Palatability studies on plants in the south-western Orange Free State sandveld

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Studies in paddocks grazed by cattle or sheep in the sandveld of the Orange Free State indicate that grasses and karroid shrubs can be classed into three groups according to their relative palatability. A palatability index (PI) was used to rank plant species according to their acceptability to grazing animals. Genera with a high PI were *Anthephora, Digitaria, Panicum, Fingerhuthia, Sporobolus, Nenax* and *Felicia*. The lowest palatability ratings were recorded for *Aristida, Chrysocoma, Walafrida* and *Cymbopogon*. The study supplies comparative data on a wide range of species which can be used in estimations of carrying capacity of grassland of varying botanical composition. The technique is low-cost and of wide application.

Studies in kampies in die sandveld van die Oranje-Vrystaat, bewei deur beeste en skape het getoon dat grasse en karoo-bossies volgens hulle relatiewe smaaklikheid in drie groepe verdeel kan word. 'n Smaaklikheidsindeks was gebruik om plantsoorte in orde van belangrikheid volgens hul aanvaarbaarheid vir weidiere, te plaas. Genusse met 'n hoë smaaklikheidsindeks was *Antephora, Digitaria, Panicum, Fingerhuthia, Sporobolus, Nenax* en *Felicia*. Die laagste smaaklikheidswaardes is toegeken aan *Aristida, Chrysocoma, Walafrida* en *Cymbopogon*. Hierdie studie verskaf ook vergelykbare inligting vir 'n wye reeks plantsoorte wat in die skatting van die weidingspotensiaal van grasveld met 'n variërende spesiesamestelling, gebruik kan word. Die tegniek is goedkoop en het 'n wye toepasbaarheid.

Keywords: Grass, palatability index, sandveld, species acceptability

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Introduction

An important factor in the management of veld is the preference animals have for plant species. Roberts *et al.* (1973) suggest a range of criteria for classifying desirable species, one of which was the palatability (or acceptability) of species to animals. In the field, animal preference may be measured by direct observation of what is being eaten or by an assessment of the progressive utilization of the plants themselves (Daines 1980). Direct measurement of what the animals have consumed can be obtained from fistulated animals or by microscopic examination of partly digested plant matter in rumen contents or faeces. The recognition of the plants in the rumen and faeces requires an adequate key based on epidermal fragments (Liversidge 1970; Scotcher 1977).

This study was an investigation of animal preferences for species, conducted while studying grassland floristics in the south-western Orange Free State sandveld by the wheel point method of survey (Anderson & Roberts 1984). This method has been used by Du Plessis (1969) and Kruger & Edwards (1972).

Materials and Methods

Paddock sites were selected in areas of uniform soil and vegetation. Each site was 150 m × 45 m with the long axis extending out at right angles to the nearest water point. The paddocks chosen had not been recently grazed. Attributes recorded included:

Rainfall — estimated from isohyets.

Soil type — assessed from soil auger holes and field texture estimates.

Paddock size — information obtained from the farmer.

Nearest water — all paddocks contained one water point and the distance from it to the middle of the site was measured.

Animals — the type and number of animals, and the date they commenced grazing was provided by the farmer.

Vegetation — recorded at each site by the wheel point method (Tidmarsh & Havenga 1955) in a grid on lines 150 m long and 5 m apart. Recordings were made at points spaced 1,5 m apart (viz. two points per revolution on a 3 m circumference wheel). At each site, vegetation was recorded at 1000 points and included percentage basal cover from 'strikes' on rooted live plant material as defined by Tidmarsh & Havenga (loc. cit.) and the plant species percentage frequency from 'nearest plant' data.

Amount grazed — at each point three plants were selected in order to estimate the amount they had been grazed. One plant was the 'nearest plant' used for the percentage frequency determinations. The other two plants chosen were the next nearest plants to the 'point', that were a different species to the initial plant chosen, and to each other. Hence for each site 3000 recordings were made of the amount that the species were grazed. The amount that each plant was grazed was subjectively assessed on an 8-point scale with uneven class intervals (Table 1).

To arrive at a rank value for an individual plant the question is first asked 'is the value more or less than half'? If judged to be less, the decision is then made as to whether it is more or less than a quarter, and so on.

Table 1 Eight-point scale showing assessment of the amount that each plant was grazed

Rank	Class interval (= % grazed)
1	0 (no grazing detected)
2	1 – 10
3	11 – 25
4	26 – 50
5	51 – 75
6	76 – 90
7	91 – 99
8	100 (only remnants of plant left)

Grazing assessments were made at four sites. Sites 1 and 2 were in adjacent paddocks on the same farm and grazed by merino sheep. Sites 3a and 3b were in the same paddock but at different distances from water, and were grazed by cattle. The attributes relating to each site with the times of grazing, when assessments were made, and the grazing intensity, are given in Table 2.

The vegetation, recorded as species relative percentage frequency, and the basal cover for the site, is shown in Table 3. The vegetation has been grouped into grasses and non-grasses. The grasses have been further subdivided into strong perennials, other perennials, and annuals. The sites had a similar range of species with *Themeda triandra* being most frequent at each site.

Table 2 The location (farm and paddock) of sites assessed for palatability showing; attributes such as rainfall, soil, paddock size and distance to water; date of assessment; the number and type of grazing animals present and the cumulative grazing in Small Stock Units ha^{-1} at each assessment

Site	1	2	3a	3b
Farm	A	A	B	B
Paddock	a	b	c	c
Rain M.A. (mm)	470	470	460	460
Soil group	D	D	C	C
Paddock size (ha)	96	83	98	98
Nearest water (m)	250	120	350	800
Animals				
Type M (Merino) D (Dorper)	Sheep (M)	Sheep (M)	Cattle	Cattle
Number	1300	1200	101	101
Grazing — start	15.6.75	27.8.75	27.6.75	27.6.75
Assessment date				
1	18.6.75	4.9.75	1.7.75	1.7.75
2	22.6.75	8.10.75	25.8.75	25.8.75
3	30.6.75	–	19.10.75	19.10.75
Grazing intensity (S.S.U. days ha^{-1})*				
1	40,6	115,6	19,3**	19,3
2	94,8	607,2	285,1	285,1
3	203,1	–	550,9	550,9

* S.S.U. = Small Stock Units

** Yearling (9 – 12-month-old) cattle grazed site 3 — these animals were rated as equivalent to 0,67 of an adult beast, 7 S.S.U. was used as equivalent to one adult beast, making these yearling cattle equivalent to 4,69 S.S.U.

Results

The results for the amount of each plant grazed have been summarized into four grazing classes — nil, 1 – 50%, 51 – 99% and 100% (of original 8-point scale). A summary of plants recorded in each grazing class for each survey on all sites is shown in Table 4 where it is seen that at the first assessment, sites 3a and 3b had the lowest percentage of grazed plants. At the final assessment about half the plants in sites 1 and 3a had been grazed.

To account for the degree that each species was utilized, the method employed by Kruger & Edwards (1972) was followed. This enabled a relative percentage utilization (R) to be calculated for each species:

$$R = \frac{(3 \times A) + (2 \times B) + (1 + C) + (0 \times D) \times 33,3}{T}$$

where: A = no. plants in class 100% grazed; B = no. plants in class 51 – 99% grazed; C = no. plants in class 1 – 50%

Table 3 The relative percentage frequency of the vegetation on the palatability assessment sites, and the basal cover (%) at each site

	Relative percentage frequency			
	Site			
Vegetation	1	2	3a	3b
Grasses*				
A				
Themeda triandra	46,13	25,30	26,47	39,73
Digitaria eriantha	15,37	2,25	1,80	0,03
Digitaria argyrograpta	6,17	0,75	13,93	12,63
Panicum stapfianum	1,13	3,85	0,03	–
Cymbopogon plurinodis	0,97	1,15	1,77	0,83
Heteropogon contortus	0,03	0,25	p	0,57
Fingerhuthia africana	–	3,55	–	–
Anthephora pubescens	–	–	p	2,57
Aristida diffusa	–	–	–	0,13
B				
Eragrostis chloromelas	4,17	0,60	0,03	0,27
Eragrostis lehmanniana	2,00	20,60	15,87	18,60
Sporobolus fimbriatus	0,73	0,40	0,03	0,73
Eragrostis superba	0,57	1,20	0,10	0,10
Eragrostis sp.	–	–	0,10	–
C				
Eragrostis obtusa	11,47	0,25	4,60	0,23
Tragus koelerioides	2,90	17,50	9,67	3,60
Aristrida congesta	1,80	8,95	7,07	2,27
Non grasses				
Pentzia globosa	2,23	2,65	2,57	0,80
Walafrida saxitalis	1,40	1,95	0,57	1,53
Felicia muricata	1,33	0,55	13,73	14,33
Nenax microphylla	0,57	3,20	0,07	p
Nestlera conferta	0,30	0,55	0,57	–
Berkheya onopordifolia	0,30	0,05	0,07	p
Helichrysum dregeanum	0,17	0,45	0,07	0,30
Chrysocoma tenuifolia	0,10	1,75	0,36	0,50
Lycium spp.	0,10	–	p	–
Pollichia campestris	0,03	–	0,03	–
Stachys rugosa	0,03	p	–	–
Lightfootia rigida	p	–	–	0,03
Pentzia calcaria	–	2,40	–	–
Pterothrix spinescens	–	0,05	–	–
Osteospermum spinescens	–	p	0,03	0,07
Eriocephalus ericoides	–	–	0,30	0,03
Ruschia hamata	–	–	0,13	0,10
Asparagus sauveolens	–	–	0,03	–
Gazania krebsiana	–	–	p	–
Othonna pallens	–	–	p	p
Helichrysum zeyheri	–	–	–	p
Arthrosolen polycephala	–	–	–	–
Nolletia ciliaris	–	–	–	–
Nestlera prostrata	–	–	–	–
Osteospermum leptolobum	–	–	–	–
Aptosimum marlothii	–	–	–	–
'Others' (7 species)	–	–	–	–
Basal cover (%)	7,5	5,4	4,2	3,7

* A, strong perennials: B, other perennials; C, annuals

p = present but not recorded

grazed; D = no. plants in class nil (ungrazed); T = total no. of plants.

A, B, C and D are multiplied by 3, 2, 1, and 0 respectively as it is assumed that plants in class A were utilized 100%, B 66,6%, C 33,3% and D 0%. The maximum value for R is 3, and by multiplying it by 33,3 the utilization percentage is obtained.

The mean relative percentage utilization for the sites is given in Table 5. Site 2 was more heavily utilized than the other sites, with its initial assessment higher than the final assessment of the other sites.

Species which were well-utilized included *Anthephora pubescens, Digitaria argyrograpta, Digitaria eriantha, Eragrostis obtusa, Felicia muricata, Fingerhuthia africana, Nenax microphylla, Nolletia ciliaris* and *Panicum stapfianum*. Species which were relatively poorly utilized included *Aristida congesta, Chrysocoma tenuifolia, Cymbopogon plurinodis, Eragrostis chloromelas, Pentzia calcaria, Pentzia globosa* and *Walafrida saxatilis. Tragus koelerioides* and *Eragrostis lehmanniana* generally had low utilization except at site 2 where they were more heavily utilized.

The above utilization figures for the species and sites are 'relative', rather than actual, due to the sampling procedure employed. During sampling, the three nearest species were selected for recording. This was done in order to increase the number of recordings of plants with a low frequency in the pasture. The relative species utilization figures were adjusted according to the actual species frequencies (Table 3) at each site to reflect composition at each site. The overall trend was that most utilization occurred on the most abundant species. For example, the first assessment at site 1 gave relative percentage frequencies of *Themeda triandra, Digitaria eriantha* and *Eragrostis obtusa*, of 46,13%, 15,37%, and 11,47%, while the corresponding site utilization for these three species was 15,04%, 4,47% and 2,89% respectively.

Although the utilization of a species at a site appeared related to its availability, a number of anomalies occurred where more or less of a species was utilized relative to its availability (frequency). To quantify this lack of selection, a palatability index (PI) was derived for each species.

$$PI = \frac{\text{species site selection}\quad (1)}{\text{species site availability}\quad (2)}$$

$$(1)\ \text{Species site selection} = \frac{\text{species site utilization}}{\text{total site utilization}}\ \% \times 100$$

(2) Species site availability = relative frequency %

The preference that an animal shows for a species is dependent not only on the species present but also on the amount of selection it is able to make of the forage on offer. The longer animals have been in a paddock the more of the available forage is utilized and hence less is available for selection. If taken to the extreme, animals are forced to eat all available forage, and the palatability index for each species becomes 1,0.

Hence the palatability index of forage species approaches unity as the paddock utilization approaches 100%. Consequently only highly unpalatable species would have a low palatability index when the paddock utilization was high while, when the paddock utilization is low, species with a high palatability index indicate that they have a high palatability.

The species in Table 6 have been ranked according to their acceptance by the animals as shown by their palatability index. The various assessments at each site have also been ranked according to their site utilization.

Species judged to have a high palatability (the 'preferred species') were those with a palatability index of greater than 1,0 under relatively low site utilization, viz., up to approximately 20%. These were *Anthephora pubescens, Digitaria argyrograpta, Digitaria eriantha, Eragrostis obtusa, Fingerhuthia africana, Felicia muricata, Nenax mircophylla, Panicum stapfianum, Sporobolus fimbriatus* and *Themeda triandra*.

The inclusion of *Fingerhuthia africana* in this group is speculative and is based on its high palatability index at two assessments (site 2) under a high site utilization percentage. The inclusion of *Nenax microphylla* and *Panicum stapfianum* is based on their high palatability indices under low site utilization and low plant numbers.

Species which were not highly palatable, but were eaten, e.g. had a palatability index greater than 0,8 when the site utilization was high (Table 6), include: *Cymbopogon plurinodis, Eragrostis lehmanniana, Eragrostis superba, Eriocephalus ericoides, Lightfootia rigida, Nestlera conferta, Osteospermum spinescens, Ruschia hamata* and *Tragus koelerioides*. The location of *Eriocephalus, Lightfootia, Osteospermum* and *Ruschia* in this group is based only on low plant numbers.

Species with a low palatability and were not readily eaten, even when the site utilization was high, included: *Aristida*

Table 4 The mean percentage of plants recorded in each 'grazing class' on all sites

Site	Survey	Grazing class (%) Nil*	1 – 50	51 – 99	100	Total grazed (%)
1	1	57,9	27,9	11,2	3,0	42,1
	2	57,4	27,8	10,4	4,4	42,6
	3	49,7	34,8	12,6	2,9	50,3
2	1	45,7	15,9	23,0	15,4	54,3
	2	25,5	14,1	26,0	34,4	74,5
3a	1	88,0	9,3	2,5	0,2	12,0
	2	59,0	30,5	9,2	1,3	41,0
	3	53,2	33,5	11,5	1,8	46,8
3b	1	85,5	11,7	2,6	0,2	14,5
	2	71,9	22,5	5,2	0,4	28,1
	3	55,2	37,5	6,5	0,8	44,8

* Nil = not grazed

Table 5 The mean relative percentage utilization of sites

Site	Survey	Utilization %
1	1	19,8
	2	20,6
	3	22,9
2	1	36,0
	2	56,4
3a	1	5,0
	2	17,6
	3	20,6
3b	1	5,8
	2	11,4
	3	17,6

Table 6 Palatability indices of plant species. Brackets indicate species with less than 20 plants per sample

Site	3a	3b	3b	3a	3b	3a	1	1	1	2	2
Survey	1	1	2	2	3	3	1	2	3	1	2
Site Utilization (%)	6,2	6,8	12,0	17,9	19,1	21,6	24,4	25,3	27,1	39,7	61,3
Fiafr*										2,0	1,4
Spfim		(1,6)	(3,9)	(3,3)	(1,9)	(3,1)	1,0	1,6	1,0	(1,3)	(1,2)
Anpub		1,7	1,3	(0)	1,6						
Thtri	2,4	1,5	1,2	1,3	1,2	1,3	1,3	1,4	1,4	1,2	1,0
Dieri	1,8			1,2	(0,5)	0,8	1,2	1,3	1,3	0,6	0,8
Nemic			(0)		(1,6)	(1,3)	0,9	1,1	1,2	1,7	1,2
Erobt	1,7	(0)	(0)	2,0	(1,8)	(2,0)	1,0	1,0	0,5	(2,3)	
Pasta				(1,7)			0,8	0,5	0,4	1,3	1,1
Diarg	1,6	2,0	1,0	1,4	1,1	1,3	0,5	0,5	0,8	0,8	0,8
Femur	0	0,2	1,6	1,4	1,3	1,2	0,5	0,8	1,2	2,0	1,5
Erleh	0,2	0,4	0,6	0,9	0,6	0,8	0,2	0,3	0,2	1,2	1,2
Osspi	(0)	(0)	(2,4)		(2,2)	(0)				(1,1)	
Lirig		(0)	(0)	(3,3)	(1,7)	(0)	(0)				
Ersup	(0)	(0)	(0)	(0)	(0,5)	(0)	(0,7)	(0,4)	0,9	0,8	0,9
Ereri	(0)	(0)	(0)	(0,3)	(0)	(0,8)					
Ruham		(0)	(0)	(0)	(0,5)	(0,7)					
Trkoe	0	0	0	0	0,4	0,4	0,2	0,4	0,6	1,1	1,6
Cyplu	0,2	0	0	0,3	0	0,3	0,2	0,2	0,4	(1,1)	1,2
Necon	0			0,2		(0,5)	0	< 0,1	0,1	1,1	0,8
Erchl	(0)	(0)	(0)		(0,4)	(0)	0,1	0,2	< 0,1	0,2	0,2
Peglo	0	0	0	0,1	0,1	0,3	< 0,1	0,1	0,1	0,5	0,5
Hecon		(0)	(0)	(1,7)	0		(1,3)	(0,3)	(0)	(0)	(0,3)
Chten	0	0	0	0,3	0	0,3	(0)	(0)	(0)	0,1	0,1
Arcon	0	0	0	< 0,1	0,1	0,1	< 0,1	< 0,1	0,1	0,1	0,2
Lyspp	(0)						(0)	(0)	(0,4)		
Beono	(0)	(0)		(0)	(0)	(0)	0	(0)	0	(0,6)	(1,0)
Hedre	(0)	0	0		0	(0)	(0)	(0)	(0)	(0,2)	0
Pecal										0,1	0,1
Wasax	0	0	0	0	0	0	0	0	0	< 0,1	0

* Acronyms from first letters of genus and species listed in Table 2

congesta, Berkheya onopordifolia, Chrysocoma tenuifolia, Eragrostis chloromelus, Helichrysum dregeanum, Heteropogon contortus, Lycium spp., *Pentzia calcaria, Pentzia globosa* and *Walafrida saxatilis*.

The following species were all recorded as not being eaten. They were omitted from Table 6 because of low (< 20) plant numbers present: viz. *Aristida diffusa, Asparagus suaveolens, Eragrostis tricophora, Gazania krebsiana, Helichrysum zeyheri, Othonna pallens, Pollichia campestris* and *Stachys rugosa*.

Discussion

The first site made available for the study was site 1. The paddock at site 1 contained a mixture of veld types, due to soil differences, but about 30% of the area contained a relatively dense uniform stand of the strong perennial Themeda veld which was located at some distance from the water point (200 – 600 m). The site was chosen in a uniform area as close to water as possible. A few sheep had been grazing the area prior to the introduction of the large flock (Table 2) so a grazing assessment was made as soon as it was known that the large group of animals was introduced into the paddock. The second and third assessments were made 4 days and 8 days later, after which the sheep were moved into another paddock. While in the paddock, the sheep spent most time grazing nearer to water than to the sampling site. This is reflected by the small change (24,4% to 27,1%) in the site utilization.

Site 2 was located in an adjoining paddock to site 1 and similarly grazed by sheep. The soil was relatively uniform throughout the paddock and similar to the soil at site 1. The veld contained the same range of species as site 1 but with the frequency of strong perennial grasses increasing as the distance from water increased, e.g. the percentage frequency of *Themeda triandra* ranged from approximately 10% to 60%. Site 2 was chosen as close to the water point as possible (120 m) in veld where *Themeda triandra* was still the major species. Again the sheep concentrated the bulp of their grazing close to water and this is reflected in the higher site utilization (Table 5). The sheep were moved out of the paddock after the second assessment.

In the paddock grazed by cattle, two sites were located, 3a at 350 m from water and 3b 800 m from water. The differences between the two sites reflected the slight variation that existed in the paddock with site 3a having a lower frequency of strong perennial grasses and a higher frequency of annual grasses than site 3b (Table 3). From limited observations it was noticeable that the cattle were foraging over the whole paddock. This is shown by the similar manner in which sites 3a and 3b were utilized (Table 5). Also included in this paddock (beyond site 3b) was a small stoney rise. It contained some of the species in 3b that were being similarly grazed, e.g. *Themeda triandra, Digitaria argyrograpta,* and *Digitaria eriantha,* while negligible grazing was occurring on *Heteropogon contortus*. It also contained *Eustachys mutica* which did not occur at site 3b but was well grazed throughout

Table 7 The ranking of various grass and non-grass species preference to grazing animals in the south-west Orange Free State sandveld

Preference category	Grasses	Non grasses
Preferred	*Anthephora pubescens* *Digitaria argyrograpta* *Digitaria eriantha* *Eragrostis obtusa* *Fingerhuthia africana* *Panicum stapfianum* *Sporobolus fimbriatus* *Themeda triandra*	*Felicia muricata* *Nenax microphylla*
Intermediate	*Cymbopogon plurinodis* *Eragrostis lehmanniana* *Eragrostis superba* *Tragus koelerioides*	*Eriocephalus ericoides* *Lightfootia rigida* *Nestlera conferta* *Osteospermum spinescens* *Ruschia hamata*
Non forage	*Aristida congesta* *Aristida diffusa* *Eragrostis chloromelas* *Eragrostis tricophora* *Heteropogon contortus*	*Asparagus suaveolens* *Berkheya onopordifolia* *Chrysocoma tenuifolia* *Gazania krebsiana* *Helichrysum dregeanum* *Helichrysum zeyheri* *Lysium* spp. *Othonna pallens* *Pentzia globosa* *Pollichia campestris* *Stachys rugosa* *Walafrida saxatilis*

the grazing period. Apart from highlighting the palatable nature of *Eustachys* this study also indicates the wide-ranging foraging characteristics of the cattle in this paddock.

The subjective assessment of the amount that each species had been grazed required some operator training in the relationship between height of defoliation and percentage removal by mass (Opperman 1973). Also Walker (1976) noted that subjective assessments of vegetation invariably require individual plants to be placed into one of a number of possible classes with respect to the variables being estimated. The fewer the classes the less likelihood there is that individuals will be assigned to the wrong class but the degree of accuracy is reduced. The five-point scale with equal class intervals of 20% is common, as used by the Zurich-Montpellier school of phytosociology (Braun-Blanquet 1964). An eight-point scale with uneven class intervals, as described by Anderson & Walker (1974) was chosen to assess the amount of herbage grazed. The inclusion of the class intervals 1 – 10% and 91 – 99% fills an important gap in the five-point scale and covers the assessment values where the plant has been either very lightly utilized or not fully utilized.

Conclusions

From the experience gained and the results obtained in this study, the species can be conveniently placed into three classes (Table 7): preferred species, intermediate species and non-forage species. Similar groupings have been used by Daines (1980) and Grunow (1980). Preferred species include those which are highly palatable as well as species generally eaten irrespective of stocking density. The non-forage species are either not eaten or only eaten when the grazing pressure has become very high.

This study was conducted during the dormant season so the results do not account for seasonal variations which might occur in the relative palatability of the species, particularly between grasses and non-grasses. Also, no attempt has been made to compare possible differences in species selection by different animals (e.g. sheep and cattle). Nevertheless the technique used can be a useful low-cost, non-destructive method for assessing grazing utilization.

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