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Chemical Evaluation of South African Prickly Pear Cladodes Varieties as Fodder for Ruminants Grown in Mara ADC, South Africa

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ABSTRACT The aim of the study was to determine the chemical composition of South African prickly pears cladodes varieties as fodder for ruminants in Mara ADC, South Africa. The experimental field was divided into four replications with ten different prickly pears varieties within each replication. The following results were obtained (percent of dry matter): crude protein 6.23-10.63, neutral detergent fiber 19.36-38.29, acid detergent fiber 12.25-19.25, ether extract 1.19-2.62 and the phosphorus content 0.19-0.29. It was concluded that the environment aspects in the Limpopo Province did not negatively impact the chemical composition of prickly pears since the concentrations of fiber was lower and crude protein content was higher.

INTRODUCTION

Prickly pear is the most important species for the production of edible fruits and cladodes. There has been an increasing interest in cactus pear as an alternative feed for livestock in the tropical and subtropical regions of the world (Stintzing and Carle 2005). The increasing interest is due to their drought resistance, high biomass yield, palatability, salinity tolerance and soil adaptability (Khalafalla et al. 2007). *Opuntia* cannot be used for ruminants as a sole diet, but it could be mixed with other feedstuffs to form a balanced diet because of their low crude protein content of about 40 g/kg DM (Berumen et al. 2015), they should be regarded as a cheap energy source rather than as a balanced fodder crop (Akanni et al. 2015). Generally, *Opuntia* has high moisture content of seventy to ninety five percentage and apparent digestibility of about seventy-five percent.

Cactus pear is a drought tolerant feed in arid and semi-arid regions of the world (Cordeiro Dos Santos et al. 2001). Nobel et al (1987) and Nobel (1988) reported that with the application of fertilizer, cactus pear respond well and can be used as supplements (FAO 2000; Nefzaoui and Ben Salem 2002).

Opuntias are highly digestible (Nefzaoui and Ben Salem 2002) and contain sufficient water and minerals that in combination with a protein source constitute a complete feed for livestock (Kueneman 2001). Cactus pear can therefore be used to substitute grass hay for up to twenty percent for the maintenance of livestock live weight (Tegegne 2001).

Pruning of cactus pear is done annually and in winter the fodder can be used. After pruning the material can be used as a source of feed for livestock (Oelofse et al. 2006). To assess the potential value of singing prickly pear as an emergency forage resource, it is important to know its forage value.

Research Objective

To determine the nutritional quality of South African different prickly pear varieties.

Research Hypotheses

There is no difference in the chemical composition of different prickly pear cladodes.

METHODOLOGY

Three cladodes per varieties (*Ficus Indice, Nudosa, Roedtan, Turpin, Van As, Nepgen, Malta, Berg x Mexican, Morado and Cross x*)

were collected in June 2012 from a plant production study at Mara Research Station, Louis Trichard, Limpopo, South Africa. Mara ADC is located approximately 54 km west of Louis Trichard, Limpopo Province at 23°05'S and 29°25'E, at an altitude of 961 m above sea level in the Arid Sweet Bushveld. The average annual minimum and maximum temperatures recorded are 12.7 and 25.1°C, respectively. The average seasonal rainfall is 441 mm. Four cladodes from three varieties were collected in four replicates, which give 48 samples for analysis. No methods were used to remove the thorns, as all the varieties are spineless.

All chemical analysis was carried out in duplicate for each variety and replicate sample. The samples were analyzed for dry matter contents (DM) (AOAC 1990; Method No 930.15), ash (AOAC 1990; method no 924.05) and crude protein (CP) (AOAC 1990; method no 984.13. The acid detergent fiber (ADF) and neutral detergent fiber (NDF) were determined using method of the ANKOM 200 Fiber Analyser (ANKOM Technology Corporation, Fairport, NY, USA), described by Holden (1999). Ether extract (EE) was determined using the ANKOM XT10, Extractor 120V (ANKOM Technology Corporation, Fairport, NY, USA). Determination of phosphorus was according to the methods described by Van Soest et al. (1991). Total number of cladodes left after pruning was recorded from ten plants per variety.

Experimental Design

The study used the randomized complete block design.

Statistical Analysis

The analysis of variance was performed with the GLM procedure of SAS (SAS 2003). Least square means was used to establish comparisons between pairs of means.

RESULTS

The chemical composition of prickly pear cladode is presented in Table 1. The variety that produced the highest amount of DM was *Nudosa*. The variety that produced the lowest amount of DM was *Berg x Mexican* (Table 1). The *Van as* variety had the highest organic matter content as compared to other varieties (Table 1). Organic matter content of the different prickly pear cladodes varieties analyzed varies from 77.75 percent to 88.96 percent of DM.

The crude protein content of the different prickly pears cladodes varied from 6.23 percent to 10.63 percent on a DM basis from this study (Table 1). The *Malta* variety had the highest and the *Cross x* cactus variety the lowest CP content. The ADF content of the different prickly pear cladodes varies significantly ($P<0.05$) from 7.58 percent (*Turpin*) to 14.73 percent (*Cross x*) and the average was 11.64 percent DM.

From Table 1 the neutral detergent fiber average was 19.93 percent of DM and varies significantly ($P<0.05$) from 13.67 percent (*Turpin)* to 26.43 percent (*Nepgen).* There was a variation in the hemicellulose content of different *Opuntia* varieties ($P < 0.05$) from 6.09 percent (*Turpin*) to 13.09 percent (*Nepgen*) on a DM ba-

Table 1: Chemical composition of different South African prickly pears cladode varieties on a dry matter basis

	DM %	*OM % DM*	*CP % DM*	*P % DM*	*ADF % DM*	*NDF % DM*	*Hemi-cellulose % DM*	*EE % DM*
Berg x mexican	91.81^{h}	84.43^{c}	9.37^{b}	0.28^{ab}	9.31^{g}	17.26^{h}	7.95^{g}	1.74^{b}
Cross x	92.89^{b}	86.45^{b}	6.23^{f}	0.19^{e}	14.73^{a}	24.04^{b}	9.32^{f}	2.35^{a}
Ficus – indice	92.68^{c}	77.75^{g}	8.12^{cd}	0.25^{c}	9.26^{g}	16.73^{i}	7.48^{h}	2.51^{a}
Malta	92.47^{e}	82.67e	10.63^{a}	0.29^{a}	9.70^{f}	19.36^{f}	9.66^{e}	1.19^{b}
Morado	92.06^{g}	83.16^{d}	8.35^{cd}	0.23^{d}	10.42^{e}	20.78^{d}	10.36^{d}	2.47^{a}
Nepgen	92.57^{d}	84.69^{c}	7.76^{de}	0.19^{e}	13.34^{b}	26.43^{a}	13.09^{a}	2.62^{a}
Nudosa	93.66^{a}	84.39^{c}	9.13^{b}	0.28^{ab}	11.29^{d}	18.57^{g}	7.28^{h}	1.33^{b}
Roedtan	92.66^{c}	80.33^{f}	8.06^{cd}	0.27^{bc}	9.19^{g}	19.89^{e}	10.69^{c}	2.58^{a}
Turpin	92.56^{d}	82.68^{e}	7.38^{e}	0.19^{e}	7.58^{h}	13.67^{j}	6.09^{i}	2.58^{a}
Van as	92.33^{f}	88.96^{a}	8.41^{c}	0.21^{de}	11.58^{c}	22.57^{c}	10.99^{b}	1.69^{a}
s.e	0.012	0.118	0.197	0.006	0.064	0.054	0.091	0.177

$^{a, b,c,d,e,f,}$ Column means with common superscripts do not differ ($P > 0.05$)

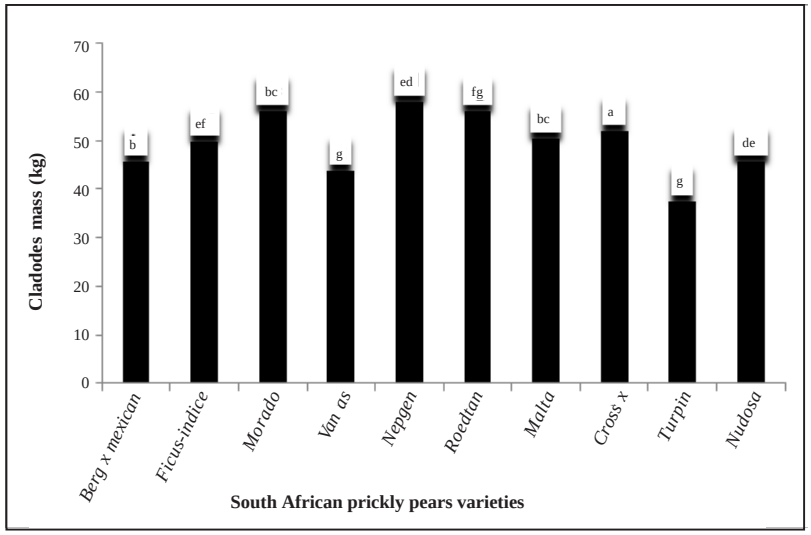

Fig. 1. Mean cladodes mass (kg) of ten South African prickly pears varieties grown in Mara ADC

sis. Ether extract average of different *Opuntia* varieties was 2.11 percent on a DM basis. The values vary significantly (P<0.05) from 1.19 percent (*Malta*) to 2.62 percent (*Nepgen*). Different *Opuntia* cladodes varieties have phosphorus average of 0.24 percent of DM.

There were significant prickly pear varieties effects on cladodes mass (Fig. 1). *Cross x* had the highest cladodes mass of approximately 1.75 kg followed by *Berg x mexican* with approximately 1.52 kg and *Roedtan*, *Turpin* and *Van as* had the similar cladodes mass of about 1.12, 1.11 and 1.08 kg, respectively. After pruning, the remaining mean number of cladodes per variety was recorded. *Nepgen* (58.0), *Roedtan* (56.0) and *Morado* (56.1) had the highest mean cladodes left as compared to other varieties (Fig. 2).

DISCUSSION

Different types of prickly pear had variation in their dry matter content and higher than 63g

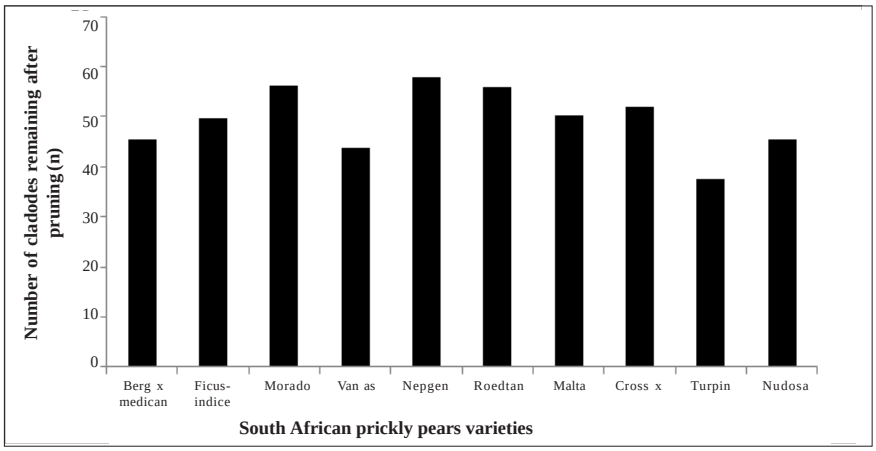

Fig. 2. Mean cladodes remaining on ten South African prickly pear varieties after pruning at Mara ADC.

reported by Pinos-Rodriquez et al (2010). However, similar to ninety percent for cactus cladodes reported by Negussie et al (2015). Thus, three varieties can be preserved as hay or silage (Pinos-Rodriquez et al. 2010). Furthermore, high moisture content of prickly pear is a desirable trait for ruminants in arid or semi-arid regions where water availability is limited. Kuenemann (2001) reported many factors influencing dry matter content such as species, genotype, variety, soil, climate and season. The results fall within the range that were reported by Ben Salem et al. (1996), Ben Salem et al. (2002), McMillan et al. (2002), Nefzaoui and Ben Salem (2002) and Zeeman (2005).

The crude protein content of prickly pear cladodes varies and ranged from 6.23 to 10.63 percent of dry matter, which varied from the range of 3.32 to 8.84 percent reported by Tegegne (2001) for *O. engelmannii and O. stenopetala*, respectively. Negussie et al (2015) found the crude protein content of 5.99 percent in dry matter, which is lower than the one in the current study. These variations in CP content of different *Opuntia* varieties could also be due to factors like soil, fertilization and climate. Misra et al (2006) recommend that in order to meet maintenance and production requirements of animals, the diet should be balanced with supplementary protein such as urea. Failure to use a nitrogen supplement in Opuntia-based diets consumed by ruminants, may limit the ingestion of a diet and its efficient utilization, resulting in a low intake of energy.

ADF content was recorded for *Cross x*, *Nepgen* and *Van as*, and lowest for *Turpin*. The acid detergent fiber average of 15.89 percent was reported for different types of Opuntia cladodes by Ben Thlija (1987) and fifteen percent by Negussie et al. (2015). These averages were higher than the average of 9.7 percent determined in the current study. The value falls within the range of acid detergent fiber content recorded in this study.

An average content of neutral detergent fiber content reported by Ben Thlija (1987) for Opuntia cladodes was 34.11 percent on a dry matter basis, which is higher than the neutral detergent fiber content of 19.9 percent found in this study. The average NDF content found in this study is relatively lower than 24.39 percent of *Algerian* reported by Scholtz (2001) on a DM basis. The neutral detergent fiber of herbage is negatively correlated with digestibility and intake (Ruddell et al. 2002). Hemicellulose range of 12.74 to 20.87 percent was reported by Ben Thlija (1987) and higher than the range of 6.09 to 13.09 percent found in the current study.

Fuentes et al. (1991) reported an ether extract of 1.62 to 2.09 percent on a dry matter basis for *Opuntia* cladodes. The current study found an ether extract range of 1.19 to 2.62 percent on a dry matter basis. Wilson and Brigstocke (1981) reported that fat levels in the diet should not exceed 8 percent of DM or fiber digestion is impaired. It is clear that the fat level of *Opuntia* is too low to impair rumen fermentation.

Phosphorus content was in the same range of 0.1-0.5 percent reported for *Opuntia* cladodes (Tegegne 2001). It was however lower than the 0.2 percent, 0.33 percent and 0.55 percent reported for *O. ficus-indica, O. engelmannii* and *O. lingheimeri*, respectively (Nefzaoui and Ben Salem 1998). Factors such as type of variety, fertilization, plant maturity, climate, irrigation, temperature and planting site could explain variation in phosphorus content.

Mashope (2007) reported that the production of fodder requires pruning of vegetative materials. Thus, the plant ability to recover after pruning is important (Wilson and Brigstocke 1981). Varieties of *Roedtan*, *Turpin* and *Malta* showed the highest cladodes mass in the study as compared to the same varieties by Mashope (2007). These differences can be due to environmental aspects.

CONCLUSION

It was concluded that chemical composition varied among different types of prickly pear cladodes varieties. It is suggested that these three varieties can be utilized as fodder during drought seasons. *Nepgen*, *Roedtan* and *Morado* were high in mean number of cladodes remained after pruning and therefore can be used as a good source of fodder for livestock. *Nepgen* and *Cross x* produced high mass as compared to other varieties.

RECOMMENDATIONS

Feeding trials to measure palatability and intake are required. The relationship between cladode maturity and nutritive value is also required as further studies.

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