Preference Test on Feed and Nutrient Intakes in Male and Female Lesser Mouse Deer (*Tragulus Javanicus*) in Captivity

Darlis, N. Abdullah*, J. B. Liang[1], S. Jalaludin[1] and Y. W. Ho

Institute of Bioscience, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

ABSTRACT : A preference test on feed and nutrient intakes were conducted on four male (1.25±0.08 kg) and four female (1.21±0.15 kg) lesser mouse deer (*Tragulus javanicus*) in captivity. Each animal was kept in individual cages placed in a well-ventilated animal house. The experiment was conducted in two weeks, where the first week was for adaptation to the feeds and the second week for measurements of nutrient intake, nutrient digestibility and nitrogen balance. The feeds offered were kangkong (*Ipomoea aquatica*), long bean (*Vigna sinensis*) and french bean (*Phaseolus vulgaris*) as roughages and proteinaceous feeds; sweet potato (*Ipomoea batatas*) and carrot (*Daucus carota*) as carbohydrate-rich feeds; and commercial rabbit pellet (0.3 cm diameter and 0.5 cm long) as a complete feed. The dry matter (DM) content of each feed in the order mentioned above was 7.1, 6.1, 3.9, 18.5, 6.2 and 87.6%, respectively. Long bean had the highest protein (CP) content (29.7%), while sweet potato had the lowest (6.2%). The CP contents of other feeds were within the range of 14.2 - 25.1%. Among the feeds, carrot had the lowest energy content (3.83 kcal/g) and long bean the highest (4.67 kcal/g). When fresh weight of the feed was considered, the male mouse deer consumed sweet potato the most (86.3±12.90 g/d), but the female had a high preference for carrot (79.2±9.76 g/d). The other feeds were consumed in lesser amounts. However, in terms of DM of the feed, the amount of commercial pellet consumed was the highest for both male (45.0±5.10%) and female (44.7±7.38%) mouse deer, followed by sweet potato (33.1±4.43% and 22.4±7.73% for male and female, respectively). Significant ($p<0.05$) differences in DM, organic matter (OM) and gross energy (GE) intakes were observed between male and female mouse deer. The male consumed higher amount of DM, OM and GE than the female. The total DM intake was 40.7±2.24 g/d/kg $W^{0.75}$ for male and 35.9±1.72 g/d/kg $W^{0.75}$ for female mouse deer. Percentage digestibilities of DM, OM, CP and GE were within 72.7~80.8% and were not significantly different between male and female mouse deer. However, male mouse deer had significantly ($p<0.05$) higher digestible DM, OM and GE intakes than the female. Both male and female mouse deer were in positive nitrogen balance (0.6 g N/d/kg $W^{0.75}$). The male mouse deer gained 7.6±3.45 g/d, while the female gained 4.3±2.40 g/d. (*Asian-Aus. J. Anim. Sci. 1999. Vol. 12, No. 8 : 1292-1297*)

Key Words : Lesser Mouse Deer, Feed Preference, Nutrients Intake

INTRODUCTION

The lesser mouse deer (*Trangulus javanicus*) is the world's smallest ruminant and is widely distributed throughout the primary and secondary forests of Southeast Asia. It is considered to be one of the most primitive ungulates still in existence (Medway, 1983). Studies on the muzzle and dental morphology of the lesser mouse deer indicate that it is a concentrate selector or selective browser, selecting nutrient rich and easily digestible plant materials with a high proportion of plant cell contents (Hoffman, 1991; Sharma et al., 1996). The gross morphology of the stomach also seems to suggest that the lesser mouse deer is a concentrate selector (Agungpriyono et al., 1992). In captivity, the lesser mouse deer has been observed to have very selective feeding habits, eating only certain types of plant or particular parts of the plant (Kudo et al., 1995). The mouse deer has a preference for succulent feeds like kangkong (*Ipomoea aquatica*) and sweet potato (*Ipomoea batatas*). Fibrous feed such as guinea grass (*Panicum maximum*) is not eaten (Kudo et al., 1995).

At present, there is little information on the feed preferences of the lesser mouse deer. Hence, the objectives of this study were to observe the feed preference as well as the nutrient intakes of the male and female lesser mouse deer in captivity.

MATERIALS AND METHODS

Animals

Eight mouse deer, consisting of four males and four females, with an average liveweight of 1.25±0.08 and 1.21±0.15 kg for male and female, respectively, were used. Before the experiment, all the animals were raised under similar conditions and therefore had similar experiences of different feeds. The animals were kept individually in stainless steel cages measuring 46 cm high, 116 cm long and 60 cm wide. During cleaning, feeding or faecal sampling times, the animal was moved into a side cage (half the size of

* Address reprint request to N. Abdullah. Department of Biochemistry and Microbiology, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia. Tel: +60-3-9486101 (ext. 3649), Fax: +60-3-9430913, E-mail: norhani@fsas.upm.edu.my.

[1] Department of Animal Science, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

Received January 18, 1999; Accepted March 22, 1999

the main cage). A movable divider separates the two compartments. The floor of the main cage was made of a fine wire mesh. A tray was placed under the mesh for urine collection. Urine was directly drained into a collecting vessel through a small opening at one corner of the tray. The cages were placed in a well-ventilated but unlit room. Each cage was fitted with canisters for pellets and water.

Feeds and experimental procedures

Six feeds were offered throughout the experimental period. The feeds were kangkong (*Ipomoea aquatica*), long bean (*Vigna sinensis*) and french bean (*Phaseolus vulgaris*) as roughages and proteinaceous feeds; carrot (*Daucus carota*) and sweet potato (*Ipomoea batatas*) as carbohydrate-rich feeds; and commercial rabbit pellet (0.3 cm diameter and 0.5 cm long) as a complete feed. Kangkong (leaves and stem), long bean and french bean were cut to 2 cm long, while unpeeled sweet potato and carrot were chopped into cubes (2 cm^3) before they were offered to the mouse deer. Each type of feed was placed separately in porcelain bowls (12 cm diameter×7 cm high) which were arranged along the sides of the cage at a distance of 20 cm from one another. Each day, the feeds were placed in a different order to ensure that the animals did not make a bias choice of feed due to the fixed position of the feed. The animals were fed once daily between 08:00-09:00 h *ad libitum* (120 % above the previous day *ad libitum* intake). The dry matter (DM), organic matter (OM) and crude protein (CP) contents of each feed were determined on dried and ground (2 mm) samples by standard procedures (AOAC, 1984); neutral detergent fibre (NDF) and acid detergent fibre (ADF) by the method of Van Goering and Van Soest (1970) and gross energy (GE) by the Bomb Calorimeter (PAR adiabatic company).

The animals were weighed at the beginning and end of the experimental period. The experimental period was two weeks. The first week was for adaptation to the feeds. During the second week, feed offered and refused, faecal and urine outputs were collected daily. The daily faecal and urine samples were stored at -20℃. All feed and refusal samples as well as faecal and urine samples were composited at the end of the experiment for analyses. The feed and faeces were dried at 65℃ in a forced-air oven for 48 h, then ground through a 2 mm screen.

Dried feed and faecal samples were analysed for DM, CP, OM and GE, while urine was analysed for total N.

Statistical analysis

The proportion of various feeds selected by the mouse deer was analysed by two way analysis of variance and the effects of sex on feed intake, digestibility, digestible nutrient intake and nitrogen balance were analysed by one way analysis of variance and the means tested by t-test using SAS program (SAS, Institute Inc., North Carolina, 1988).

RESULTS

The chemical compositions of the feed materials used are shown in table 1. Commercial rabbit pellet had the highest DM content (87.6%) and fairly high NDF and ADF contents (34.1 and 23.6%, respectively). Long bean had the highest CP content (29.7%), while sweet potato had the lowest (6.2%). In terms of OM content, sweet potato had the highest (96.7%) and kangkong the lowest (80.6%). The gross energy of the feeds were in the range of 3.83～4.67 kcal/g.

The amount of fresh feeds consumed by the mouse deer are shown in table 2. The male mouse deer seemed to have the most preference for sweet potato (86.3±12.90 g/d), followed by carrot (56.4±7.92 g/d), kangkong (51.0±14.74 g/d), french bean (42.1±24.74 g/d), long bean (27.8±11.12 g/d) and commercial pellet (24.9±5.04 g/d). On the other hand, the female mouse deer had the most preference for carrot (79.2±9.76 g/d), followed by long bean (57.3±6.46 g/d), french bean (52.9±21.65 g/d), sweet potato (50.1±18.25 g/d), kangkong (42.5±9.59 g/d) and pellet (21.1±4.02 g/d). Significant ($p<0.05$) differences in feed preferences were observed between male and female mouse deer for long bean, sweet potato and carrot. The male had higher intake of sweet potato than the female, while the female had higher intakes of long

Table 1. Chemical composition of feeds offered

Feed material	Composition (% DM basis)					GE (kcal/g)
	DM[a]	CP	OM	NDF	ADF	
Kangkong	7.1	25.1	80.6	40.5	31.5	4.12
Long bean	6.1	29.7	90.9	33.6	28.2	4.67
French bean	3.9	23.4	86.7	35.1	16.8	4.13
Sweet potato	18.5	6.2	96.7	19.4	5.6	4.19
Carrot	6.2	14.2	89.1	17.8	18.9	3.83
Commercial pellet	87.6	22.5	80.7	34.1	23.6	3.99

[a] Based on fresh weight.

bean and carrot than the male.

Table 2. Fresh feed consumed by lesser mouse deer

Feed material	Intake (g/d/animal)		Male vs. Female
	Male	Female	
Kangkong	51.0 ± 14.74^{b}	42.5 ± 9.59^{b}	NS
Long bean	27.8 ± 11.12^{c}	57.3 ± 6.46^{b}	**
French bean	42.1 ± 24.74^{bc}	52.9 ± 21.65^{b}	NS
Sweet potato	86.3 ± 12.90^{a}	50.1 ± 18.25^{b}	*
Carrot	56.4 ± 7.92^{b}	79.2 ± 9.76^{a}	*
Commercial pellet	24.9 ± 5.04^{c}	21.1 ± 4.02^{c}	NS

[a,b,c] Means within the same column with different superscripts are significantly different ($p<0.05$).

NS: Not significantly different.

* Significantly different at 5% level ($p<0.05$).

** Significantly different at 1% level ($p<0.01$).

The amount of feeds consumed in terms of DM and their percentage proportions are shown in table 3. The proportions of DM consumed by both male and female mouse deer were highest for commercial pellet ($45.0 \pm 5.10\%$ and $44.7 \pm 7.38\%$ for male and female, respectively), followed by sweet potato ($33.1 \pm 4.43\%$ and $22.4 \pm 7.73\%$ for male and female, respectively). The percentage proportions of other feeds (kangkong, french bean, long bean and carrot) consumed by both male and female mouse deer were in the range of 3.4～11.9%.

The DM intakes of long bean, sweet potato and carrot were significantly ($p<0.05$) different between the male and female mouse deer. As with fresh weight intakes (table 2), DM intake of sweet potato was higher in the male mouse deer, but DM intakes of long bean and carrot were higher in the female. Generally, both male and female mouse deer chose the fresh feed materials first, particularly sweet potato or kangkong, and the commercial pellets were eaten at random later.

The daily feed intake and digestibility, nitrogen balance and body weight gain of the male and female lesser mouse deer are shown in table 4. The total DM, OM and GE intakes of the male mouse deer (40.7 ± 2.24, 35.5 ± 1.79 g/d/kg $W^{0.75}$, and 166.4 ± 9.08 kcal/d/kg $W^{0.75}$, respectively) were significantly ($p<0.05$) higher than those of the female mouse deer (35.9 ± 1.72, 31.1 ± 2.62 g/d/kg $W^{0.75}$, and 146.6 ± 6.64 kcal/d/kg $W^{0.75}$, respectively). However, CP intake (6.8～6.9 g/d/kg $W^{0.75}$), digestibility of DM (72.7～72.8%), OM (80.0～80.4%) and CP (80.6～80.8%) and digestible energy (77.5～78.0%) were not significantly different between male and female mouse deer.

Apparent digestible DM, OM and energy intakes were significantly ($p<0.05$) higher in the male than in the female, but no significant difference was found in apparent digestible CP intake. Both male and female mouse deer showed a positive nitrogen balance during the experimental period (0.6 ± 0.09, 0.6 ± 0.12 g/d/kg $W^{0.75}$ for male and female, respectively). Although the growth rate of the male mouse deer was higher (7.6 ± 3.45 g/d) than the female (4.3 ± 2.40 g/d), the difference was not significant.

Table 3. Dry matter and percentage proportions of feed consumed by lesser mouse deer

Feed material	Dry matter intake (g/d/animal) (% proportions)		Male vs. Female
	Male	Female	
Kangkong	3.6 ± 1.05^{c}	3.0 ± 0.68^{c}	NS
	$(7.6 \pm 2.15)^{c}$	$(7.3 \pm 1.26)^{c}$	(NS)
Long bean	1.7 ± 0.69^{c}	3.6 ± 0.40^{c}	**
	$(3.6 \pm 1.36)^{c}$	$(8.7 \pm 1.40)^{c}$	(**)
French bean	1.6 ± 0.97^{c}	2.1 ± 0.85^{c}	NS
	$(3.4 \pm 1.88)^{c}$	$(5.1 \pm 2.17)^{c}$	(NS)
Sweet potato	15.9 ± 2.38^{b}	9.3 ± 3.37^{b}	*
	$(33.1 \pm 4.43)^{b}$	$(22.4 \pm 7.73)^{b}$	(NS)
Carrot	3.5 ± 0.49^{c}	4.9 ± 0.60^{c}	*
	$(7.3 \pm 1.89)^{c}$	$(11.9 \pm 1.89)^{c}$	(*)
Commercial pellet	21.9 ± 4.41^{a}	18.5 ± 3.52^{a}	NS
	$(45.0 \pm 5.10)^{a}$	$(44.7 \pm 7.38)^{a}$	(NS)

[a,b,c] Means within the same column with different superscripts are significantly different ($p<0.05$).

NS, Not significantly different.

* Significantly different at 5% level ($p<0.05$).

** Significantly different at 1% level ($p<0.01$).

DISCUSSION

The mouse deer used in this study were still growing as their weights (1.21～1.25 kg) have not reached maturity weights (1.3～1.8 kg; Kudo et al., 1997). However, the daily body weight gain was small (4.3～7.6 g) as Dahlan et al. (1995) have reported that growing mouse deer can gained up to 8.8～11.4 g/d. The difference could be due to the animals used. In this experiment, the animals were nearing maturity weights and the growth rates would be lower.

The mouse deer consumed 6.8～6.9 g CP/d/kg $W^{0.75}$ (equivalent to 1.1 g N/d/kg $W^{0.75}$) from the various feeds. This intake was close to the value of 0.9 g N/d/kg $W^{0.75}$ reported by Nolan et al. (1995) for male mouse deer weighing 1.53 kg fed lundai (*Sapium baccatum*) leaves. Nitrogen retention was estimated to be 0.6 g N/d/kg $W^{0.75}$, which was higher than the value (0.14 g N/d/kg $W^{0.75}$) reported by Nolan et al. (1995). This difference in N retention could probably be due to the different feeds used, as well as the different age of the animals. The animals in the

Table 4. Feed intake and digestibility, nitrogen balance and bodyweight gain of male and female lesser mouse deer

Parameter	Male	Female	T-test
DM intake (g/d/kg $W^{0.75}$)	40.7±2.24	35.9±1.72	*
OM intake (g/d/kg $W^{0.75}$)	35.5±1.79	31.1±2.62	*
CP intake (g/d/kg $W^{0.75}$)	6.9±0.62	6.8±0.58	NS
GE intake (kcal/d/kg $W^{0.75}$)	166.4±9.08	146.6±6.64	**
DM digestibility (%)	72.8±4.25	72.7±3.09	NS
OM digestibility (%)	80.4±2.93	80.0±1.87	NS
CP digestibility (%)	80.6±3.44	80.8±1.66	NS
Digestible energy (%)	78.0±2.40	77.5±2.69	NS
Digestible DM intake (g/d/kg $W^{0.75}$)	29.6±1.74	26.2±1.90	*
Digestible OM intake (g/d/kg $W^{0.75}$)	28.5±1.47	24.8±1.54	*
Digestible CP intake (g/d/kg $W^{0.75}$)	5.6±0.37	5.5±0.55	NS
Digestible energy intake (kcal/d/kg $W^{0.75}$)	129.6±5.66	114.2±8.46	*
Nitrogen balance (g/d/kg $W^{0.75}$)	0.6±0.09	0.6±0.12	NS
Bodyweight gain (g/d)	7.6±3.45	4.3±2.40	NS

NS: Not significantly different.
* Significantly different at 5% level ($p<0.05$); ** Significantly different at 1% level ($p<0.01$).

present study were still at the growing stage, whereas those used by Nolan et al. (1995) were close to reaching maximum weight.

The daily DM intake of the male mouse deer (40.7 g/kg $W^{0.75}$) in the present study was similar to those reported by Nolan et al. (1995) for male mouse deer fed lundai leaves (42.4 g/kg $W^{0.75}$) and by Hawa et al. (1993) for male mouse deer fed commercial pellet (41.2 g/kg $W^{0.75}$). The DM intakes, equivalent to 3.9% liveweight in the male and 3.4% liveweight in the female were similar to the values reported by Nolan et al. (1995) and Hawa et al. (1993). However, an earlier study by Nordin (1978) showed a much lower intake (2.2~2.4% liveweight) when the animals (three males and five females) were fed 20 g fresh peanuts (*Arachis hypogaea*) and kangkong *ad libitum*. The low DM content of kangkong (7%) may have resulted in a lower DM intake of the animals.

Daily apparent digestible DM and OM intakes were 29.6±1.74 and 28.5±1.47 g/kg $W^{0.75}$, respectively, for male and 26.2±1.90 and 24.8±1.54 g/kg $W^{0.75}$, respectively, for female mouse deer. The intake values for the female mouse deer were higher than those reported by Nordin (1978) for female mouse deer (calculated as 21.4 and 17.6 g/d/kg $W^{0.75}$) fed 20 g fresh peanuts and kangkong *ad libitum*. Nordin (1978) calculated the digestible energy (DE) intake to be 45.6 kcal g/d/kg $W^{0.75}$ for both male and female mouse deer with animals maintaining nearly constant weights. This value was very much lower than those observed in the present study for both male and female mouse deer (129.6 and 114.2 kcal/d/kg $W^{0.75}$, respectively) and that of Nolan et al. (1995) for male mouse deer (149.8 kcal/d/kg $W^{0.75}$) fed lundai leaves. The results of the present study and those of Nolan et al. (1995) showed that the mouse deer could increase energy intake when fed other diets.

The apparent digestibilities of various nutrients in the feeds (72~80%) were lower than the values reported by Nolan et al. (1995). In their studies, the apparent digestibility values for DM and OM in mouse deer fed lundai leaves were 81 and 84 %, respectively. However, the higher digestibility values could be the result of a longer mean retention time (MRT) as estimates by Hawa et al. (1994) showed that the MRT in mouse deer fed lundai leaves was 48 h, while the MRT in animals fed commercial pellets was 25 h. In the present study, the animals consumed a high proportion of commercial pellet and based on the MRT reported by Hawa et al. (1994), the digestibility values were expected to be lower.

The male mouse deer were found to have higher intakes of digestible DM, OM and GE than the female. This may be related to their physical activity and higher energy requirement. It was observed that the males were more active (walking and standing) than the females. Thus, more energy was required, compared to the females which spent a lot of time lying down. According to Scheeman (1994), energy intake is correlated to energy expenditure, which is primarily determined by physical activity. As a consequence, the male mouse deer tended to eat more, preferring sweet potato and commercial pellet.

The results showed that the male mouse deer had a preference for sweet potato, while the female for carrot (table 2). The other feeds were consumed in moderate amounts and the least amount of feed consumed (in terms of fresh weight, table 2) was commercial pellet which is the driest of the feeds offered. This is not surprising as the mouse deer has

been shown to be a selective browser (Sharma et al., 1996), feeding on more succulent plant materials. The high water contents of these succulent materials (82~96 %) would contribute a major fraction of the water intake of these animals. It was estimated that the daily water intake of the mouse deer (258 ml/d; 182 ml/kg $M^{0.82}$) was at the lower end of the range found for other ruminants in the humid tropics (Nolan et al., 1995; Macfarlane et al., 1974) and only contributed 25 % of the water entering the body-water pool. The greater part (64%) of the water was ingested with the food.

However, in terms of DM of feeds, commercial pellet was consumed the most. It is rather surprising that the animals would select a drier feed material (88% DM) in a substantial quantity (21~25 g/d/animal). Nevertheless, the commercial pellet is a more balanced feed and the mouse deer may have acquired a preference for nutritious foods. Moreover, the small and compact form of the pellets made them easy for the mouse deer to pick up with their narrow, elongated muzzle and small mouth. Also, it has been shown that mouse deer fed a diet solely of commercial pellet consumed up to 3.7% liveweight (Hawa et al., 1993). Hence, the commercial pellet can be considered a favoured food of the mouse deer.

Another interesting finding of the present study was the difference in feed preference between the male and female mouse deer. The female mouse deer preferred carrot to sweet potato but the male preferred sweet potato to carrot. The reason for this is not known, but the study by Kyriazakis et al. (1993) on pigs showed that pigs selected a diet based on their protein and energy requirements. The carrot contained more than twice the amount of protein and half the amount of energy of sweet potato. The higher intake of sweet potato by the male could be related to its higher energy requirement. A significant ($p<0.01$) difference between the male and female mouse deer was also observed in the intake of long bean by the animals. The female consumed more than twice the amount of long bean than the male. The long bean contained the highest amount of CP (29.7%) when compared to the other feeds offered. However, because of the low DM content of both carrot and long bean (6.2 and 6.1%, respectively) and a significantly ($p<0.05$) higher intake of DM in the male, the CP intakes of both male and female mouse deer were not significantly different. These results indicated that when the male and female mouse deer were offered different foods of similar nutritional values or foods of different nutritional values, they were able to choose and regulate the intake of each food for their protein and energy requirements. It has been reported by Provenza et al. (1996) that different foods of similar nutritional values or different foods of different nutritional values or similar foods of different flavours could influence food preference and intake in lambs.

The present study showed that the mouse deer would consume the various feeds offered, but with an order of preference and the order was different between the male and female. Although the mouse deer consumed a high amount of fresh succulent feeds (sweet potato, carrot, kangkong, long bean and french bean), they also consumed a substantial amount of the commercial pellet offered.

ACKNOWLEDGEMENTS

The funds provided by the Ministry of Science, Technology and the Environment of Malaysia under the Intensification of Research Priority Areas (IRPA) Program (Project Code 01-02-04-079) are acknowledged.

REFERENCES

Agungpriyono, S., Y. Yamamoto, N. Kitamura, J. Yamada, K. Sigit and T. Yamashita. 1992. Morphological study on the stomach of the lesser mouse deer (*Tragulus javanicus*) with special reference to the internal surface. J. Vet. Med. Sci. 54:1063-1069.

AOAC. 1984. Official Method of Analysis. Association of Official Analytical Chemists, Washington, DC.

Dahlan, I., S. Jalaludin and H. Kudo. 1995. Growth performance and feed intake of lesser mouse deer (*Tragulus javanicus*) in captivity. Proceedings of the 7th Veterinary Association Malaysia Congress. pp. 139-140.

Goering, H. K. and P. J. Van Soest. 1970. Forage Fibre Analyses. U.S.D.A. Agric. Handb. No. 379.

Hawa, I., M. K. Vidyadaran, J. B. Liang, J. J. Roch and H. Kudo. 1993. Digestible energy and protein intake of the lesser Malaysian mousedeer (*Tragulus javanicus*) fed lundai (*Sapium baccatum*) and a commercial pellet. Proceedings of the 5th Veterinary Association Malaysia Congress. pp. 87-88.

Hawa, I., M. K. Vidyadaran, J. B. Liang and J. J. Roch. 1994. The rate of passage of food particles estimated using chromium mordanted fibre in the lesser Malaysian mousedeer (*Tragulus javanicus*). Proceedings of the 3rd Symposium of Applied Biology. pp. 10-11.

Hofmann, R. R. 1991. Endangered tropical herbivores - their nutritional requirements and habitat demands. In: Ho, Y. W., Wong, H. K., Abdullah, N. and Tajuddin, Z. A. (Ed.), Recent Advances on the Nutrition of Herbivores. Proceedings of the Third International Symposium on the Nutrition of Herbivores. pp. 27-34.

Kudo, H., N. Abdullah, Y. W. Ho, S. Jalaludin, I. Hawa and K. Fukuta. 1995. Behavior and reproduction of captive lesser mouse deer (*Tragulus javanicus*). Malays. J. Anim. Sci. 1:24-28.

Kudo, H., K. Fukuta, S. Imai, I. Dahlan, N. Abdullah, Y. W. Ho and S. Jalaludin. 1997. Establishment of lesser mouse deer (*Tragulus javanicus*) colony for use as a new laboratory animal and/or companion animal. Journal of Japan International Research Centre for Agricultural Sciences (JIRCAS). 4:79-88.

Kyriazakis, I., G. C. Emmans and A. J. Taylor. 1993. A note on the diets selected by boars given a choice between two foods of different protein concentrations from 44 to 103 kg. Anim. Prod. 56:151-154.

Macfarlane, W. V., B. Howard and B. F. Good. 1974. Tracers in field measurements of water, milk and thyroxine metabolism in tropical ruminants. In: Tracer Techniques in Tropical Animal Production. International Atomic Energy Agency, Vienna. pp. 1-23

Medway, L. 1983. The Wild Mammals of Malaya and Singapore (2nd Ed.). Oxford University Press, Kuala Lumpur.

Nolan, J. V., J. B. Liang, N. Abdullah, H. Kudo, H. Ismail, Y. W. Ho and S. Jalaludin. 1995. Food intake, nutrient utilization and water turnover in lesser mouse-deer (*Tragulus javanicus*) given lundai (*Sapium baccatum*). Comp. Biochem. Physiol. 111A:177-182.

Nordin, M. 1978. Voluntary food intake and digestion by the lesser mousedeer. J. Wildl. Manage. 42:185-187.

Provenza, F. D., C. B. Scott, T. S. Phy and J. J. Lynch. 1996. Preference of sheep for foods varying in flavours and nutrients. J. Anim. Sci. 74:2355-2361.

SAS. 1988. SAS/STAT User's Guide (Release 6.03 Ed.) SAS Institute Incorporation. Cary. North Carolina.

Scheeman, B. O. 1994. Carbohydrates: Significance for energy balance and gastrointestinal function. J. Nutr. 124: 1747-1753.

Sharma, S. R. K., M. K. Vidyadaran, S. Sumita and A. Razeem Mazlan. 1996. Morphological adaptations of the muzzle and anterior dentition of the lesser mousedeer, *Tragulus javanicus* (Osbeck), in relation to its dietary preferences. J. Vet. Assoc. Malaysia. 8:57-62.