Seasonal Comparison of Voluntary Intake and Feeding Behaviour in Korean Spotted Deer (*Cervus nippon*)[a]

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ABSTRACT : This experiment was carried out to examine the seasonal changes in feed intake and feeding behavior in Korean spotted deer under farmed condition to obtain basic information for efficient feeding management. The seasonal daily gain was the highest ($p<0.05$) in summer and the lowest ($p<0.05$) in winter. Dry matter intake (DMI) was the highest ($p<0.05$) in spring (2,685 g/day) and the lowest in winter (1,929 g/day). Intake of roughage in the DMI was the greatest in spring and that in winter was significantly lower ($p<0.05$) than in spring. Also DMI, expressed in terms of metabolic body weight ($kgW^{0.75}$), was 85.5 g, 70.6 g, 70.9 g and 65.1 g for spring, summer, autumn and winter, respectively, and thus was the highest in spring and the lowest in winter ($p<0.05$). Deer exhibited similar eating patterns, comparatively short and frequent periods, in all seasons. They showed comparatively intensive patterns of rumination during midnight for autumn and winter and relatively continuous patterns of chewing activity during spring and summer. There were no significant differences in seasonal eating time and ruminating time. However, exercise time was the greatest for winter and the lowest for summer and there was a significant difference ($p<0.05$) between summer and winter. Although not significant, eating time per 100 gDM ingested tended to be short in spring and summer and long in autumn and winter. Ruminating time per 100 gDM ingested was the shortest ($p<0.05$) in spring compared with in other seasons. The conclusion can be drawn that since deer have seasonal differences in feed intake and feeding habits, it is necessary to establish and develop an efficient feeding system for deer. (***Asian-Aus. J. Anim. Sci. 2000. Vol. 13, No. 10 : 1394-1398***)

Key Words : Deer, Daily Gain, Dry Matter Intake, Seasonal Change, Eating, Ruminating

INTRODUCTION

Deer farming has expanded rapidly in Korea and the number of deer has increased considerably to about 220,000 head. However, deer farming in Korea has several difficulties regarding the improvement of productivity due to little information about efficient feeding management. Basic and systematized research on deer nutrition is urgently needed.

Seasonal changes of body weight, food intake and digestibility in deer are well-known from previous research (French et al., 1956; Suttie and Corson, 1993; Odashima et al., 1993). These were also observed when deer were kept under farm conditions or fed indoors on high quality diets *ad libitum* (Blaxter et al., 1974; Hudson, 1998). Especially, deer that inhabit a temperate zone have a seasonal variation in growth in that maximum accretion of body tissue occurs in spring and summer, body weight may be lost during autumn, and little or no weight gain takes place over winter, particularly in male deer (Suttie and Corson, 1993). This was mainly due to minimum growth over winter and virtual no intake over the rut in male deer, so they did not require very much feed nor did they require high quality feed over the autumn-winter period (Fennessy, 1995). Adam (1996) reported that voluntary intake of red deer shows a marked seasonal variation, being high in the summer and low in the winter. This seasonal change in feed intake is thought to be associated with a seasonality in basal metabolic rate (Blaxter and Boyne, 1982; Silver et al., 1969). Other researchers reported the conflicting result that metabolic rate in red deer has not shown consistent seasonal variations (Adam, 1996). Therefore, it is important to consider seasonal cycles in the nutrition of deer.

Seasonal variations of food intake and body weight have been investigated in farmed or wild white-tailed deer, red deer and wapiti but not in spotted deer (*Cervus nippon*). This experiment was conducted to examine seasonal changes in feed intake and feeding behavior in Korean spotted deer under farm conditions to provide basic information for efficient feeding management.

MATERIALS AND METHODS

This experiment was carried out at the HANA deer research institute, Chungju, from August 10, 1997 to May 31, 1998 targeting four males exposed to the same management conditions during a long period. Four male spotted deer (*Cervus nippon*) four years

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old, weighing 96.5 kg at the beginning of the experiment, were individually housed in a single building in pens with a floor area of 4×8 m. Seasonal feed intakes and behavioral investigations were conducted at 3 month intervals: August (Summer, Avg. 25.1℃), November (Autumn, Avg. 7.1℃) in 1997, February (Winter, Avg. 2.1℃) and May (Spring, Avg. 18.0℃) in 1998, with 10 days preliminary and 7 days collection period. After each observation ended, all deer were allowed back into the ordinary feeding system (concentrate, oak browse, green chop). Throughout the experiment, a diet of concentrate (CP 19%), oak browse (CP 7%) and commercial mixed roughage (CP 15%), the composition of which is given in table 1, was available *ad libitum* to all deer and a diet was prepared with 17% of crude protein. The experimental diet was offered to each deer at approximately 4% of body weight on a dry matter basis. The feed offered and refused was weighed twice a day at 0900 and 1800 h. To assess possible individual differences and for comparative purposes, voluntary intake of deer was estimated in relation to metabolic body weight as g dry matter intake/day per $kg^{0.75}$.

Behavior was continuously recorded during 24 hours through a video camera on the 6th day of each collection period.

All deer were weighed pre- and post-experiment in each investigation. The accuracy of the scales used for these measurements was ±0.1 kg.

Chemical analysis was made by common methods (AOAC, 1980) for air-dried samples of feed. Data were expressed as means and were statistically analyzed with Duncan's multiple range test using SAS package (1995).

RESULTS AND DISCUSSION

Seasonal changes in mean daily gains of body weight (DG) are given in table 2. DG was the highest ($p<0.05$) in summer and the lowest ($p<0.05$) in winter. This is a common phenomenon (Holter et al., 1977; Odashima et al., 1993; Adam, 1996) largely attributed to low basal metabolic rate (Blaxter and Boyne, 1982) and low feed intake owing to puberty (Short et al., 1969; Odashima et al., 1993). Metabolic rate and feed intake, body weight in deer have a great seasonality, high in summer and low in winter, thus nutritional management that considers these seasonal changes is very important in deer production (TDF, 1997). Seasonal performance is linked. If deer growth is depressed owing to feed restriction in winter, compensatory growth will occur in the following summer (Suttie et al., 1983; Adam and Moir, 1985).

Seasonal voluntary intake of dry matter (DMI) is given in table 2. DMI was significantly ($p<0.05$) the highest in spring and the lowest in winter. Roughage DMI was the greatest in spring and in winter was significantly lower ($p<0.05$) than in spring. DMI expressed in terms of metabolic body weight ($kgW^{0.75}$) was 85.5 g, 70.6 g, 70.9 g and 65.1 g for spring, summer, autumn, and winter respectively, and there was a similar tendency to DMI.

Table 1. Chemical analysis of experimental diet

Feed	Ingredient (% in DM)*					
	DM	CP	EE	CF	ASH	NFE
Concentrate	87.8	20.7	3.1	11.9	6.9	57.4
CMR**	84.8	15.2	5.2	21.2	7.6	50.8
Oak browse	90.2	9.7	2.7	39.1	9.4	39.1

* DM: dry matter, CP: crude protein, EE: ether extract, ASH: crude ash, NFE: nitrogen free extract.

** CMR: commercial mixed roughage.

Wild deer have a strong seasonality in body weight and feed intake and penned deer have also a similar seasonal variation during the year in much the same way as wild deer (Blaxter et al., 1974; Pollock, 1975; Milne et al., 1978; Kay 1979). Seasonal appetance has been reported in other cervids such as white-tailed deer (Cowan and Long, 1962), reindeer (McEwan and Whitehead, 1970), and moose (Gasaway and Coady, 1974). These seasonal changes in feed intake are probably consequences of an underlying seasonal rhythm in metabolic rate and energy requirement (Silver et al., 1969; Renecker and Hudson, 1986), photoperiod (Brown et al., 1979; Kay, 1979), and a passage rate of feed and a decreasing digestibility in winter season (Sasaki et al., 1987; Kato et al., 1989).

On the other hand, a seasonal DMI per day in Korean spotted deer when expressed on a metabolic body weight basis ($kg^{0.75}$) was similar to Japanese sika deer (Kato et al., 1991) and to other deer such as red deer (Milne et al., 1978) and Pere Davids deer (Loudon et al., 1989). And DMI per $kg^{0.75}$ in spotted deer was higher than those in goat (Moon et al., 1995) and sheep (Milne et al., 1978). Kato et al. (1989) reported that sika deer had a lower digestibility and a shorter mean retention time in the rumen than sheep. Milne et al. (1978) concluded that a shorter

Table 2. Seasonal mean daily gains (DG) of body weight and dry matter (DM) intakes in Korean spotted deer

	Spring	Summer	Autumn	Winter
DG (g)	395^{bc}	$1,560^{a}$	490^{b}	107^{c}
DMI (g/d)	$2,685^{a}$	$2,255^{ab}$	$1,997^{ab}$	$1,929^{b}$
DMI ($g/kgW^{0.75}/d$)	85.5^{a}	70.6^{ab}	70.9^{ab}	65.1^{b}

^{a,b} Values with different superscripts in the same row differ ($p<0.05$).

retention time in rumen for the deer than the sheep was associated with a lower digestibility and a higher feed intake. Thus a higher feed intake for the spotted deer than the goat and sheep was attributed to shorter retention time of feed particles in rumen and lower digestibility, and in this experiment a greater DMI for spring than winter was also due to seasonal differences in digestibility and metabolic rate (Odashima et al., 1993).

Diurnal patterns of seasonal feeding behavior and the seasonal changes in time spent on each behavior are given in figure 1 and table 3. The deer exhibited similar patterns of comparatively short and frequent periods of eating in all seasons. They showed comparatively intensive patterns of rumination around midnight in autumn and winter and relatively continuous patterns of chewing activity during spring and summer. Eating and ruminating times were not significantly different among seasons. However, exercise time was greatest in winter and significantly ($p<0.05$) lower in summer. In spite of differences in DMI between seasons, the lack of differences in eating and ruminating times could be attributed to large bite size and high passage rate in spring and no concentrate feeding owing to puberty and much exercise in autumn and winter. This was associated with seasonality in eating and ruminating per unit DMI. Hofmann (1988) classified three ruminant feeding types by feeding habits and classified deer as concentrate selectors, or intermediate types, selecting plants or plant parts rich in easily digestible and highly nutritious plant cell contents. He concluded that this was mainly due to weak development of the rumen, having a very limited capacity to digest cell wall such as fiber and cellulose. Deer have relatively short and frequent eating and ruminating periods unlike cattle and sheep which are classified as typically grass/roughage eaters, having concentrated eating or ruminating behavior for uniform periods. Previous research (Leaver, 1982; Renecker, 1987; Jeon and Kim, 1992; Jeon et al., 1998) reported that especially eating time in deer was shorter than in other ruminants but ruminating time was only a little

Table 3. Seasonal changes in times spent on behaviours in Korean spotted deer

Behaviour	Time spent (min.)			
	Spring	Summer	Autumn	Winter
Eating	145.0^{a}	134.5^{a}	131.5^{a}	122.5^{a}
Ruminating	432.5^{a}	600.5^{a}	461.5^{a}	413.5^{a}
Resting	486.5^{a}	473.0^{a}	578.0^{a}	436.5^{a}
Exercise	376.0^{ab}	232.0^{b}	269.0^{ab}	467.5^{a}

^{a,b} Values with different superscripts in the same row differ ($p<0.05$).

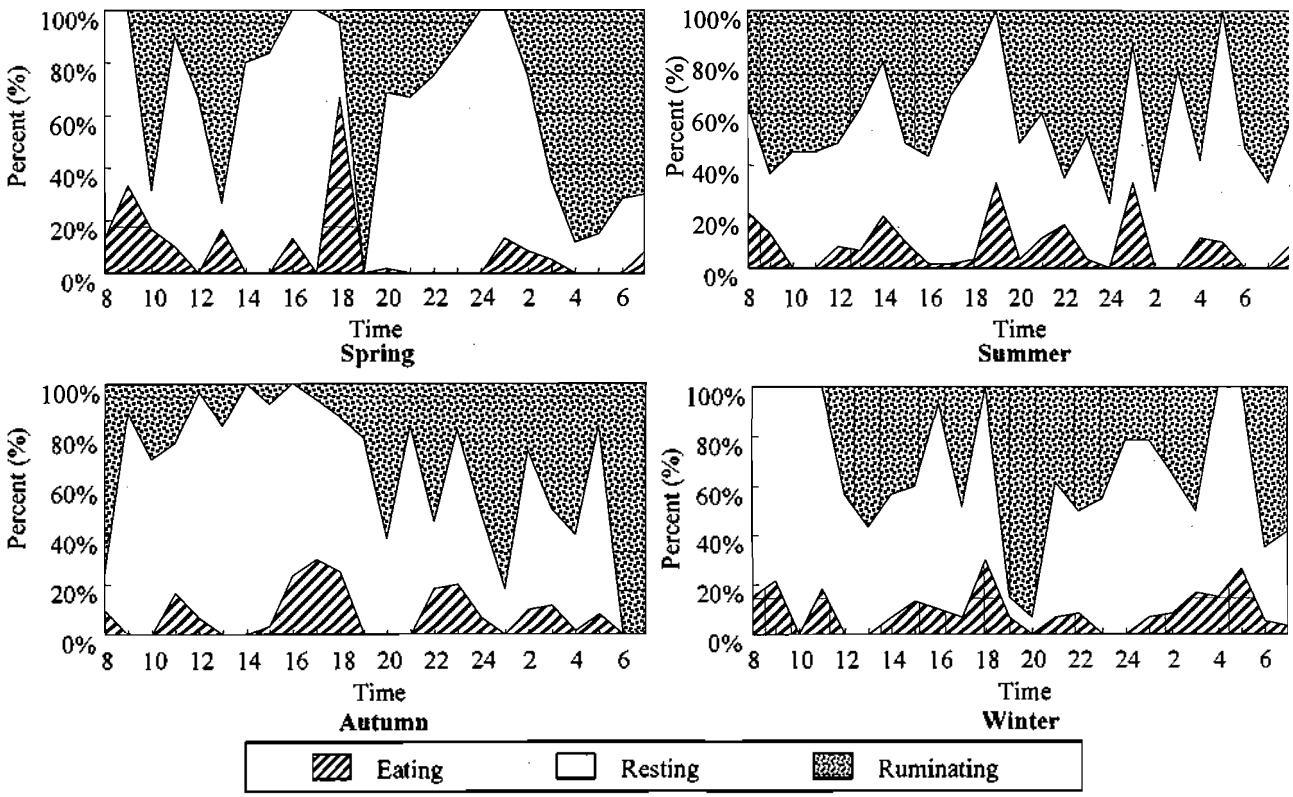
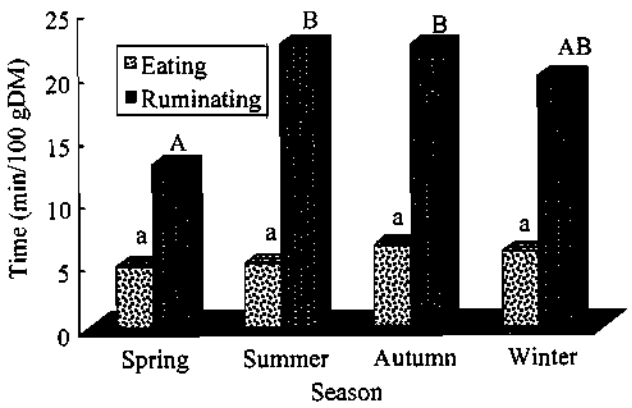


Figure 1. Seasonal feeding behaviour in Korean spotted deer

lower, or similar. It is well known that eating and ruminating time is generally influenced by amount of feed or physical treatment of feed. Although eating and ruminating times reflected seasonal differences in dry matter intake, eating time in the above researches and this experiment, however, was comparatively shorter than those of other ruminants despite differences in amount and physical form of feed. This may mean that deer have a larger bite size or faster feeding rate than other ruminants. Consequently, higher productivity in deer farming might be obtained with free choice feeding management.

The seasonal changes in eating and ruminating time per unit ingested dry matter in Korean spotted deer are given in figure 2. Although there were no significant differences between seasons, eating time per 100 gDM ingested tended to be shorter in spring and summer than in autumn and winter. Ruminating time per 100 gDM ingested was the shortest ($p<0.05$) in spring but remained at a similar level in other seasons. The shorter time spent on eating and ruminating per unit ingested dry matter in spring and summer was mainly due to a comparatively high intake of dry matter although there was little seasonal difference in total time spent on eating and ruminating. It might be assumed that this can be attributed to fast passage rate and short retention time of feed particles in rumen of deer in spring and summer (Kato et al., 1989; Odashima et al., 1993). On the other hand, eating time per unit ingested dry matter in deer was a similar level with that in cattle (Teller et al., 1989) and was shorter than that in sheep (Okamoto, 1974). Ruminating time per unit ingested dry matter in deer was lower than those of other ruminants (Gordon, 1958; Welch and Smith, 1969; Okamoto, 1974). Thus, since deer have seasonal differences in feed intake and different feeding habits to other ruminants, it is necessary to establish and develop an efficient feeding system for deer.



a, b and A, B Means with different superscripts differ ($p<0.05$).

Figure 2. Seasonal changes in eating and ruminating time per 100gDM ingested in Korean spotted deer

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