were recorded for ADF and OM.

Table 2 The daily (mean±s.e.) feed and water intake and faeces and urine excretion during a 7-day trial by Dorper wethers on diets containing incremental levels of sun-dried and coarsely ground *Opuntia* cladodes

Variables	Treatment diets*			P	CV[1] (%)
	T0	T24	T36		
Feed intake (g DM/day)	1096 ± 84.8	1296 ± 80.9	1087 ± 95.8	0.24	13.06
Water intake (mL/day)	1993 ± 75.1	2431 ± 265.3	2295 ± 273.8	0.42	17.35
Faeces excreted (g DM/day)	345[a] ± 20.1	351[a] ± 21.0	250[b] ± 21.1	0.02	11.39
Urine excreted (mL/day)	921 ± 33.8	960 ± 42.9	948 ± 144.4	0.95	16.38

*Inclusion levels of sun-dried and coarsely ground *Opuntia* cladodes: T0 - 0%; T24 - 24%; T36 - 36%;
[1]Coefficient of variance; [a,b] Means followed by different superscripts within the same row differ significantly at P <0.05.

Table 3 Apparent digestibility coefficients of DM and some chemical constituents (mean ± s.e.) by Dorper wethers fed diets containing incremental levels of sun-dried and coarsely ground *Opuntia* cladodes

Chemical constituents	Treatment diets*			P	CV[1] (%)
	T0	T24	T36		
Dry matter (DM)	0.653[a] ± 0.01	0.712[b] ± 0.01	0.723[b] ± 0.01	0.002	2.07
Crude protein (CP)	0.730[a] ± 0.01	0.765[a,b] ± 0.01	0.793[b] ± 0.01	0.007	1.98
Acid-detergent fibre (ADF)	0.509 ± 0.01	0.458 ± 0.02	0.503 ± 0.01	0.069	4.70
Neutral-detergent fibre (NDF)	0.582[a,b] ± 0.01	0.562[a] ± 0.02[a]	0.638[b] ± 0.01	0.015	3.81
Lipid	0.587[a] ± 0.03	0.715[a,b] ± 0.04	0.725[b] ± 0.02	0.035	7.93
Organic matter (OM)	0.323 ± 0.06	0.222 ± 0.02	0.294 ± 0.03	0.222	23.03

*Inclusion levels of sun-dried and coarsely ground *Opuntia* cladodes: T0 - 0%; T24 - 24%; T36 - 36%; [1] Coefficient of variance; [a,b] Means followed by different superscripts within the same row differ significantly at P <0.05.

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Conclusions

Sun-dried and coarsely ground *Opuntia* cladodes were well accepted by the Dorper wethers in diets and may perhaps even improve its acceptability. Within a few days of ingesting *Opuntia* in the diet, sheep produced wetter faeces. In addition to a poor aesthetical aspect it seems to have no major detrimental effects. Inclusion of 24% to 36% in diets has pronounced effects on feed and water intake and on urine excretion of Dorper wethers. Due to its relatively high soluble carbohydrate and low fibre contents, inclusion of sun-dried *Opuntia* cladodes in diets increased the digestibility (particularly DM) and tended to stimulate voluntary intake. Despite an increase in the watery fresh faeces, less faecal DM was excreted. Optimum inclusion of sun-dried and coarsely ground *Opuntia* cladodes in ruminant diets, as well its effects on the digestive processes and renal function should be established.

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