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DIGESTIBILITY STUDIES WITH *PROSOPIS JULIFLORA* (MESQUITE THORN) PODS

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OPSOMMING: VERTEERBAARHEIDSSTUDIES MET *PROSOPIS JULIFLORA* (MUSKIETBOOM) PEULE

Verteerbaarheids- en vrywillige inname studies is met S.A. Vleismerinohamels uitgevoer. Hulle het 'n basale dieet van gemaalde lusern- en hawerhooi ontvang (kontrole) wat trapsgewys verplaas is met gemaalde *Prosopis juliflora* peule tot 100% verplasing. *Ad lib.* innames van suiwer Prosopis-peule het nie betekenisvol van die kontroledieet verskil nie, maar verteerbaarheid, veral van ruvesel, is verlaag namate die vlak van peule insluiting verhoog is. Die gevolgtrekking is gemaak dat die verteerbaarheid van dié peule op 40% insluiting 'n maksimum bereik het.

SUMMARY:

Digestibility and voluntary intake trials were undertaken with S.A. Mutton Merino wethers fed a basal diet of milled lucerne and oat hay (control diet) to which various proportions of milled *Prosopis juliflora* pods were added up to 100% replacement. *Ad lib.* intakes of pure Prosopis pods did not differ significantly from the control diet, but at high levels of pod inclusion, digestibilities were reduced, especially that of crude fibre. In this study it was concluded that the digestibilities of pod constituents appeared to maximize at 40% pod inclusion.

The value of fodder trees, particularly in the more arid regions of South Africa, has yet to be fully realized. In other parts of the world fodder trees make valuable contributions to stock feeding. An example of this is the use of various oak species in Europe and America as well as the mesquite tree in south western U.S.A. and Mexico. Farmers along the Mediteranean have long been aware of the value of carob pods (*Ceratonia seliqua*) as a stock feed (Bartolucci, 1916; Loock, 1940; Alibrand, 1971).

In South Africa natural fodder trees comprise mainly the deciduous bushveld trees, which are not only in most cases resistant to droughts, but also do not lose their leaves until well into Winter. This is so in the case of the mopani (*Copaifera mopane*) which, although it has a pronounced odour, is readily consumed by both cattle and sheep (Bonsma, 1942).

The mesquite (Prosopis species) is not indigenous to Southern Africa, but was introduced from Mexico. The first *Prosopis juliflora* was reputedly planted before the turn of the century at Okahandja (Loock, 1947) and since then this species has adapted itself well to the drier north western Cape Province and Southwest Africa.

The feeding value of the mesquite lies in its pods which, to be utilized efficiently, should be mature and preferably milled. Analysis of seeds of the S.A. variety shows a medium protein level and reasonably high energy content. Very little information is available on its digestibility and palatability. For this reason and because fodder trees with potentially high energy yields may in future become more important in a grain-hungry world, voluntary intake and digestibility trials were undertaken.

Procedure

Two separate short-term experiments were carried out. For Trial 1 a limited supply of pods from the Calvinia district, was available. In Trial 2 a larger quantity of pods from the Kenhardt district made a more elaborate trial possible.

In Trial 1 mesquite pods (hammer milled through a 6,25 mm screen) replaced 10 or 20% of the basal hay diet (50 oat hay:50 lucerne hay, hammer milled through a 18 mm screen) fed to 12 South African Mutton Merino wethers. The trial consisted of a preliminary *ad lib.* feeding period of 28 d followed by a 7 day period of constant intake and then a collection period of 6 d. Diets and feeding levels during the digestibility trial were as set out in Table 1.

Table 1

Levels of pod inclusion and feeding levels in Trial 1

Group	No. of sheep	Pod inclusion %	Levels of feeding	Amounts fed daily	
				basal (g)	pods (g)
I	2	0	80% *ad lib.*	1 200	0
II	2	20	60% *ad lib.*	720	180
III	2	10	60% *ad lib.*	810	90
IV	2	20	80% *ad lib.*	960	240
V	2	10	80% *ad lib.*	1 080	120
VI	2	0	60% *ad lib.*	900	0

In Trial 2, twenty-four S.A. Mutton Merino wethers were randomly allotted to 6 groups of 4 each. A basal hay diet (50 oat hay:50 lucerne hay, hammer-milled through a 18 mm screen) was replaced by milled pods at the rate of 0%, 20%, 40%, 60%, 80% and 100% of the basal diet.

The two groups of sheep on 0% and 100% pods had an *ad lib.* feeding period of 18 d while the other 4 groups were, over this same period, adapted to their respective diets in restricted amounts. At the completion of the *ad lib.* feeding period, live mass measurements were made after a 15 h fast and *ad lib.* intakes were calculated in terms of metabolic body size. After this a 7 d period of constant intake was followed by a 7 d collection period with all 6 groups. The mean *ad lib.* intake of pods and basal diet was determined and sheep received 60% of this according to mass.

In both trials, oven dried samples of feed and faeces were analysed for protein (N x 6,25), diethyl ether extract, crude fibre and ash by standard procedures (A.O.A.C., 1965). Gross energy was determined with a Gallenkamp adiabatic bomb calorimeter.

Results

In Table 2 the mean voluntary intakes of the basal hay and pod-containing diets are presented. In comparison with the basal hay diet, the voluntary intake by sheep of pod containing diets was high. Even a diet of 100% milled pods in Trial 2 was consumed at the rate of $75 g/kg^{0,75}$ which amounts to 1 400 g per day for a 50 kg sheep. The pods are clearly palatable to sheep despite the fairly strong aromatic odour present in the milled material.

The mesquite pods used in the two trials were obtained from different districts and differed in chemical composition. As can be seen from Table 3 the pods used in Trial 1 were higher in all constituents except nitrogen-free extract (NFE) which is logical because the latter is obtained by difference.

A very large difference is observed in the energy values of the oat-lucerne hay in the two trials. The explanation probably lies in the higher ether extract value (20% higher) in the basal hay used in Trial 1.

With the object of forestalling associative effects due to different protein contents of control diet and test material an effort was made to manipulate the protein content of the oat-lucerne hay to a level as closely as possible to that of the mesquite pods. This was not completely successful, but protein contents were of the same order.

Table 4 summarizes digestibility values (mean of 2 sheep) for crude protein, crude fibre and energy as well as digestible crude protein (DCP) and digestible energy (DE) contents of the basal and mixed diets in Trial 1. The data in Table 4 show that within feeding levels the apparent digestiblity of protein increased and the digestibility of crude fibre decreased as the level of pod inclusion was raised. To arrive at DCP and DE values for pods as a possible single feed, the data in Table 4 were used in a regression analysis. Table 5 gives the estimates obtained by this method for 2 feeding levels. A slight level of feeding effect is apparent.

Table 2

Mean voluntary intakes of basal diet and 100% pod diet in Trial 2 and of basal diet and basal diet plus milled pods at 10% and 20% rates in Trial 1

Trial	Diet	No. of sheep	Mean *ad lib.* intakes ($g/kg^{0,75}/day$)	Mean *ad lib.* intakes used in trials ($g/kg^{0,75}/day$)
1	Basal	2	78,3	
1	Basal + 10% pods	2	77,8	78,1
1	Basal + 20% pods	2	78,3	
2	Basal	4	86,6 ± 9,9	80,7
2	Pods alone	4	74,9 ± 8,7	

Table 3

The chemical composition and gross energy content (moisture free basis) of basal diet and pods used in Trial 1 and Trial 2

Feed	Trial	Crude protein (%)	Crude Fibre (%)	Ether extract (%)	Ash (%)	N.F.E. (%)	Energy (MJ/kg)
Oat-lucerne hay	1	10,19	29,41	3,72	6,04	50,64	19,00
Oat-lucerne hay	2	10,30	26,64	2,95	6,40	53,71	16,87
Mesquite pods (ex Calvinia)	1	11,36	19,37	4,41	5,70	59,16	18,67
Mesquite pods (ex Kenhardt)	2	9,83	17,14	3,48	4,25	65,30	17,27

Table 4

Digestibility coefficinets of protein, crude fibre, energy as well as DCP – and DE contents of the basal – and mixed diets in Trial 1

Pod inclusion (%)	Feeding level	Coefficients of digestibility			Dig. crude protein	Dig. energy
		Protein	Crude fibre	Energy	(%)	(MJ/kg)
0	60% *ad lib.*	0,6479	0,5722	0,6019	6,59	11,40
10	60% *ad lib.*	0,6649	0,5738	0,6200	6,85	11,72
20	60% *ad lib.*	0,6899	0,5447	0,6181	7,19	11,67
0	80% *ad lib.*	0,6373	0,5674	0,6089	6,49	11,51
10	80% *ad lib.*	0,6664	0,5560	0,6208	6,87	11,71
20	80% *ad lib.*	0,6718	0,5190	0,6141	7,00	11,63

Table 5

Estimates of apparently digestible crude protein and digestible energy (in % and MJ/kg D.M. respectively) of mesquite pods

Digestible nutrient	Feeding level	Estimation by means of regression analysis
DCP	60% *ad lib.*	9,84
DCP	80% *ad lib.*	9,12
DE	60% *ad lib.*	12,77
DE	80% *ad lib.*	12,16

Table 6

The mean digestibility coefficients of dry matter, crude protein, crude fibre, ether extract, N.F.E. and G.E. together with standard deviations and coefficients of variation (CV) of mesquite pods from Trial 2

Pod inclusion (%)	D.M.	Crude protein	Crude fibre	Ether extract	N.F.E.	G.E.
100	0,6504 ±0,061	0,6719 ±0,0611	0,2807 ±0,125	0,8022 ±0,045	0,7435 ±0,046	0,6200 ±0,1177
	CV = 9,3%	9,0%	44,5%	5,6%	6,2%	19,0%
80	0,6495 ±0,0413	0,6885 ±0,0611	0,3446 ±0,073	0,7863 ±0,016	0,7382 ±0,032	0,6150 ±0,0787
	CV = 6,3%	6,8%	21,1%	2,0%	4,3%	12,8%
60	0,6507 ±0,0409	0,6951 ±0,0508	0,4281 ±0,082	0,7524 ±0,049	0,7288 ±0,047	0,6176 ±0,0778
	CV = 6,3%	8,3%	19,1%	6,5%	6,4%	12,6%
40	0,6718 ±0,048	0,7240 ±0,042	0,4674 ±0,088	0,8550 ±0,028	0,7488 ±0,037	0,6387 ±0,0951
	CV = 7,1%	5,8%	18,8%	3,2%	4,9%	14,9%
20	0,6136 ±0,014	0,6750 ±0,016	0,4586 ±0,053	0,8045 ±0,051	0,7017 ±0,036	0,5813 ±0,0281
	CV = 2,3%	2,3%	11,5%	6,3%	5,1%	5,3%
0	0,6233 ±0,016	0,6753 ±0,0115	0,4752 ±0,027	0,7622 ±0,010	0,6959 ±0,022	0,5889 ±0,0266
	CV = 2,5%	1,7%	5,6%	1,3%	3,1%	4,5%

Table 7

Digestible crude protein, digestible crude fibre and digestible energy values estimated by regression analysis in Trial 1 at 60% ad lib. *feeding level, and obtained in Trial 2 compared to corresponding values given by Schneider (1947) and Morrison (1958)*

Type and origin	Digestible crude protein (%)	Digestible crude fibre (%)	Digestible energy (MJ/kg)
Mesquite pods (Trial 1)	9,84	8,54	12,77
Mesquite pods (Trial 2)	6,60	4,80	10,70
Mesquite beans (Schneider, fed to sheep)	11,30	17,20	13,80*
Mesquite beans (Schneider, low protein type, fed to cattle)	6,60	12,50	11,90*
Mesquite pods Morrison)	11,70	15,30	13,20*

* 1 kg TDN = 18,42 MJ

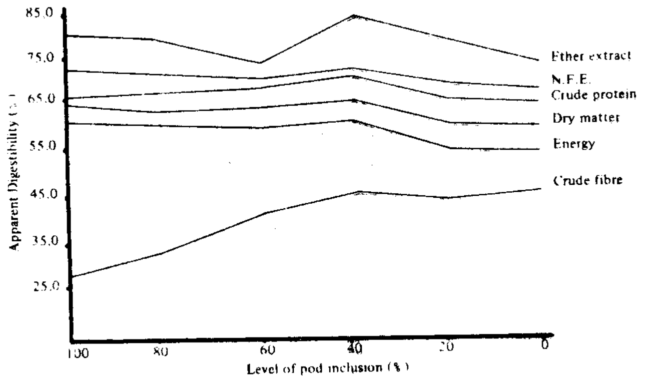

Fig. I *The digestibility values for the proximate constituents of the experimental diet at different inclusion rates.*

In the second trial only one feeding level viz. 60% *ad lib.* was applied so that each group consisted of 4 sheep. The average digestibility coefficients of dry matter, crude protein, crude fibre, ether extract, nitrogen-free extract and the digestible energy of the rations fed in Trial 2 are given in Table 6. Within groups the variability in coefficients of digestibility apparently increased with increasing level of pod inclusion. To investigate this further the correlation between level of pod inclusion and coefficient of variation was determined. These values are given below.

Correlation between level of pod inclusion and the coefficient of variation for digestibility of:

Dry matter	r	=	0,8330*
Crude protein	r	=	0,9212**
Crude fibre	r	=	0,8994*
Ether extract	r	=	0,2797
NFE	r	=	0,6376
DE	r	=	0,8811**

* significant at 5% level
** significant at 1% level

The correlation between level of pod inclusion and coefficient of variation is highly significant in the case of crude protein, while those for dry matter, crude fibre and energy are all significant at the 5% level of probability.

In Table 7 the digestible crude protein, digestible crude fibre and digestible energy values of mesquite pods obtained in Trial 1 (by regression analysis) and in Trial 2 are compared with values given by Schneider (1947) and Morrison (1958). It is noted that the values given by Schneider (with sheep) and Morrison are almost identical, whilst the "low protein mesquite bean" fed to cattle by Schneider has in fact a digestible crude protein value exactly the same as the value obtained in Trial 2. Even the digestible energy is of the same order, whilst crude fibre values differ markedly.

Discussion and conclusions

It was unfortunate that the chemical composition not only of the pods but also of the oat-lucerne hay used in the two trials differed to such an extent. This would not have been of so much importance, however, had there been enough pods initially to incorporate high levels of this material into the experimental diets.

In Trial 2 it was found that with high levels of pod inclusion, large individual variations in digestibility coefficients occurred. In Table 6, which shows the mean digestibility coefficients as well as standard deviations and coefficients of variation, it is noticed that the higher the pod inclusion the higher the coefficient of variation. This relationship gives rise to the significant correlation values obtained.

The largest variation in digestion coefficients at high levels of pod inclusion was found in crude fibre, which in addition showed a very low mean digestibility. It is difficult to suggest reasons for the variation of digestibility of crude fibre at higher levels of pod inclusions in the rations. One possibility is that the animals did not have adequate time in which to accustom themselves to the mesquite pods. The voluntary mean intake of pods, established in the preliminary *ad lib.* period, was, however, surprisingly high, comparing favourably with a "medium quality forage" fed to sheep by Blaxter, Wainman & Wilson (1961). This suggests that the sheep did not in fact have adaptation problems. A second possibility is that the pods contain some constituent or other which impeded digestion. This would naturally result in the effect being most pronounced at the higher levels of pod inclusion.

In Table 7 digestible crude protein, digestible crude fibre and digestible energy values obtained by Schneider (1947) and Morrison (1958) are compared to values obtained in both Trial 1 and Trial 2. Only in the case where a low protein pod was used by Schneider on cattle is there any similarity with values obtained in Trial 2, although the values estimated in Trial 1 compare very favourably with those of Schneider (sheep) and Morrison.

The digestibility value for protein, estimated in Trial 1 was thought to be unrealistically high viz. 0,8661 when the rations were fed at 60% of the *ad lib.* intake but both Schneider (sheep) and Morrison report values greater than this. This raises the possibility that there are other differences, apart from those observed in proximate analysis, between the mesquite pods used in Trial 1 and Trial 2.

Studying the "digestion trends" it is clear that there is an optimum at 40% pod inclusion. This effect is shown by the graph (Fig. 1). Particularly interesting is the curve given by digestible crude fibre, which increases steadily, and almost linearly, from 100% pod inclusion to 40% after which it flattens out.

In mixed diets such as those used in the present study, digestibilities of pod constituents appear to maximize at 40% inclusion. However, even when the diet consists of pods only it is well digested. Although no analyses of mineral elements were included in the present study, it is clear that milled Mesquite Pods constitute a fairly well balanced, highly digestible diet for sheep.

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