Digestibility and Number of Bites and Chews on Hay at Fixed Level in Hokkaido Native Horses and Light Half-bred Horses

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Hokkaido native horses (HH) were compared with light half-bred horses (LH) for digestibility and the number of bites and chews when fed non-chopped timothy hay at 90% of the maintenance level in the pen. Apparent digestibility of nutrient and energy in HH were similar to those in LH. The time budget of eating by HH per day was shorter than that by LH ($P < 0.05$, 403.3 vs 557.5 min), while there was no difference between HH and LH in the eating rate. The rate of biting, bite size, chewing rate per a minute and the number of chews per 1 g DM intake in HH were similar to those in LH. Ingestion by HH was indicated to be more efficient than that by LH.

Key words: Hokkaido native horses, digestibility, frequency of chewing and biting, hay

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Hokkaido native horses are one of the landrace of Japanese horses, which have traditionally been kept outdoors on woodland all year round. In Hokkaido forests, bamboo grass occupies over 90% of the undergrowth [2] and their life span is more than 20 months [4]. In woodlands, Hokkaido native horses have been grazing mainly on Miyako Zasa (*Sasa nipponica*), one of the bamboo grasses, through the year, and it seemed that these horses had great ability to digest low quality roughage. Shingu *et al.* [8] showed that the fiber digestibility of *Sasa nipponica* in Hokkaido native horses on woodland pasture tended to be a little higher than that in light half-bred horses, and the time budget of grazing and the daily staying area of HH were a little longer and larger than those of LH, respectively. The results of the above study failed to show whether digestion of such roughage was effective in Hokkaido native horses or Hokkaido native horses grazed on a comparatively higher quality *Sasa nipponica* on woodland pasture. To determine the digestibility of roughage and activity of ingestion such as biting and chewing by Hokkaido native horses, Hokkaido native horses were compared with light half-bred horses for

digestibility and the number of bites and chews in eating timothy hay at a fixed level.

The horses studied were three non-lactating mares of the Hokkaido native horse (HH: body weight 385 ± 15.7 kg) and three non-lactating mares of the light half-bred horse (LH: body weight 536 ± 26.3 kg) that have been kept outdoors all year round from birth on Shizunai Livestock Farm, Field Science Center for Northern Biosphere, Hokkaido University. For the digestion trial, the horses were kept in individual outdoor pens (HH 3.6×3.3 m, LH 3.6×4.0 m) during this experiment. The hay mainly consisted of unchopped timothy and was fed at 9:00 and 16:30 equally at 90% of maintenance level according to the nutrition requirements of the NRC [7]. Water and mineral salt were available *ad libitum*.

After a seven day for adjustment period, total feces was collected for four days to determine digestibility. The hay fed and total feces collected were dried at 60°C for a minimum of 72 hr, then ground and passed through a 1 mm screen and used for determining the chemical composition. Analysis of the dry matter (DM), the crude ash (C.ash), the organic matter (OM), the crude protein (CP) and the ether extracts (EE) were done by the AOAC [1] method. The neutral detergent fiber (NDF) and the acid detergent fiber

Table 1. Chemical composition of the hay fed

Dry matter	(%)	87.3
Crude ash	(%DM)	6.2
Organic matter	(%DM)	93.8
Crude protein	(%DM)	7.5
Ether extract	(%DM)	1.8
Neutral detergent fiber	(%DM)	74.1
Acid detergent fiber	(%DM)	44.4
Gross energy	(Mcal/kgDM)	4.4

Table 2. Dry matter intake and digestibility of the hay in Hokkaido native horses (HH) and light half-bred horses (LH)

		HH	LH
Dry matter intake	(kgDM/d)	5.8 ^B ± 0.2	7.7 ^A ± 0.4
	(%BW/d)	1.5 ± 0.1	1.5 ± 0.1
Digestibility			
Dry matter	(%)	46.7 ± 4.0	47.1 ± 2.5
Organic matter	(%)	47.7 ± 3.9	48.2 ± 2.3
Crude protein	(%)	53.4 ± 2.3	51.3 ± 1.7
Neutral detergent fiber	(%)	44.2 ± 4.6	45.0 ± 2.9
Acid detergent fiber	(%)	41.0 ± 5.4	42.1 ± 3.4
Gross energy	(%)	44.5 ± 4.1	45.6 ± 2.6

Mean ± SD. ^{AB} P<0.01.**Table 3.** Eating behaviour of Hokkaido native horses (HH) and light half-bred horses (LH)

	HH	LH
Time budget for eating (min/d)	403.3 ^b ± 17.4	557.5 ^a ± 46.4
Eating rate (gDM/min)	24.5 ± 2.5	24.8 ± 2.2
Rate of bites (number/min)	4.7 ± 0.2	5.5 ± 0.5
Bite size (gDM/bite)	5.2 ± 0.7	4.6 ± 0.0
Chewing (number/min)	68.1 ± 6.2	64.2 ± 3.7
(number/gDM intake)	2.8 ± 0.0	2.6 ± 0.1

Mean ± SD. ^{ab} P<0.05.

(ADF) were analyzed according the method of Van Soest [10] and the gross energy (GE) was determined with a bomb calorimeter (CA-3 type: Shimadzu, Japan).

For each horse, eating behavior was recorded with a video tape recorder (VTR) for 4 days when feces was collected. On the assumption that eating behavior was maintained for 10 min, the time budget for eating was calculated at 10 min intervals from the frequency of observed eating behavior on the VTR tape. In the 10 min after feeding hay at 9:00 and 16:30, the number of bites and chews were measured with intake in this time period. All data were analyzed by *t*-test.

Table 1 shows the chemical composition of the hay. The CP and NDF content were 7.5% and 74.1%, respectively. The hay was of relatively low quality for general timothy hay.

Table 2 shows DM intake, apparent digestibility of nutrients and energy in the hay. DM intake per body weight in both HH and LH was 1.5% per body weight. The digestibility of DM, OM, CP, NDF, ADF and GE in HH were similar to those in LH. Kawai *et al.* [3] reported that the digestibility of DM, CP, NDF and GE in Hokkaido native horses fed hay *ad libitum* were 48.2, 49.3, 45.6 and 46.1%, respectively. The results of this

study closely agreed with the results obtained by Kawai *et al.* [3]. Reynolds [9] reported that a number of studies on cattle have shown that increasing intake reduced DM digestibility, whereas Martin-Rosset *et al.* [6] reported that digestibility in heavy breed non-lactating mares was not affected by the feeding level. Therefore, the digestibility of hay *ad libitum* in both HH and LH would be similar to those at the maintenance level.

Table 3 shows the eating behavior of HH and LH. The time budget for eating per day in HH was shorter than that in LH (403.3 vs 557.5 minutes, P<0.05), while there was no statistical difference in the eating rates of HH and LH. In spite of the same intake level per body weight both HH and LH, the time budget for eating per day in HH was shorter than that in LH. Therefore HH would be eating more efficiently than LH.

The rate of bites in HH was similar to that in LH. As the result of the eating rate and the rate of bites, the bite size in HH when intake was divided by the number of bites in 10 min was similar to that in LH. Chewing by HH and LH were 68.1 and 64.2 times per minute, respectively, and the total chewing time per a day in HH was estimated to be about 27,500, which was

smaller than about 35,800 in LH. Therefore, the number of chews per 1 gDM intake in HH would be similar to that in LH (2.8 vs 2.6 time/gDM intake, respectively), as the intake per day in LH was larger than that in HH.

The present study indicated no essential difference between HH and LH in digestibility. Shingu *et al.* [8] showed that the fiber digestibility of HH found by a double-indicator method on woodland pasture tended to be higher than that of LH. Koike *et al.* [5] indicated a difference between HH and LH in fecal bacteria flora when HH and LH were kept on woodland pasture. The difference in bacteria flora on woodland could effectively contribute to the digestibility of fiber in HH. These difference in fiber digestion and bacteria flora suggested that HH would graze on *Sasa nipponica* of different quality from LH as a result of selective grazing on woodland pasture, because the digestibility of HH was similar to that of LH when fed hay in the pen.

The time budget for eating per day in HH was shorter than that in LH for the same intake level per body weight of both HH and LH. The results suggest that ingestion by HH would be more efficient than that by LH.

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