Nutrient selection by cattle, goats and sheep on natural Karoo pasture. 1. Digestibility of organic matter

P.J.L. Zeeman, P.G. Marais and M.J. Coetsee
Research Institute of the Karoo Region, Middelburg, Cape

The digestibility of organic matter (DOM) of material selected by cattle, Boer goats, Dorper and Merino sheep on natural Karoo pasture was investigated. A highly significant difference ($P \leqslant 0{,}01$) in DOM selected between years, with an interclass (animal types) between years correlation of 0,88 ($P \leqslant 0{,}01$) was recorded. A close relationship in pattern of DOM selection between years is evident. The difference in DOM selected by castrated male and dry female ewes was significant ($P \leqslant 0{,}05$). However, this difference was not substantiated by a t-test between averages. Correlations ranging between $r = 0{,}971$ and $r = 0{,}979$ between sexes, within animal types, implies a close relationship for selected DOM. The difference in % DOM selected between Merino (58,57 ± 7,92) and Dorper sheep (57,76 ± 6,70) was not significant, but was higher than that selected by Boer goats (55,44 ± 6,47) ($P \leqslant 0{,}05$) and by cattle (52,07 ± 7,98) ($P \leqslant 0{,}01$). The value for Boer goats was also higher than that for cattle ($P \leqslant 0{,}01$).

A large discrepancy was established between the % DOM selected by the animals and the % DOM of material sampled by hand. It seems that the discrepancy between these two methods is larger on grazing with a divergent botanical composition. A substantial seasonal variation in the DOM content of selected material is illustrated. It seems that sheep and Boer goats are more proficient than cattle at selecting material with a sufficient DOM content at maintenance or exceeding it. Furthermore, a relationship between DOM selected and the active growth stage of pasture plants in the Karoo is suggested.
S. Afr. J. Anim. Sci. 1983, 13:236 – 239

Ondersoek is ingestel na die verteerbaarheid van organiese materiaal (VOM) deur beeste, Boerbokke, Dorper- en Merinoskape op Karooveld geselekteer. 'n Hoogsbetekenisvolle ($P \leqslant 0{,}01$) verskil in VOM geselekteer tussen jare is vasgestel en 'n interklas (diersoorte) korrelasie van $r = 0{,}88$ ($P \leqslant 0{,}01$) tussen jare is bereken. Dit dui op 'n nou verwantskap in die patroon van VOM seleksie tussen jare. 'n Betekenisvolle verskil ($P \leqslant 0{,}05$) is tussen gekastreerde manlike en droeë vroulike diere vasgestel. Hierdie verskil is nie met 'n t-toets tussen gemiddeldes bevestig nie. Verder dui korrelasies van $r = 0{,}971$ tot 0,979 op 'n noue verwantskap tussen geslagte binne diersoorte vir VOM geselekteer. Die verskil in gemiddelde % VOM geselekteer tussen Dorper- (57,78 ± 6,70) en Merinoskape (58,57 ± 7,92) was nie betekenisvol nie, maar was hoër as vir Boerbokke (55,44 ± 6,47 % VOM) ($P \leqslant 0{,}05$) en beeste (52,07 ± 7,98) ($P \leqslant 0{,}01$). Boerbokke het ook materiaal met 'n hoër % VOM-inhoud as beeste geselekteer ($P \leqslant 0{,}01$).

Geen ooreenkoms is gevind tussen die % VOM inhoud van materiaal deur vee geselekteer en met die hand gemonster nie. Dit blyk verder dat hierdie afwyking tussen die twee metodes van monsterneming toeneem met 'n toename in die aantal plantsoorte wat op 'n weiding voorkom. 'n Opmerklike seisoenale variasie in die VOM-inhoud van geselekteerde materiaal word ge-illustreer. Dit blyk dat skape en Boerbokke beter as beeste in staat was om materiaal met 'n voldoende VOM-inhoud rondom en hoër as onderhoud te selekteer. Verder blyk dit dat die seisoenale variasie in VOM geselekteer deur vee 'n ooreenkoms toon met die aktiewe groeistadiums van veldplante in die Karoo.
S.-Afr. Tydskr. Veek. 1983, 2:236 – 239

Keywords: Digestibility, Karoo veld, ruminants, selective grazing

P.J.L. Zeeman*
Present address: Research Institute of the Eastern Cape Region, Private Bag X15, Stutterheim, 4930 Republic of South Africa
P.G. Marais and M.J. Coetsee
Research Institute of the Karoo Region, Private Bag X529, Middelburg, Cape Province, 5900 Republic of South Africa

*To whom correspondence should be addressed

Received 17 December 1982

Introduction

A sizable amount of natural plants in the Karoo Region was analysed for its nutritional value (Botha, 1938; Steenkamp, 1967; Louw, Steenkamp & Steenkamp, 1968a, b & c; Louw, 1969; Steenkamp & Hayward, 1979). These values are, however, based on the chemical analyses of the most important plants sampled by hand. Kennedy (1962) concluded that the value of chemical analyses of hand collected plant samples to predict nutritional value is subject to two major disadvantages, namely nutritive value and chemical composition, which are not sufficiently related for accurate predictions and secondly, the samples used for chemical analyses are not necessarily representative of plants consumed by free grazing animals. The latter discrepancy is enlarged on natural pastures with a divergent botanical composition. This view of Kennedy *loc. cit.* is also corroborated by McDonald (1968). Troelsen & Beacom (1970) rated digestibility of organic matter determined *in vitro* (I.V.O.M.D.) highly as a preliminary estimate of nutritional value. In pooled data I.V.O.M.D. accounted for 56% of the body mass gain of steers and sheep when protein accounted for 20% (Troelsen & Beacom, 1970). Consequently I.V.O.M.D. may be used as an estimate of nutritive value. Furthermore, Engels & van der Merwe (1967) and Zeeman & Coetsee (1981) reported that digestibility of organic matter (DOM) may be closely predicted from results obtained by I.V.O.M.D.

Material and Methods

The experiment was conducted on natural pasture at the Research institute of the Karoo Region, Grootfontein, Middelburg, Cape (25°10′E, 31°30′S). The pasture was representative of the False Upper Karoo (Veld type 36 of Acocks, 1975. The experimental paddock was 28,3 ha in size and a carrying capacity of 2,2 ha per small stock unit (S.S.U.) per annum was maintained throughout the duration of the experiment. One permanent watering point was available.

Oesophageally fistulated (O.F.) Afrikaner heifers and oxen, Boer goat castrates, Dorper ewes and wethers (four each) and Merino ewes and wethers (five each) were used in this study. Oesophageal fistulation was performed according to the technique described by Schutte, Wilke & Compaan (1971) about one year before the start of this investigation. Ten Boer goat castrates and 14 Merino wethers were included to obtain the aforementioned carrying capacity of 2,2 ha per S.S.U. After fire destroyed about 5 ha of the paddock on 31 July 1976, reserves were reduced to six sheep and seven goats. The destroyed part was fenced off for the subsequent part of the trial. A prescribed dosing and inoculation programme given by the state veterinarian was applied. Sampling of the pasture with the oesophageal fistulated animals commenced during May 1975 and was concluded in October 1977. Samples (extrusa) were collected at six-week intervals. Between sampling periods the fistulated animals were removed from the paddock and kept in feeding pens containing lucerne hay *(Medicago sativa)*.

After a 3-day adaptation period in the paddock, extrusa samples were collected on four consecutive days. Prior to sampling the animals were penned for approximately 2 h to prevent rumination and contamination of extrusa with rumen contents. Contaminated extrusa (which occurred rarely) was discarded. After removal of the O.F. plugs and attachment of collection bags, the animals were allowed to graze freely from 08h00 to 09h00. On replacement of the O.F. plugs animals grazed unrestrained for the remainder of the day.

Extrusa of each individual animal including the saliva, was mixed thoroughly, sealed in a plastic bag and stored at – 15 °C. Subsequently the samples were freeze dried, ground through a 1 mm screen, pooled on a mass basis for the first and last 2 days of sampling and stored in airtight containers for further analysis.

Available biomass on the experimental paddock was determined as described by Botha (1981), on a three monthly basis. At plant specie level this material was divided into edible and inedible parts. The edible portion of this hand-sampled material was dried for 24 h at 80 °C in a forced draught oven, ground through a 1 mm screen and stored in airtight containers for further analysis. Botanical composition in the experimental camp was determined by the descending wheelpoint method of Roux (1963). I.V.D.O.M. was determined according to the method described by Engels & van der Merwe (1967). A control with known digestibility was included in each *in vitro* run to compensate for variation between runs. The regression equation $y = 10{,}5704 + 0{,}8469x$ where y = DOM and x = I.V.D.O.M. (Zeeman & Coetsee, 1981) was used to predict DOM from I.V.D.O.M.

Results and Discussion

No Boer goat ewes were available for this investigation. Consequently two approaches were followed for analysis of variance, namely, a factorial approach excluding Boer goats and a one way analysis including Boer goats. The factorial analysis indicated a significant difference ($P \leqslant 0{,}05$) between the % DOM selected by dry female (56,64 ± 6,78) and castrated male animals (55,63 ± 7,70). This is contradictory to the findings of Langlands (1969) who observed no differences between dry sheep varying in sex. However, a t-test did not substantiate a difference between sexes. Furthermore, close relationships were calculated between sexes within animal types (Table 1). This illustrates a similarity in the selective DOM consumption and grazing behaviour between castrated male and dry female ruminants. Findings by Botha (1981), with the same animals and experimental plot, also indicated that sexes within animal types preferred the same plant species.

A relatively high grazing pressure was maintained during sampling periods (0,3 ha per S.S.U.). Consequently, it was suspected that a decline in the DOM content of selected material would occur during the sampling period. However, the % DOM of extrusa pooled for the first and last 2 days of the 4-day sampling period did not differ significantly ($P \leqslant 0{,}05$). Langlands (1967) observed significant differences between diets selected on different days. In this study, pooling of extrusa could have obscured differences which seem to be small, with variance being reduced by pooling.

Analysis of variance with 1229 degrees of freedom (DF) for error and 1 252 for total showed a highly significant difference ($P \leqslant 0{,}01$) in extrusa DOM content between animal types (F = 63,67; DF = 3) and years (F = 21,28; DF = 2), with a highly significant interaction between animal types and years (F = 7,36; DF = 6).

On average cattle-selected material had a lower DOM content (52,07 ± 7,98) than Boer goats and sheep ($P \leqslant 0{,}01$), with Boer goats (55,44 ± 6,47) being lower than sheep ($P \leqslant 0{,}05$). The difference between Dorper (57,78 ± 6,70) and Merino (58,57 ± 7,92) sheep was not significant ($P \leqslant 0{,}05$). The latter is in accordance with Langlands (1969) who found no differences in nutrient selection between breeds of sheep. Furthermore, the aforementioned indicates that sheep were more proficient in the selection of material with a higher DOM content than were goats and cattle on mixed Karoo veld. This is also illustrated in Figure 1. Moreover, the differences between animal types can be ascribed to differences in preference for the divergent plant species occurring on the experimental plot and their grazing behaviour or method of grazing (Arnold & Dudzinski, 1978).

The relationship between the castrated male and dry female within animal types and between the different classes of livestock used in this experiment are given in Table 1.

According to Table 1 a close relationship between sexes within animal types ($r = 0{,}971$ to $r = 0{,}971$, $P \leqslant 0{,}01$) occurred. The high correlations and low Sy.x values suggest the possibility of predicting DOM selection between dry female and castrated male animals. Between-animal correlations were highest for Dorper and Merino sheep and lowest for cattle and small stock. The closer relationship between sheep could be ascribed to a similarity in DOM selection (Langlands, 1969). On the other hand, the lower correlations and higher Sy.x values between cattle and small stock indicate a dissimilarity in their DOM selection, a tendency described by Dudzinski & Arnold (1973)

Pooled avarages for % DOM selected for year 1, 2 and 3 were 55,55 ± 7,95^{b}, 58,28 ± 8,9^{a} and 54,76 ± 11,72^{bb} respectively (a > b, $P \leqslant 0{,}05$) and (a > bb, $P \leqslant 0{,}01$)). Notwithstanding these differences between years, an interclass

Table 1 Correlations and regression equations between sexes and animal types for DOM selected

Relationship	Correlation	Regression	Sy.x
Oxen *(x)* and heifers *(y)*	$r = 0{,}979$	$y = 3{,}2640 + 0{,}9566x$	1,489
Dorper wethers *(x)* and dry Dorper ewes *(y)*	$r = 0{,}971$	$y = 9{,}6368 + 0{,}8503x$	1,339
Merino whether *(x)* and dry Merino ewes *(y)*	$r = 0{,}976$	$y = 2{,}9455 + 0{,}9657x$	1,371
Merino sheep *(x)* and Dorper sheep *(y)*	$r = 0{,}949$	$y = 4{,}5627 + 0{,}9081x$	1,864
Merino sheep *(x)* and Boer goats *(y)*	$r = 0{,}906$	$y = 5{,}4453 + 0{,}8410x$	2,436
Merino sheep *(x)* and Cattle *(y)*	$r = 0{,}743$	$y = 1{,}0990 + 0{,}8699x$	4,868
Dorper sheep *(x)* and Boer goats *(y)*	$r = 0{,}913$	$y = 3{,}3169 + 0{,}8893x$	2,355
Dorper sheep *(x)* and Cattle *(y)*	$r = 0{,}778$	$y = 3{,}1614 + 0{,}9558x$	4,564
Boer goats *(x)* and Cattle *(y)*	$r = 0{,}773$	$y = 1{,}2558 + 0{,}9744x$	4,612

$r = 0{,}433$ at the 5 % and 0,549 at the 1 % level of significance.

(animal types) between year correlation of $r = 0{,}88$ ($P \leqslant 0{,}01$) was calculated. This, combined with the interaction between animal types and years, which is also illustrated in Figure 1 suggests a strong correspondence in the between year seasonal pattern of DOM selection by ruminants on the natural pasture of the experimental plot. This seasonal variation is also a characteristic of natural Karoo pasture (Roux, Vorster, Zeeman & Wentzel, 1981). According to Engels & Malan (1978), Engels & Malan (1979), De Waal, Engels & van der Merwe (1980) and Roux, Vorster, Zeeman & Wentzel (1981), climatic factors, especially rainfall, are mainly responsible for the variation in DOM selected by grazing animals on natural pastures.

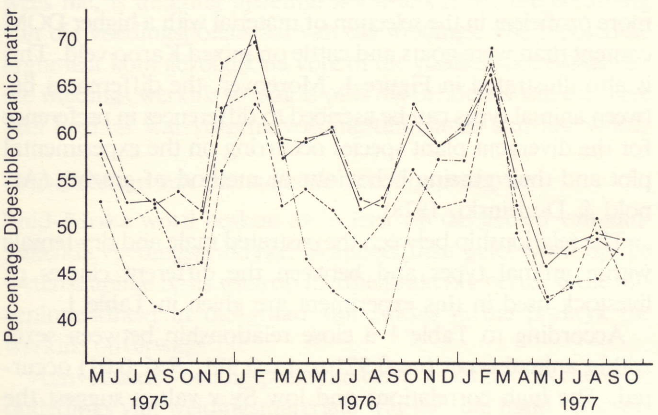

Figure 1 % DOM in material selected by cattle (—••—), Boer goats (- - -), Dorper (—) and Merino sheep (—•—) on natural Karoo pasture.

Figure 1 illustrates the DOM content of material selected by the different animal types on a time related basis. The DOM content of selected material shows peak values during February, after which it declines to the lowest values from July to October. Differences between animal types are also illustrated in Figure 1 and show that cattle were less proficient than small stock in DOM selection. Tests for significance of differences between animal types within individual sampling times indicated that a non-significant ($P \leqslant 0{,}05$) difference in DOM content of material selected in February occurred. The between animal differences (sheep and goats and small stock and cattle) increased with the decline in % DOM (Figure 1) and the largest differences ($P \leqslant 0{,}01$) occurred from June to October. Between sheep comparisons indicated a marked correspondence in the DOM content of selected material.

Determination of the botanical composition by the descending wheelpoint method (Roux, 1963) revealed that 33 Karoo bush, 19 grass and 23 ephemeral species occurred on the experimental plot, of which 30 Karoo bush, 17 grass and 13 ephemeral species produced sufficient material for DOM and other analyses. The average % DOM of the main plant communities and their relative compositions expressed as a percentage are given in Table 2 on a seasonal basis.

Comprehensive variation is demonstrated in Table 2 by the large standard deviations, a large range between maximum and minimum values and difference in the % importance of plant communities between seasons. It is, furthermore, evident from Table 2 that Karoo bush and grass were the most important species on the experimental plot and that ephemerals made a small contribution to the available plant material. Comparison of the values illustrated in Figure 1 with the average DOM content of hand-sampled plant material (Table 2) shows a substantial discrepancy between the DOM content of material sampled by hand and that selected by free grazing animals. This confirms the observations made by Langlands (1966), McDonald (1968) and Engels & Malan (1978) that results obtained from hand-sampled material not only underestimate the nutritive value of natural pastures but also deviate from nutritive values obtained with grazing animals. This discrepancy also seems to be more pronounced on pastures with a divergent botanical composition.

Blaxter (1960) inferred that ruminants cannot consume sufficient energy for maintenance on diets with a digestibility of lower than 50 %. If this value is superimposed on Figure 1, it can be reasoned that sheep selected material with a DOM

Table 2 The average DOM content (%) of edible material, sampled by hand, and relative composition (%), descending wheelpoint method, Roux (1963) of the main plant communities on the experimental plot

	Karoo bush DOM (%)				Grass DOM (%)				Ephemerals (self-sown) DOM (%)			
Sample date	Mean ± SD	Maximum	Minimum	Relative composition (%)	Mean ± SD	Maximum	Minimum	Relative composition (%)	Mean ± SD	Maximum	Minimum	Relative composition (%)
January 1976	33,21 ± 10,31	57,4	16,8	49,08	41,75 ± 8,20	52,19	30,33	47,77	40,47 ± 5,81	51,14	34,6	3,11
April 1976	28,10 ± 8,21	49,04	10,04	41,7	34,44 ± 8,66	51,75	20,73	55,26	41,26 ± 9,57	54,1	25,0	2,97
July 1976	27,05 ± 6,46	42,28	18,51	53,24	30,81 ± 4,77	35,65	20,20	45,27	44,40 ± 7,19	51,98	37,68	1,53
November 1976	27,61 ± 5,57	34,75	17,81	56,8	36,42 ± 8,42	52,68	27,55	40,12	45,19 ± 10,38	62,10	30,11	2,11
January 1977	29,54 ± 7,41	42,29	17,40	59,24	45,97 ± 5,92	45,60	29,97	39,87	36,98 ± 13,68	61,43	22,83	0,83
April 1977	31,86 ± 12,12	55,89	19,30	53,43	39,16 ± 9,10	56,40	26,71	43,26	46,50 ± 9,50	54,34	39,98	3,33
July 1977	32,26 ± 13,02	53,05	18,60	62,37	35,02 ± 9,54	43,95	18,15	36,64	43,05 ± 5,27	48,32	37,77	0,93

content exceeding maintenance, with the exception of the period from April 1977 to the end of the experiment. On the other hand cattle selected material with a DOM content below maintenance during the winter and spring of 1975, 1976 and 1977. The findings of Botha (1981) that cattle concentrated mainly on the grass component, could be responsible. Engels & Malan (1978) showed that the feeding value of grass during winter is below the DOM requirement for maintenance.

All animals, however, selected material with a DOM content in excess of maintenance during summer. The DOM content of selected material reached a peak during February of 1976 and 1977. It is also evident (Figure 1) that small stock, especially sheep, were better able to select material with a DOM content exceeding maintenance than were cattle. A comparison between the DOM content of material selected by ruminants (Figure 1) and the growth activity of pasture plants in the Karoo (Roux (1968) suggests a definite relationship between DOM selection and the growth activity in Karoo plants. Botha (1981) and Roux *et al.* (1981) concluded that the selective grazing behaviour of ruminants is related to the active growth stage of pasture plants in the Karoo.

Acknowledgements

We gratefully acknowledge the cooperation of the Pasture Science section in the collection of samples and care of the animals. We are also grateful to Mr B.A. Lötter for the processing of data and Mrs E.M. van Tonder and G. Bath for the fistulation of the animals.

References

ACOCKS, J.P.H., 1975. Veld types of South Africa. *Bot. Surv. S. Afr. Mem., 40.* Government Printer, Pretoria.

ARNOLD, G.W. & DUDZINSKI, M.L., 1978. Ethology of free-ranging animals. Elsevier Scientific Publishing Company. Amsterdam.

BLAXTER, K.L., 1960. The utilization of the energy of grassland products. *Proc. 8th Intl. Grassl. Congr.* 479.

BOTHA, J.P., 1938. The digestibility and nutritive value of Karoo pasture plants. VI. Groot gansie. *Fmng. S. Afr.* 13, 305.

BOTHA, P., 1981. Die invloed van spesieseleksie deur skape, beeste en bokke op die floristiese samestelling van gemengde Karooveld. D.Sc. tesis. P.U. vir C.H.O.

DE WAAL, H.O., ENGELS, E.A.N. & VAN DER MERWE, F.J., 1980. Supplementing sheep with protein and phosphorus on native pasture of the central Orange Free State. 1. Diet composition, digestibility and rumen ammonia concentration. *S. Afr. J. Anim. Sci.* 10, 203.

DUDZINSKI, M.L. & ARNOLD, G.W., 1973. Comparisons of diets of sheep and cattle grazing together on sown pastures on the southern tablelands of New South Wales by principal components analysis. *Aust. J. Agric. Res.* 24, 899.

ENGELS, E.A.N. & MALAN, A., 1978. Die invloed van twee veebeladings op die samestelling van die dieet en inname van skape in 'n driekampstelsel in die sentrale Oranje Vrystaat. *S. Afr. Tydskr. Veek.* 8, 19.

ENGELS, E.A.N. & MALAN, A., 1979. Feed intake of non-pregnant, pregnant and lactating ewes on native pasture and lucerne hay. *S. Afr. J. Anim. Sci.* 9, 27.

ENGELS, E.A.N. & VAN DER MERWE, F.J., 1967. Application of an *in vitro* technique to South African forages with special reference to the effect of certain factors on the results. *S. Afr. J. Agric. Sci.* 10, 983.

KENNEDY, W.K., 1962. Chemical composition of pasture herbage. In: Pasture and range research techniques. By joint committee. Comstock Pub. Assoc., Ithaca, New York.

LANGLANDS, J.P., 1966. Studies on the nutritive value of the diet selected by grazing sheep. 1. Differences in composition between herbage consumed and material collected from oesophageal fistula. *Anim. Prod.* 8, 253.

LANGLANDS, J.P., 1967. Studies on the nutritive value of the diet selected by grazing sheep. II. Some sources of error when sampling oesophageally fistulated sheep at pasture. *Anim. Prod.* 9, 167.

LANGLANDS, J.P., 1969. Studies on the nutritive value of the diet selected by grazing sheep. IV. Variation in the diet selected by sheep differing in age, breed, sex, strain and previous history. Anim. Prod. 11, 369.

LOUW, G.N., 1969. The nutritive value of natural grazing in South Africa. *Proc. S. Afr. Soc. Anim. Prod.* 8, 57.

LOUW, G.N., STEENKAMP, C.W.P. & STEENKAMP, E.L., 1968a. Chemiese samestelling van die vernaamste plantsoorte in die Noorsveld. Teg. Med. No. 77 Dept. L.T.D., Pretoria.

LOUW, G.N., STEENKAMP, C.W.P. & STEENKAMP, E.L., 1968b. Chemiese samestelling van die vernaamste plantspesies in die westelike Berg Karoo in die distrik Frazerburg. Teg. Med. No. 78. Dept. L.T.D., Pretoria.

LOUW G.N., STEENKAMP, C.W.P. & STEENKAMP, E.L., 1968c. Chemiese samestelling van die vernaamste plantspesies in die dorre, skyn-dorre, skyn-sukkulente en sentrale Bo-Karoo. Teg. Med. No. 79. L.T.D., Pretoria.

MC DONALD, I.W., 1968. The nutrition of grazing ruminants. *Nutr. Abs. & Rev.* 38, 381.

ROUX, P.W., 1963. The descending-point method of vegetation survey. A point-sampling method for the measurement of semi-open grasslands and Karoo vegetation. *S. Afr. J. Agric. Sci.* 6, 273.

ROUX, P.W., 1968. Principles of veld management in the Karoo and the adjacent dry sweet-grass veld. In: The small stock industry in South Africa. Ed. Hugo, W.J., Government Printer, Pretoria. p.318.

ROUX, P.W., VORSTER, M., ZEEMAN, P.J.L. & WENTZEL, D., 1981. Stock production in the Karoo region. *Proc. Grassld Soc. sth Afr.* 16, 29.

SCHUTTE, J.A., WILKIE, P.J. & COMPAAN, J.P., 1971. Surgical procedure for the creation of an oesophageal fistula in a sheep. *Agroanimalia* 3, 99.

STEENKAMP, C.W.P., 1967. Die voedingswaarde van die weidings in die Petrusville-Hopetownse Sandveldgebied. M.Sc. (Landbou) tesis. Univ. Stellenbosch.

STEENKAMP, C.W.P. & HAYWARD, F.C., 1979. Chemiese samestelling van die vernaamste plantspesies in die suid-sentrale sektor van die Groot Eskarpement. Teg. Med. No. 249. Dept. L.T.D., Pretoria.

TROELSEN, J.E. & BEACOM, S.E., 1970. Feeding value of forage as fed to steers and estimated by *in vitro* digestion. *Can. J. Anim. Sci.* 50, 547.

ZEEMAN, P.J.L. & COETSEE, M.J., 1981. The influence of divergent inocula on *in vitro* digestibility. *S. Afr. J. Anim. Sci.* 11, 287.