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Studies on Grazing Behavior of Goats in the Cook Islands: The Animal-Plant Complex in Forage Preference/Palatability Phenomena

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ABSTRACT

A study on the grazing behavior of goats in the Cook Islands was undertaken during the dry season period to elucidate goat-plant complex in forage preference/palatability phenomena. Three locations namely, the Seven-day Adventist School goat farm; Paringaru goat farm and Prisons farm were selected for the study. The breeds of goats found in the locations are Sannen and crossbred Anglo-Nubian goats. A total of 110 goats with live-weight of between 18-35 kg were included in the study. There were some variations in the types of plant species available for grazing in the locations. Most dominant grass species were Guinea grass (*Panicum maximum),* Signal grass (*Brachiaria decumbens),* water grass (*Commelina benghalensis),* carpet grass (*Axonopus compressus)* (broad leaf), *A. affinis* (narrow leaf) and wild sorghum. Two creeping legumes *Centrosema pubescens* and *Calopogonium mucuniodes* including browse species such as *Cassia spp., Bothriochloa spp., Leucaena leucocephalla, Morinda citrifolia, Mimosa pudica* and *Borelia spp* were found in the different locations. Foliage of grass species was the dominant component of available forage in the three locations. Goats consumed *Commelina benghalensis* a weed commonly called "water grass" in the Cook Islands in the dry season period. *Commelina benghalensis*, has high moisture and high protein contents. Goats were observed also to eat the bark of *Lantana camara* a poisonous weed *and Morinda citrifolia.* Foliage cover, feeding time and preference index/palatability and selective grazing had effects on the quantity and quality of ingested fractions of available foliage by goats. Except for crude protein, there were no significant differences ($P > 0.05$) in nutrient contents of similar forages among the three locations. *Axonopus affinis*, *Cynodon nlemfuensis* and *Panicum maximum* had low crude protein values (5.7–8.5%). Available macro mineral content of grasses and legume/browse species were comparatively higher than the average requirements for growing goats. The high digestibility of nutrients including the fibre fractions and organic matter were due to preference/palatability that influenced the goats to be selective and browse. In conclusion, this study demonstrate that goats like other small ruminants select their diets within the evolutionary processes of plant–herbivore interactions, and available forage in the Cook Island is able to provide nutrients for the goats to meet growth requirements and other physiological functions.

Key Words: Goat-plant complex; Preference/palatability; Grazing; Nutrients; Foliage cover; Cook Islands

INTRODUCTION

In the livestock census of 1988 there were approximately 5500 goats with an average herd of 7 goats per household in the Cook Islands; however, goats numbers dropped to 3,679 in 2000 (Tamarua, 2001). Goat meat is widely accepted in the Cook Islands, as an alternative to beef, therefore the Ministry of Agriculture in the Cook Islands places much emphasis on improving the available goat number through cross-breeding with Anglo-Nubian crosses from Fiji (Tamarua, 2001), and also on improve feeding and health management (Aregheore, 2001).

Food and Agriculture Organization (FAO) Tele-food program in 1999/2000 gave technical assistance to the Government of Cook Islands to develop and improve the goat industry. Since then interest in the raising of goats has increased due to changes in management systems being adopted by smallholder farmers and the supply of off-spring for breeding purposes by the Ministry of Agriculture to farmers in Rarotonga and the outer Islands. The major grazing systems used by majority of the subsistence and small-holder farmers are continuous, strip and tethering of goats under coconut trees.

Quantitative information on the physiology and nutrition of goats that forage freely on open paddocks/rangeland is lacking in the Pacific Island countries. Goats, unlike other ruminant animals are selective and have aversion for browsing (Aregheore, 1998). Besides they are also highly adaptable to changing environment and feeding conditions (Distel & Provenza, 1991; Lechner-Doll

et al., 1991). Among farm animals the goat is well known for utilizing wide spectrum of native forage plants including foliage from trees and shrubs. At pasture, goats are free to choose their diet from a variety of different plant species as man has only limited influence on their feeding (Becker & Lohrmann, 1992).

Preference and palatability are major indices that influence the goats' ability to be selective and browse. Preference is a complex phenomenon determined by the animal, the plants and the environment in which the plant or plant-part discrimination occurs, (Real *et al*., 2001). For this reason it is important to identify suitable method of determining preference during grazing and browsing. On the other hand, forage palatability could be defined as an appeal sufficient to hold animals to the grazing of one or more species for days or even weeks on end. It could also be standard of tastiness that will attract animals to particular plants when the scope for selection is comparatively wide (Marten, 1978).

Interest in forage-based livestock production continues to grow in the small Pacific Island countries including the Cook Islands. Smallholder goat farmers with little prior experience in pastoral agriculture need information on pasture management including agronomic, livestock and economic aspects. Farmers in the Cook Islands need timely grazing management information especially during the dry season so as to develop and implement land-use plans and minimize production risk in their goat production operations.

Low nutritive values with associated anti-nutritive factors are probably the most important factors, which could limit forage digestibility and thus intake in ruminants. The dry season (May–October) is the most critical period of the year during, which forage is most limiting in the Cook Islands. Also, the small size of Cook Islands is another indicator of limited forage resources and this could therefore affect grazing patterns of the goat.

The overall development of the goat industry in the Cook Islands through scientific investigation of grazing patterns (preference/palatability) of available feed resources (grass & forage legume species) is therefore imperative because, the extent to which good nutrition and management could improve the production of the goats population in the Cook Islands is not known.

Consequently, there is no forage and grazing management practices in the Cook Islands, therefore the smallholder farmers graze their goats on any available rangeland pasture/forage. An understanding of the composition and quality of goat diets and dietary preferences would facilitate efficient goat production during the dry season, because this would assist to develop suitable nutritional plan. There is no study on the characterization of the diets selected by goats in the Cook Islands or any other Pacific Island countries; therefore, the objective of this study was to investigate the grazing behavior of goats to elucidate goat-plant complex in forage preference/palatability phenomena during the dry season period in the Cook Islands.

MATERIALS AND METHODS

Site of investigation and sample collection. This study was carried out in three locations, namely-The Seven-day Adventist School goat farm; Paringaru goat farm and Prisons farm all in the Island of Rarotonga, Cook Islands. Forage samples were taken from materials observed and usually consumed by goats in the locations. Others were clipped from standing grass and browse species to be either grazed or harvested for feeding in a manner designed to obtain herbage representative as possible of that selected by the goats.

Animals. The goats were sannen and cross-bred Anglo-Nubian goats. A total of 110 goats with live-weight that ranged between 18-35 kg were included in the observation. Goats grazed all day and they were observed for about 4-5 h (8:00–13:00 h) during the study.

Experimental Procedures. Sites were goats are frequently grazed were identified. Vegetation was assessed at different sites in the grazing area. The vegetation composition of the three locations were assessed quantitatively and cover of different plant groups (grasses, browse, herbs & weeds) were defined as percentage of area of ground surface covered or shaded by vertical projection of aerial parts of a plant onto which the plane surface of the ground (Risser, 1984).

Diet composition was estimated by direct observation of goats while feeding (Holechek *et al.*, 1984). Total observation time of 4-5 h was carried out during the period. Since it would not be possible to count the number of goats' bites on individual plants, diet composition was estimated by recording feeding station intervals (FSI) (Schwartz, 1981). Goats were followed for a 10-30 min.

The plants, plant parts and the time spent at each plant by the goat without taking more than three steps were recorded. It was assumed that the time spent at a plant reflects the proportion of that plant in the diet. From these recordings, plant groups and browse species, average feeding time, proportion of individual plants in goat diet, frequency of feeding on plant groups, individual species, feeding time on respective vegetation were calculated.

Preference/palatability factor or index was calculated according to Becker and Lohrmann (1992) as:

$$PF = \frac{\text{Plant consumed}}{\text{Plant available}} \qquad (1)$$

Where plant consumed was taken to be the feeding time on respective vegetation as a percentage of the total feeding time and plant availability as cover of the plant material not exceeding a height of 2 m. Based on preference factor, palatability was recognized and categorize, therefore

a second equation was derived as:

$$PF = \frac{\text{Frequency at which forage species were counted during all FSI}}{\text{Frequency in all examined areas}} \quad (2)$$

Feed intake and digestibility study. Representative herbage samples of what the goats ate in each location were collected and the samples were dried, processed and stored until required for chemical analysis. Voluntary herbage intake of the goats in each location was estimated and intake of goat was determined using the following formula:

$$\text{Forage intake, kg/d} = \frac{\text{Faecal output, kg/d}}{1 - \text{herbage digestibility}}$$

Digestible energy (DE) content of the representative forage sample was calculated from the *in vivo* OM digestibility (OMD) according to Butterworth (1964): DE = 0.1705*OMD+0.637.

Analytical procedures. Leaves of grass and browse species were collected. Leaves of the most common grass and browse species of the same size and appearance were plucked by hand, oven-dried and then ground to pass through 1–mm sieve. DM was determined by drying at constant weight at 70^0C for 24 h in a forced-air oven, ash by incineration at 600^0C for 2 h, protein by the micro-Kjeldahl procedure (N x 6.25) (Procedure ID Number 954.02), and organic matter was determined by standard procedure. All analyses were done in triplicate. Fibre fractions, neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin, cellulose and hemicellulose were determined by the procedures of Van Soest *et al*. (1991). The NDF was assayed with sodium sulfite, without alpha amylase and was expressed with residual ash. The gross energy (MJ/kg) value of forage and legumes, forbes/herbs samples were determined by a bomb calorimeter (Adiabatic bomb, Parr Instrument Co., Moline, IL) using thermo-chemical benzoic acid as standard. Minerals (macro) were determined using an atomic absorption spectrophotometer (GBC 908 AA, Scientific Equipment Pty Ltd, Dandenog, Victoria, Australia) as described by AOAC (1995).

RESULTS AND DISCUSSION

Table I presents data on farm locations, size (area covered) and number of goats in each. The size of the farm and goats found in each are a testimony to the fact that goat farming is mainly for subsistence and to cater for the local market in order to substitute meat import from overseas. Goat meat is a delicacy among the Cook Islanders (Tinuaru, 2001). Therefore, in the Cook Island goat is animal of choice among majority of people. The number of goats per person in the Cook Island is 7 and this is the highest in the Pacific Islands (FAO, 1996). Goats are tethered or reared extensively.

Table I. Farm location/size and number of goats

Farms	Area	No of goats
Seven day Adventist School farm	80 m x 100 m [Continuous grazing (Open area)]	32
Paringaru farm	60 m x 80 m [Strip grazing (Electric fence)]	70
Prisons farm	50 m x 100 m [goats tethered (grazing under coconut trees)]	8

Table II presents forage availability and frequency (%) of plant species in the grazing locations. In the three locations there are variations in the types of plant species available for grazing. Among the grass species Guinea grass (*Panicum maximum)*, Signal grass (*Brachiaria decumbens)*, water grass (*Commelina benghalensis*, carpet grass (*Axonopus compressus* (broad leaf), *A. affinis* (narrow leaf) and wild sorghum are most predominant. Two creeping legumes *Centrosema pubescens* and *Calopogonium mucuniodes* including browse species such as *Cassia spp., Bothriochloa spp., Leucaena leucocephalla, Morinda citrifolia, Mimosa pudica* and *Borelia spp.* were found in the different locations.

Foliage of grass species was the dominant component of the available forage in the three locations. Cook Island has a total land area of 58,452 Km^2 out of which the Southern group of Islands (Rarotonga, Mangaia, Mauke, Atiu, Mitiaro & Aitutaki) has a land area of 212.3 Km^2. High population of goats in the Cook Islands are found in these southern group Islands (Teira, Personal communication 2004) because of the availability of land with grass and legumes that supports grazing all year round.

Table III presents average vegetation cover, feeding time and preference index/palatability of goats on natural pasture in the locations. It was observed that feeding time and preference where influence by species of forage available for grazing. The goats spent more time grazing the grass species because they are the most abundant compared to legumes and others in the locations. This observation supports Lu (1988) who reported that goats have a unique grazing behavior and diet selection and shifting between browsing and grazing is largely dependent on the availability of browse and grass. Goats generally are tolerant to bitter tasting compounds of plants and the characteristic and well developed use of lips and tongue give them a greater ability to harvest forages from shortest grasses and forbes to the thorniest shrubs (Lu, 1988). The goats were observed to graze short grasses such as *Axonopus compressus* and *A. affinis*.

Also goats consumed *Commelina benghalensis* a weed commonly called "water grass" in the Cook Islands especially in the dry season period. *Commelina benghalensis*, has high moisture and protein content. Goats were also observed to eat the barks of *Lantana camara* a poisonous weed *and Morinda citrifolia*. Goats selected diets that were higher in crude protein, cell wall content and

Table II. Frequency (%) of plant species (grasses, browse, herbs and weeds) in the grazing locations Farms/grazing locations

The Seven-day Adventist School goat farm	**%**	**Paringaru goat farm**	**%**	**Prisons farm**	**%**
Grasses		**Grasses**		**Grasses**	
Axonopus compressus (broad leaf)	18.5	*Axonopus affinis* (narrow leaf)	12.8	*Axonopus affinis* (narrow leaf)	20.8
Axonopus affinis (narrow leaf)	12.0	*Brachiaria decumbens*	68.5	*Panicum maximum*	72.4
Panicum maximum	78.9	*Wild Sorghum spp.*	28.6	*Brachiaria decumbens*	1.8
Wild Sorghum spp.	0.45	*Cynodon nlemfuensis*	1.5	*Wild Sorghum spp.*	17.6
Cynodon nlemfuensis	5.8	*Sporobolus pyramidalis*	0.2		
Sporobolus pyramidalis	0.5				
Legumes/shrubs/forbes		**Legumes/shrubs/forbes**		**Legumes/shrubs/forbes**	
Calopogonium mucuniodes	1.8	*Centrosema pubescens*	2.4	*Centrosema pubescens*	4.8
Mimosa pudica	0.8	*Leucaena leucocephalla*	1.8	*Cassia spp.*	1.8
Cassia spp.	0.4	*Morinda citrifolia*	5.6	*Mimosa pudica*	4.6
Bothriochloa spp.	1.3			*Borelia spp*	1.8
Weeds		**Weeds**		**Weeds**	
Commelina benghalensis	20.1	*Mikania micrantha*	2.0	*Commelina benghalensis*	22.9
Mikania micrantha	2.4	*Commelina benghalensis*	20.6	*Mikania micrantha*	2.8
Eleusin indica	2.1			*Eleusine indica*	0.8
Kyllinga polyphylla	0.2			*Lantana camara*	0.5
Lantana camara	0.8				

Table III. Cover, feeding time and preference index for goats on natural pasture during the period

Forages	**Cover**	**Relative Feeding time (% of total)**	**Preference index**	**Palatability***
Grasses fresh	70	60.1	6.8	HP
Legumes fresh	1.5	26.3	4.6	VP
Herbs/forbes fresh	2.8	9.6	2.4	P
Weeds	3.5	4.0	1.0	P

* HP - Highly palatable; *VP - Very palatable; * P - Palatable

lowest in lignin in the three locations. The preference goats have for any grass or browse species may be due to its high nutrient content or other contents such as aromatic compounds and other compounds of medicinal importance (Mecha & Adegbola, 1980; Aregheore, 1998), therefore the consumption of *Commelina benghalensis* and the bark of *Lantana camara* are of nutritional importance.

Furthermore the preference of goats for certain plant species (for example *Commelina benghalensis* and *Lantana camara*) in relation to other available ones may in part be determined genetically, by prior experience or conditioning and by environmental circumstances including the relative availability of various plant from which choice is made (Malechek & Provenza, 1981; Solanki, 1994). Selective feeding on morphological fractions of plants and variety of plants seems to have contributed immensely to the success of goat nutrition in the Cook Islands.

Based on available foliage cover, feeding time and preference index/palatability, selective grazing has an effect on the quantity and quality of ingested fractions of available foliage by goats. Degen *et al.* (2002) reported that when animals are browsing from a particular plant species, the more palatable parts are eaten first and the less palatable later. Consequently, with time, selection and intake will vary as the forage supply decreases. Our observation on the contribution and high proportion of grass species in goat diets in the Cook Island is in agreement with Orta (1981) and Mellado *et al*. (1991).

However, palatability should be distinguished from selection which is a source of variation in determining intake under grazing and/or browsing conditions. Factors that relate to plant's palatability include its chemical make-up, particularly the presence of secondary metabolites such as tannins, volatile oils, alkaloids and glycosides (Malechek & Provenza, 1983; Bryant *et al*., 1991). Palatability both within and among plant species is a characteristic that can vary with seasonal growth, plant development and differentiation; and age and rejuvenation after defoliation (Van Soest, 1994). Finally, chemical composition plays a great role in diet selection of the goat, but, phonological stage of the plant seem to be more responsible for the time spent feeding on each forage species (Van Soest, 1994; Ngwa *et al*., 2000).

Although the proportion of browse and herbs in the diet were low, a mixed diet is obligatory for goats as it not only provides a ration, which is better balanced but also prevents the animal's detoxification mechanism from being confronted with a large dose of one single toxin (Moss, 1991; Bredan & Thomson, 1991; Becker & Lohrmann, 1992; Smith, 1992). Mixtures are more effective than monocultures at providing the energy: protein ratio required for optimum livestock performance. Furthermore, mixtures of forage species can increase the duration of forage production and buffer variation in production and utilization by grazing goats.

Table IV presents the proximate chemical composition of plant species (grasses, browse, herbs & weeds) found in the grazing locations. Except for crude protein (CP) content that was significant ($P < 0.05$) there were no significant differences ($P > 0.05$) in other nutrient contents of similar forages found in the three locations. *Cynodon nlemfuensis, Panicum maximum* and *Axonopus affinis* had low crude protein value that ranged from 5.7–8.5%. *Cynodon nlemfuensis* had the lowest CP content of 5.7% a level that

Table IV. Proximate chemical composition of some plant species (grasses, browse, herbs and weeds) in the grazing locations
Nutrients*

Grass species	Locations**	DM	CP	CF	NDF	ADF	ADL	OM	Hemi	Cellu.	GE
Brachiaria decumbens	2	31.4	10.8c	30.8	61.5	43.9	22.7	89.9	17.6	21.2	15.4
Axonopus compressus	1	41.6	12.5c	34.0	51.9	42.2	26.8	87.4	9.7	15.4	15.4
Axonopus compressus	2	31.5	12.4c	21.9	59.9	44.5	24.8	90.8	15.4	19.7	15.6
Axonopus affinis	3	57.8	8.5d	28.9	58.6	47.4	21.8	88.8	10.8	25.6	15.2
Cynodon nlemfuensis	2	27.7	5.7d	25.1	63.9	46.9	26.6	91.1	17.0	20.3	15.9
Panicum maximum	1	49.4	7.5d	36.0	63.1	48.2	20.9	89.6	14.9	27.3	15.6
Commelina benghalensis	1	20.2	18.4b	31.6	48.5	35.5	16.2	84.3	13	19.3	14.4
Commelina benghalensis	2	19.0	18.8b	32.7	47.8	35.8	18.2	86.0	12.0	17.6	14.0
Commelina benghalensis	3	19.3	18.6b	31.7	48.6	38.1	19.8	84.8	10.5	18.3	14.8
Legume/Browse species											
Centrosema pubescens	1	35.4	17.3b	30.6	45.2	39.8	27.2	94.3	5.4	12.4	17.8
Mimosa pudica	1	48.0	16.7b	27.3	67.7	51.6	29.1	94.3	16.1	22.5	17.3
Leucaena leucocephalla	2	43.6	28.2a	13.7	56.9	45.5	24.8	93.8	11.4	20.7	18.4

*DM, Dry matter; CP, Crude protein; CF, Crude fibre; NDF, Neutral detergent fibre; ADF, Acid detergent fibre; ADL, Acid detergent lignin; OM, Organic matter; Hemi, Hemicellulose; Cellu, Cellulose; Gross energy (MJ/kg, DM).
**1 = The Seven-day Adventist School goat farm; 2 = Paringaru goat farm; 3 = Prisons farm.
a,b,c,d ($P<0.05$).

would not allow for moderate weight gains. The CP contents of *Panicum maximum*, and *Axonopus affinis*, however were not below the 7% at which intake could decline and subsequently moderate gain (Norton, 1998).

Other grass, legume/browse species and weed were high in crude protein with a range of 10.8–28.2%. Crude protein value of 11–12% is adequate to meet requirements for moderate weight gains in goats (NRC, 1981). Gross energy content of the foliage varied from 14.0 to 18.4 MJ/kg GE DM. The gross energy content of the different foliage is consistent with published estimates for forages fed to ruminants in tropical and sub-tropical countries (Butterworth, 1964).

The mineral content of *Commelina benghalensis* was higher than those of grass and legume/browse species. This attribute in addition to its high moisture contents may be the reasons why goats in the Cook Islands graze it along with available other forages. Overall the macro mineral content of grass and legume/browse species is higher than the average requirement for goats (NRC, 1981; Underwood, 1981; Kessler, 1991; Meschy, 2000). This therefore indicated that the consumption of any of the grasses or browses on a single basis can satisfy the mineral requirements of goats in the Cook Islands for growth, reproduction, lactation and maintenance (Table V). Van Soest (1965), reported that the nutritive value of forage can be determined by their chemical composition, therefore based on the nutrient contents of the foliage from the three locations it could be adduced that they contain adequate nutrients to meet the requirements of goats for growth and other physiological functions during the dry season in the Cook Islands.

Dietary levels of crude protein approached or exceeded the requirements for goats in all the farms (Table VI). The recommended maintenance requirements for CP of dry pregnant goats, (30 kg) are 10.9% (NRC, 1981) and based on crude protein values of representative samples of

Table V. Mineral concentration of some grasses and legumes (g/kg DM)

Grass species	Locations*	Ash	Ca	Mg	K	P
Signal grass (*Brachiaria decumbens*)	2	10.1	3.7	2.1	23.5	3.1
Carpet grass (*Axonopus compressus*)	1	12.6	3.1	1.8	35.6	3.0
Carpet grass (*Axonopus compressus*)	2	9.2	2.8	3.1	11.7	2.5
Carpet grass (*Axonopus compressus*)	3	11.2	3.5	2.3	12.1	2.9
Giant star grass (*Cynodon nlemfuensis*)	2	8.9	2.9	0.9	11.6	2.6
Guinea grass (*Panicum maximum*)	1	10.4	-	-	-	-
Water grass (*Commelina benghalensis*)	1	15.7	10.6	3.3	44.0	2.9
Water grass (*Commelina benghalensis*)	2	14.9	11.2	3.0	38.0	2.6
Water grass (*Commelina benghalensis*)	3	15.2	10.8	2.8	42.8	2.8
Legume/Browse species						
Centrosema (*Centrosema pubescens*).	1	5.7	7.1	2.9	21.3	2.4
Mimosa (*Mimosa pudica*).	1	5.7	9.2	2.0	12.4	3.7
Leucaena (*Leucaena leucocephalla*)	2	6.2	17.2	3.9	18.0	4.1
Daily mineral requirements**		-	6.0	2.0	4.2	4.2

*1 = The Seven-day Adventist School goat farm; 2 = Paringaru goat farm; 3 = Prisons farm.
**Recommended average requirements by NRC (1981); Underwood (1981); Kessler (1991) and Meschy, (2000).

hand plucked forage grazed by goats during the dry season, available CP was adequate to meet requirements for growth, pregnancy and lactation. Also, the content of macro-minerals (Ca, Mg, K & P) in the hand plucked representative samples meet requirements of growing, pregnant and lactating goats (NRC, 1981; Underwood, 1981; Kessler, 1991; Meschy, 2000) (Table VI).

Table VII presents estimated herbage intake and apparent nutrient and organic matter digestibilities of hand plucked representative samples of forage grazed in one of the locations (The Seven day Adventist School goat farm). The estimated herbage intake of the grazing goats is not lower than values reported for goats of similar size in confinement (Aregheore, 2002 & 2004). The high

Table VI. Proximate chemical composition and mineral content of hand plucked representative samples of forage grazed
Locations*

Nutrients (%)	1	2	3
Dry matter	48.8	48.6	37.9
Analysis on DM basis			
Crude protein	14.0	15.9	14.3
Crude fibre	27.7	21.4	24.4
Neutral detergent fibre	55.2	55.2	53.0
Acide detergent fibre	40.7	42.4	44.0
Acid detergent lignin	24.9	23.2	25.1
Organic matter	89.4	90.8	89.8
Hemicellulose	14.5	12.8	9.0
Cellulose	15.8	19.2	18.9
Gross energy (MJ/kg, DM)	16.5	16.6	16.0
Ash	10.6	9.2	10.2
Minerals (g/kg)			
Ca (6.0)**	6.2	7.7	6.9
Mg (2.0)**	1.9	2.9	2.4
K (4.2)**	17.9	21.3	20.1
P (4.2)**	3.0	2.4	2.8

*1 = The Seven-day Adventist School goat farm; 2 = Paringaru goat farm; 3 = Prisons farm.
**Recommended average requirements by NRC (1981); Underwood (1981); Kessler (1991) and Meschy, (2000).

digestibility of the nutrients including the fibre fractions and organic matter were due to preference and palatability that influenced the goats to be selective and browse. Palatability of the forage grazed by goats in the three locations had an appeal sufficient to hold them to the grazing of one or more species. Preference and palatability factors might have resulted in higher voluntary feed intake, which resulted in faster outflow of particulate matter because of a reduction in retention time of the particulate matter; and consequently improved digestion rate.

Nutritive value index is a measure of voluntary intake of digestible dry matter (DDM) and it is one of the several indices used to evaluate the quality of pasture (Moore & Undersander, 2002). The high nutritive value index of the hand plucked representative samples of forage grazed by goats demonstrated that variety and quality of forages available for grazing in dry season period were of high quality (NRC, 2001) and the diets selected by the goats had little or no anti-nutritive factors that limit dry matter intake and digestibility. There is evidence that low nutritive value with associated anti-nutritive factors is probably the most important factors, which could limit forage digestibility and thus intake in ruminants (Aregheore, 1998). Throughout the study, goats in the three locations remained healthy.

This study therefore demonstrated that goats like other small ruminants select their diets within the evolutionary processes of plant–herbivore interactions, and available forage in the Cook Island is able to provide nutrients for goats to meet their requirements for growth and other physiological functions. Finally, it could therefore be adduced that standard of tastiness attracted the goats to particular plant species when the scope for selection was comparatively wide as demonstrated in this study.

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Table VII. Herbage intake and apparent nutrient and organic matter digestibility of hand plucked representative samples of forage grazed at The Seven day Adventist School goat farm
Nutrients (%)*

Location	Estimated amount consumed/goat(kg/goat)	DM	CP	CF	NDF	ADF	OM	GE	DE	NVI
The Seven-day Adventist School goat farm	0.61	79.3	73.5	75.0	62.8	61.2	72.7	65.4	12.4	652.8

*DM, Dry matter; CP, Crude protein; CF, Crude fibre; NDF, Neutral detergent fibre; ADF, Acid detergent fibre; ADL, Acid detergent lignin; OM, Organic matter; Gross energy (MJ/kg, DM), DE, Digestible energy; NVI, Nutritive value index (KJ/kg $^{0.75}$/day)

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