# Fibre digestion in the hyrax

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Transit time and digestibility of two diets differing in fibre content were studied using captive hyrax *(Procavia capensis)*. Significant negative correlations were found between transit time and NDF content of the diets. During these studies the hindgut played a major role in retaining fibrous foods and constituted 11,2% of the body mass while the stomach made up only 4,2% of the body mass on the high fibre diet (49,5% NDF). Hyrax appear to be one of the most efficient fibre digesters among the hindgut fermenters.

Deurvoertyd en verteerbaarheid van twee rantsoene wat verskil in veselinhoud is bestudeer deur gebruik te maak van dassies *(Procavia capensis)* in gevangenisskap. Betekenisvolle negatiewe korrelasies is gevind tussen deurvoertye en NVV inhoud van die rantsoene. Tydens hierdie studie het die agterderm 'n belangrike rol gespeel in die terughou van veselvoedsel en het 11,2% van die liggaamsmassa uitgemaak terwyl die maag slegs 4,2% van die liggaamsmassa uitgemaak het op 'n hoë vesel rantsoen (49,5% NVV). Dassies is skynbaar een van die mees effektiewe veselverteerders van die agterderm fermenteerders.

**Keywords:** Hyrax, transit time, fibre digestibility, hindgut fermenter.

## Introduction

In certain semi-arid rocky areas of southern Africa the hyrax, *Procavia capensis,* is of special interest as it has become an agricultural pest. They are highly adaptable feeders consuming unpalatable and even poisonous plants.

No detailed information is available on their ability to digest fibre. A study examining the digestive tract, particularly the unique hindgut in terms of transit time and digestibility of two diets differing in fibre levels, was undertaken.

## Methods

Ten adult captive hyrax of similar mass were divided into two equal groups and housed in individual stainless steel cages at room temperature (26° C). Each was given a different fibre diet containing 15,5% and 49,5% NDF, respectively. Water was freely available. Following an adaptation period of four weeks, digestibility trials lasting seven days were carried out.

The transit time of digesta was measured by incorporating coloured plastic particles into the pelleted diets. Pellets were fed and faeces samples collected every hour for two days to calculate the first and last appearance of the plastic particles.

Prior to sacrificing the animals, each group was starved for 24 h before being fed pellets with plastic particles at 03h00 on the morning of the ingesta movement experiment. One hyrax from each group was then killed at six hour intervals commencing at 07h00. After sacrifice, the masses and volumes of the contents of stomachs, sacs and caeca were recorded.

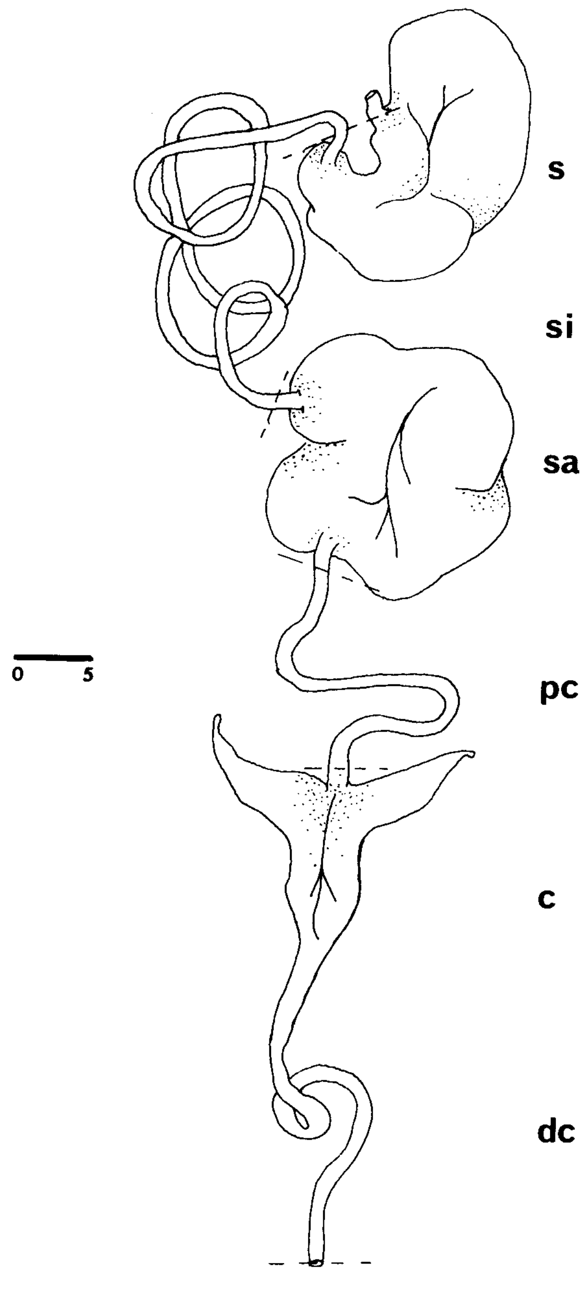


**Figure 1** Gastro-intestinal tract of the hyrax *Procavia capensis*. Symbols represent the stomach (s); small intestine (si); sacculation (sa); proximal colon (pc); caeca (c); distal colon (dc). Bar represents a length of 1 cm = 5 cm.

All diet and faeces samples were oven dried at 75° C until the mass remained constant. GE was determined on the dried samples by calorimeter combustion. The fibre content was determined by the method of Van Soest (1964) using a Fibretec 1020 hot extraction apparatus. Two-way analysis of variance was used to test for differences between the two most important fibre digesting gut regions, the sacculation and caeca.

## Results

### Digestive system

The digestive system of the hyrax is shown schematically in Figure 1 and for this study was separated into six segments as illustrated.

### Transit time

Hyrax fed diet 2 showed a significantly slower transit time of digest compared with hyrax fed diet 1, as is demonstrated by the 14-h difference both in the times of the first and last appearance (Table 1a). At least 16 h was required for particles to reach the caeca of hyrax fed diet 2 compared with 10 h for diet 1. Significant negative correlations were found between transit time and NDF content of the diets ($r = -0,97$).

**Table 1a** Mean transit time of digesta through ten hyrax fed on two different diets (hours). Values are means ± standard deviation of five animals per treatment. (★ = different at $P<0,05$)

| Diet | First appearance | Last appearance | Significant differences between fibre levels |
|---|---|---|---|
| 1 | 34 ± 2,0 | 48 ± 3,0 | ★ |
| 2 | 44 ± 1,0 | 59 ± 9,0 | ★ |

**Table 1b** Ingesta movement in the digestive tracts of 10 hyrax (hours)

| Diet | Animal No. | Time between feeding and killing | Furthest gut part containing plastic particles |
|---|---|---|---|
| 1 | 1 | 4 | Sac |
| | 2 | 10 | Caeca |
| | 3 | 16 | Caeca |
| | 4 | 22 | Caeca |
| 2 | 5 | 4 | Sac |
| | 6 | 10 | Sac |
| | 7 | 16 | Caeca |
| | 8 | 22 | Caeca |

### Digestive tract content masses and volumes

Mean masses and volumes of the contents of stomach, sac and caeca of hyrax fed diet 1 were significantly lower than those fed diet 2 (Table 2). The stomach content mass expressed as % of body mass was 2,9 and 4,2 for diet 1 and 2, respectively. The values for the sac content were 3,2 and 7,7, and 2,0 and 3,5 for the caeca content, respectively.

**Table 2** Mean body mass, digestive tract content mass and volume of hyrax on diets 1 and 2. Values are mean ± standard deviation of five animals per treatment. N S = not significant; ★ = different at $P<0{,}05$.

| Measurement | Diet 1 | Diet 2 | Significant differences between fibre levels |
|---|---|---|---|
| Animal mass (kg) | 3,3 ± 0,6 | 2,6 ± 0,5 | N S |
| Stomach content mass as % of body mass | 2,9 | 4,2 | ★ |
| Stomach volume (ml) | 145 ± 14,0 | 160,0 ± 22,0 | ★ |
| Sac content mass as % of body mass | 3,2 | 7,7 | ★ |
| Sac volume (ml) | 220,0 ± 11,0 | 290,0 ± 26,0 | ★ |
| Caeca content mass as % of body mass | 2,0 | 3,5 | ★ |
| Caeca volume (ml) | 177,0 ± 3,0 | 200,0 ± 7,0 | ★ |

**Table 3** Digestibility of fibre by hyrax. Values are means ± standard deviations of five animals per treatment. NDF: neutral detergent fibre; ADL: acid detergent lignin; D E: digestible energy. N S = not significant; ★ = different at $P<0{,}05$

| Measurement | Diet 1 | Diet 2 | Significant differences between fibre levels |
|---|---|---|---|
| Average body mass | 3,3 ± 0,6 | 2,6 ± 0,5 | N S |
| Intake (g per day) | 52,7 ± 3,6 | 55,0 ± 6,4 | N S |
| Gross energy intake (kJ/kg $W^{0,75}$) | 412,1 ± 28,1 | 488,6 ± 15,5 | ★ |
| NDF intake % | 15,5 | 49,5 | ★ |
| ADL intake % | 6,0 | 15,5 | |
| Faecal output (g per day) | 8,3 ± 2,3 | 18,17 ± 4,0 | ★ |
| Faecal output (kJ/kg $W^{0,75}$) | 43,4 ± 8,1 | 119,2 ± 5,4 | ★ |
| NDF output % | 28,6 | 62,5 | ★ |
| ADL output % | 14,0 | 19,3 | ★ |
| D E (kJ/kg $W^{0,75}$) | 368,8 ± 11,0 | 369,2 ± 6,1 | N S |
| Apparent digestibility % | 84,2 | 66,9 | ★ |
| NDF digestibility % | 71,0 | 58,3 | ★ |

### Digestibility

Increasing the NDF and ADL levels from 15,5% in diet 1 to 49,5% in diet 2 resulted in a significantly lower apparent digestibility (84,2 and 66,9% for the two diets) and NDF digestibility (71,0 and 58,3% respectively) of dry matter. There was a significantly higher intake and output of dry matter when the fibre level was increased. Although the digestibilities differed significantly between diet 1 and 2, equal amounts of D E (kJ/kg$W^{0,75}$) were available to hyrax in both groups (Table 3).

## Discussion

The results of these experiments on hyrax indicate that the higher NDF and ADL and lower energy content of diet 2, increased the intake of dry matter and extended the transit time of digesta. This was associated with an enlarged hindgut (Table 2) to promote efficient digestion and energy availability.

Clemens (1977) and Leon (1980) found high amounts of volatile fatty acids (VFA) in the cardiac stomach and suggested it to be an important digesting chamber. However, Eloff (1981) found that the highest VFA and methane production rates were measured in the sacculation and caeca. During these studies the hindgut played a major role in retaining fibrous foods and constituted 11,2% of the body mass while the stomach made up only 4,2% of the body mass when considering the high fibre diet. These results emphasize that the hyrax is a hindgut fermenter and support the idea of Leon (1980) that the hyrax cannot be a true ruminant-like herbivore.

Cell wall components (NDF, ADL) were considered to be chemically inactive when fed to monogastric animals. However, research in the last decade on animals like beavers, rabbits, pigs, zebras, elephants and oppossums indicates the opposite. The fact that hindgut fermentation is not restricted to animals with large body size indicates that Sibley's theory (1981) does not hold. Hyrax are evidently one of the most efficient fibre digesters among the hindgut fermenters. This peculiar hindgut with the ability to ferment high fibre diets is its primary adaptation to overcome an energy shortage and survive extreme environments.

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