

## Influence of species/cultivar and season on the quality of *Atriplex* grown at different sites in South Africa

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### Abstract

*Atriplex* species/cultivars [*Atriplex nummularia*, *A. canescens* (Santa Rita) and *A. canescens* (Field Reserve 1)] were compared in terms of chemical composition and *in vitro* digestibility. The plant material was sampled at different seasons (autumn and winter) and from different sites (Hatfield in the Gauteng Province and Mier and Lovedale, both in the Northern Cape Province) and were analysed for crude protein (CP), neutral detergent fibre (NDF) and *in vitro* digestibility (IVOMD). The CP and IVOMD of the leaves were higher than the stem for the *Atriplex* species. Leaf percentage for the autumn samples was not affected by species at Hatfield and Mier, but *A. canescens* (Field Reserve 1) had lower leaf percentage at Lovedale as well as for winter samples at Hatfield. At Lovedale, however, *A. nummularia* had the highest leaf : stem ratio compared to *A. canescens* (Santa Rita) and *A. canescens* (Field Reserve 1). *Atriplex nummularia* had a higher CP concentration than *A. canescens* (Field Reserve 1) and *A. canescens* (Santa Rita) at both Mier and Lovedale, but species/cultivar had no effect on CP concentration at Hatfield. Autumn samples had a higher CP concentration than winter samples at both Mier and Lovedale, but season had no effect on the N concentration at Hatfield. *Atriplex nummularia* had a lower NDF and higher IVOMD concentration compared to *A. canescens* (Santa Rita) and *A. canescens* (Field Reserve 1). Autumn samples were less fibrous and more digestible than winter samples. *Atriplex nummularia* seems to be better in terms of its nutritive value compared to *A. canescens* (Santa Rita) and *A. canescens* (Field Reserve 1), with better quality forage in autumn than winter.

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**Keywords:** Chemical composition, drought tolerant, fodder, salt bush, shrubs

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### Introduction

In semi-arid and arid rangelands of South Africa forage availability and quality is often limiting due to extremely low rainfall and drought conditions. In these areas *Atriplex* species has been identified as adaptable species that produce good fodder to increase animal production. The adaptability is mainly due to their ability to tolerate drought and salinity (Le Houérou, 1992, Malan, 2000). However, the nutritive value is related to the palatability of the fodder for a given animal type, which in turn is affected by phenological stage at harvest, plant parts and season of use (Squires & Ayoub, 1992). At an earlier stage of evaluation, the nutritive value of the feed could be ranked based on chemical composition and *in vivo* digestibility of the forage. This study was undertaken to compare *Atriplex* species/cultivars on the basis of their chemical composition and *in vitro* digestibility when harvested at different seasons from different sites.

### Material and Methods

*Atriplex* species/cultivars (*Atriplex nummularia*, *A. canescens* Santa Rita and *A. canescens* Field Reserve 1) were established at three sites (Hatfield in the Gauteng Province and Mier and Lovedale, both in the Northern Cape Province) and the plant materials were harvested both during the autumn and winter season. It was separated into leaf and stem material and then dried in a forced draught oven at 60 °C for 24 hours. The percentage of leaf material was determined. Representative samples of the edible forage harvest were analysed for crude protein (CP) according to AOAC (2000), NDF according to Robertson & Van Soest (1970) and *in vitro* organic matter digestibility (IVOMD) according to Tilley & Terry (1963) as modified by Engels & Van der Merwe (1967).

Analysis of variance with the Proc GLM model (SAS, 2001) was used to determine the significance between different species/cultivars, sites, seasons and plant parts. Least square means and standard errors

were calculated for main effects where there was no significant interaction effect. A difference between means was declared by Bonferroni's test (Samuels, 1989).

## Results and Discussion

Generally, regardless of the location, the CP and IVOMD of the leaves were significantly higher than that of the stem for all *Atriplex* species (Table 1). This is in agreement with Wilcock *et al.* (2004) who found higher CP and IVOMD in the leaves than in the stems for three browse species.

**Table 1** Crude protein and *in vitro* organic matter digestibility (IVOMD) of leaf and stem fractions of *Atriplex* species/cultivars grown at different locations

| Parameter          | Location | Plant fraction | <i>Atriplex</i> species/cultivars   |  |                                     |
|--------------------|----------|----------------|-------------------------------------|--|-------------------------------------|
|                    |          |                | <i>A. canescens</i><br>(Santa Rita) | <i>A. canescens</i><br>(Field Reserve 1) | <i>A. nummularia</i>                |
| CP<br>(g/kg DM)    | Hatfield | Leaves         | 148 <sup>a</sup> ± 19               | 133 <sup>a</sup> ± 25                    | 156 <sup>a</sup> ± 8                |
|                    |          | Stem           | 72 <sup>b</sup> <sub>1,2</sub> ± 8  | 55 <sup>b</sup> <sub>1</sub> ± 9         | 91 <sup>b</sup> <sub>2</sub> ± 13   |
|                    | Mier     | Leaves         | 187 <sup>a</sup> <sub>1</sub> ± 26  | 206 <sup>a</sup> <sub>1</sub> ± 37       | 256 <sup>a</sup> <sub>2</sub> ± 26  |
|                    |          | Stem           | 99 <sup>b</sup> <sub>1</sub> ± 12   | 91 <sup>b</sup> <sub>1</sub> ± 17        | 133 <sup>b</sup> <sub>2</sub> ± 30  |
|                    | Lovedale | Leaves         | 178 <sup>a</sup> <sub>1</sub> ± 26  | 167 <sup>a</sup> <sub>1</sub> ± 28       | 239 <sup>a</sup> <sub>2</sub> ± 27  |
|                    |          | Stem           | 75 <sup>b</sup> <sub>1</sub> ± 11   | 72 <sup>b</sup> <sub>1</sub> ± 19        | 128 <sup>b</sup> <sub>2</sub> ± 17  |
| IVOMD<br>(g/kg DM) | Hatfield | Leaves         | 685 <sup>a</sup> ± 28               | 681 <sup>a</sup> ± 51                    | 648 <sup>a</sup> ± 47               |
|                    |          | Stem           | 249 <sup>b</sup> <sub>2</sub> ± 28  | 245 <sup>b</sup> <sub>2</sub> ± 49       | 327 <sup>b</sup> <sub>1</sub> ± 30  |
|                    | Mier     | Leaves         | 663 <sup>a</sup> ± 113              | 749 <sup>a</sup> ± 57                    | 774 <sup>a</sup> ± 47               |
|                    |          | Stem           | 329 <sup>b</sup> ± 38               | 258 <sup>b</sup> ± 62                    | 424 <sup>b</sup> ± 104              |
|                    | Lovedale | Leaves         | 672 <sup>a</sup> <sub>1</sub> ± 77  | 685 <sup>a</sup> <sub>1,2</sub> ± 75     | 775 <sup>a</sup> <sub>2</sub> ± 120 |
|                    |          | Stem           | 277 <sup>b</sup> <sub>1</sub> ± 64  | 256 <sup>b</sup> <sub>1</sub> ± 96       | 406 <sup>b</sup> <sub>2</sub> ± 47  |

<sup>a,b</sup> means within a column followed by different superscripts differ at P < 0.05.

<sub>1,2</sub> means within a row followed by different subscripts differ at P < 0.05.

The interaction effect between species/cultivars, season and sites were significant for the leaf percentages. Percentage of leaf for the autumn sample was not affected by species/cultivar in Hatfield and Mier, but in Lovedale *A. canescens* (Field Reserve 1) had a lower leaf percentage compared to the other two *Atriplex* species/cultivars (Table 2). For winter samples, *A. canescens* (Field Reserve 1) had the lowest leaf percentage compared to the rest of the samples collected from Hatfield and Mier. At Lovedale, however, *A. nummularia* had the highest leaf percentage compared to the other two *A. canescens* species.

The interaction effect between species/cultivars and site as well as between season and site were significant for CP concentration of the edible forage material (Tables 3 and 4). *A. nummularia* had a higher CP concentration than *A. canescens* in samples collected from both Mier and Lovedale, but the difference between the species was not significant in Hatfield. The CP values recorded in Hatfield for both *A. canescens* spp. and *A. nummularia* were lower than the CP values reported for the respective species by Benjamin *et al.* (1995) whereas in Mier and Lovedale the CP values were higher than that reported by Benjamin *et al.* (1995). Autumn samples had a higher CP concentration than winter samples for samples collected from Mier and Lovedale, but season had no effect on the N concentration of samples collected from Hatfield.

There was no interaction effect between species/cultivars, season and site in terms of the NDF and IVOMD of the samples. However, the main effects of species/cultivars, season and sites were significant for NDF and IVOMD concentrations of the edible components. Generally *A. nummularia* had lower NDF and

**Table 2** Interaction effects between species/cultivars, season and location on the percentage of leaf material of certain *Atriplex* shrubs

| Location | Season | <i>Atriplex</i> species/cultivars     |  |                          |
|----------|--------|---------------------------------------|--|--------------------------|
|          |        | <i>A. canescens</i><br>(Santa Rita)   | <i>A. canescens</i><br>(Field Reserve 1) | <i>A. nummularia</i>     |
| Hatfield | Autumn | 55.5 ± 4.81                           | 44.5 <sup>a</sup> ± 4.81                 | 53.6 ± 4.81              |
|          | Winter | 51.5 <sub>1</sub> ± 4.81              | 27.4 <sup>b</sup> <sub>2</sub> ± 4.81    | 54.7 <sub>1</sub> ± 4.81 |
| Mier     | Autumn | 73.2 ± 4.81                           | 68.5 <sup>a</sup> ± 4.81                 | 72.7 ± 4.81              |
|          | Winter | 78.9 <sub>1</sub> ± 4.81              | 44.6 <sup>b</sup> <sub>3</sub> ± 4.81    | 64.2 <sub>2</sub> ± 4.81 |
| Lovedale | Autumn | 69.1 <sup>a</sup> <sub>1</sub> ± 4.81 | 51.3 <sup>a</sup> <sub>2</sub> ± 4.81    | 65.8 <sub>1</sub> ± 4.81 |
|          | Winter | 50.1 <sup>b</sup> <sub>2</sub> ± 4.81 | 36.8 <sup>b</sup> <sub>2</sub> ± 4.81    | 74.6 <sub>1</sub> ± 4.81 |

<sup>a,b</sup> means within a column followed by different superscripts differ at P < 0.05.

<sub>1,2</sub> means within a row followed by different subscripts differ at P < 0.05.

**Table 3** Interaction effects of species and location on the crude protein (g/kg DM) concentration of three *Atriplex* species

| Species/cultivars                     | Location               |                                     |                                     |
|---------------------------------------|------------------------|-------------------------------------|-------------------------------------|
|                                       | Hatfield               | Mier                                | Lovedale                            |
| <i>A. canescens</i> (Santa Rita)      | 148 <sub>2</sub> ± 8.3 | 187 <sup>b</sup> <sub>1</sub> ± 8.3 | 178 <sup>b</sup> <sub>1</sub> ± 8.3 |
| <i>A. canescens</i> (Field Reserve 1) | 133 <sub>2</sub> ± 8.3 | 206 <sup>b</sup> <sub>1</sub> ± 8.3 | 167 <sup>b</sup> <sub>2</sub> ± 8.3 |
| <i>A. nummularia</i>                  | 156 <sub>2</sub> ± 8.3 | 256 <sup>a</sup> <sub>1</sub> ± 8.3 | 239 <sup>a</sup> <sub>1</sub> ± 8.3 |

<sup>a,b</sup> means within a column followed by different superscripts differ at P < 0.05.

<sub>1,2</sub> means within a row followed by different subscripts differ at P < 0.05.

**Table 4** Interaction effects of season and location on the crude protein (g/kg DM) concentration of *Atriplex* species

| Season | Location               |                                     |                                     |
|--------|------------------------|-------------------------------------|-------------------------------------|
|        | Hatfield               | Mier                                | Lovedale                            |
| Autumn | 141 <sub>3</sub> ± 6.8 | 235 <sup>a</sup> <sub>1</sub> ± 6.8 | 209 <sup>a</sup> <sub>2</sub> ± 6.8 |
| Winter | 150 <sub>2</sub> ± 6.8 | 198 <sup>b</sup> <sub>1</sub> ± 6.8 | 179 <sup>b</sup> <sub>1</sub> ± 6.8 |

<sup>a,b</sup> means within a column followed by different superscripts differ at P < 0.05.

<sub>1,2,3</sub> means within a row followed by different subscripts differ at P < 0.05.

higher IVOMD concentrations compared to *A. canescens* (Santa Rita), but the differences between IVOMD of *A. nummularia* and *A. canescens* (Field Reserve 1) were not significant (Table 5). Benjamin *et al.* (1995) also reported a higher IVOMD for *A. nummularia* compared to *A. canescens*. In contrast to our study, Watson (1990) found higher NDF concentrations in *A. nummularia* compared to *A. canescens*. Autumn samples were less fibrous and more digestible than winter materials. Among the sites, samples collected from Hatfield were more fibrous and less digestible compared to those collected from Mier and Lovedale. The exception was for the IVOMD concentration that was not significantly different between Hatfield and Lovedale samples.

**Table 5** Average influence of species/cultivars, season and site on the NDF (g/kg DM) concentration and *in vitro* digestibility (g/kg DM) of *Atriplex* shrubs

| Variable                              | NDF concentration<br>(g/kg DM) | <i>In vitro</i> digestibility<br>(g/kg DM) |
|---------------------------------------|--------------------------------|--|
| Species/cultivars                     |                                |  |
| <i>A. canescens</i> (Santa Rita)      | 531.3 <sup>b</sup> ± 11.74     | 673.4 <sup>b</sup> ± 17.29                 |
| <i>A. canescens</i> (Field Reserve 1) | 605.7 <sup>a</sup> ± 11.74     | 704.8 <sup>ab</sup> ± 17.29                |
| <i>A. nummularia</i>                  | 491.7 <sup>c</sup> ± 11.74     | 732.4 <sup>a</sup> ± 17.29                 |
| Season                                |                                |  |
| Autumn                                | 511.2 <sup>b</sup> ± 9.59      | 720.1 <sup>a</sup> ± 14.12                 |
| Winter                                | 574.5 <sup>a</sup> ± 9.59      | 687.0 <sup>b</sup> ± 14.12                 |
| Site                                  |                                |  |
| Hatfield                              | 618.8 <sup>a</sup> ± 11.74     | 671.2 <sup>b</sup> ± 17.29                 |
| Mier                                  | 480.6 <sup>c</sup> ± 11.74     | 728.7 <sup>a</sup> ± 17.29                 |
| Lovedale                              | 529.3 <sup>b</sup> ± 11.74     | 710.7 <sup>ab</sup> ± 17.29                |

<sup>a,b</sup> means within a column followed by different superscripts differ at P < 0.05.

## Conclusion

*A. nummularia* had a higher crude protein concentration than the two *A. canescens* species in the Northern Cape where the autumn samples were also higher in CP than the winter samples. *Atriplex nummularia* had lower NDF and higher IVOMD concentrations than the two *A. canescens* species, resulting in a higher nutritive value. As expected, the leaves had higher CP and IVOMD values than the stems.

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