A Study on the Dry Matter Yield and Nutritive Values of Wild Korean Lespedeza (*Lespedeza stipulacea* Maxim.)

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ABSTRACT : This study was conducted to evaluate the dry matter (DM) yield, quality and utilization of nutrients in Korean lespedeza (*Lespedeza stipulacea* Maxim.) swards as a roughage source. DM yield in various stages, chemical composition, and DM digestibility were observed, and DM intake, digestibility and utilization of nitrogen and energy by Korean native goat were determined. Experimental diets include three treatments: mixture hay (MH) 100%, MH (80%)+wild Korean lespedeza hay (LH) 20% and MH (60%)+LH (40%). As growth stage advanced, the DM yield of Korean lespedeza tended to increase significantly ($p<0.05$). The mean DM yield of all growing stages was observed as 7,336 kg/ha. Crude protein (CP) content of Korean lespedeza tended to decrease, but fibrous contents tended to increase when the growth stage advanced. The tannin content of Korean lespedeza was the highest at the bud stage (64.7 mg/g). However, it showed a tendency to decrease as the growth stage advanced, and thus it was the lowest at the ripe seed stage (26.8 mg/g) ($p<0.05$). With increasing level of LH, voluntary DM intake by Korean native goats slightly increased, but no differences were observed between diets. The digestibility of DM, cellular constituents and NDF was slightly higher in LH containing diets than that of MH 100% diet ($p<0.05$). There was no significant difference in apparently digested N% among all diets, but retained N% and retained N% of the absorbed were higher in MH (60%)+LH (40%) than those of other diets ($p<0.05$). A difference in the utilization of energy was not detected. In conclusion, Juvenile LH improved the digestibility of nutrients, presumably due to its high CP content and low fibrous compound. Especially, tannin in LH did not affect in DM intake, but increased the nitrogen utilization of Korean native goats. Accordingly, it could be suggested that Korean lespedeza has a potential to be provided as a roughage source for Korean native goats. ***(Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 3 : 396-400)***

Key Words : Korean Lespedeza, Nutritive Value, Nitrogen and Energy Utilization, Korean Native Goat

INTRODUCTION

Korean lespedeza (*Lespedeza stipulacea* Maxim.) was one of the important forage resources which was introduced into USA from Korea in 1919. It was increased at the USDA experimental farm in Arlington, Va., and distributed during 1922-23, and widely cultivated at east-south area of USA (Hoveland and Donnelly, 1985). It grows well on soils in Korea which are infertile, not drained, and acid (pH 5.5-6.2) (Kim and Lee, 1993). It is rather late to start growth in spring but it grows well during the summer compared with perennial grasses (Lee and Kim, 1959; Kim et al., 1968) and so it is of particular value during that season in providing high quality pasture at a time when the quality of perennial grasses is generally low. It has been reported that Korean lespedeza is well accepted by animals, does not cause bloat, and that although its dry matter (DM) production is lower than that of alfalfa or clover forage its feeding value is equal to that of alfalfa (Kim and Lee, 1993). Hence, objectives of this study were planned as follows; (1) to determine the DM yield at the different harvesting stages, (2) to evaluate the chemical composition at different harvesting stages, and (3) to determine the effect of grade level of Korean lespedeza on voluntary intake, digestibility, nitrogen and energy utilization by Korean native goat.

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MATERIALS AND METHODS

Sites

The experimental field was located at Gongju city of Chungnam province in South Korea (36°30′N, 127°11′E). Elevation is 110 m, slope is 2-5% and soil is loamy. Average annual precipitation was 1,912.4 mm in 1998, and it has varied from 1,074 to 1,912 mm during 1994-1998. Precipitation is seasonally distributed: about 70% of precipitation as rain occurs between June to August. Temperature average has varied from 11.4 to 13.2°C, and temperature average from June to August has varied from 22.0°C to 25.0°C during 1994-1998, but daytime maximum frequently exceeds 30°C from July to August.

Feeding trials

For preventing diet selection and to obtain uniform mixtures of feeds, experimental diets were crushed and pressed by a small sized pellet machine (1 cm diameter outlet), and they were fed to Korean native goats. Twelve goats were selected which had nearly the same body weight (average 9.04 kg) and nearly the same date of birth.

During this study, the goats were fed for a 9 day

preliminary period, followed by a 5 day collection period. Throughout these periods, fecal and urinary outputs were measured and samples were collected for analysis. Feed was supplied two times a day at 08:00 and 16:00 in amounts roughly 30% in excess of the maximum predetermined voluntary intake level in the metabolic cage in environmentally controlled stalls. Goats had free access to water and minerals throughout.

After estimating the fecal amount, daily fecal samples were pooled for individual animals, and dried in a forced-draft oven at 40°C. Volatilization of ammonia from urine was prevented by the addition of 20 ml of 25% H_2SO_4 solution daily to the plastic urine receptacles; collected sub-samples were stored at -10°C. The average temperature and humidity of environmental stalls during this experimental period were 20-25°C and 64-73%, respectively.

Nutritive value

Korean lespedeza was collected at each growth stage, dried in a forced-draft oven at 40°C for 48 h and weighed and ground in Wiley Mill (1 mm screen). Korean lespedeza diet for Korean native goat was prepared as hay sun-dried at the vegetative stage. Mixture hay (MH) was prepared as hay sun-dried at the heading stage of an orchardgrass dominant pasture. The diets used in digestion test by Korean native goats include three treatments: mixture hay (MH) 100%, MH (80%)+wild Korean lespedeza hay (LH) 20% and MH (60%)+LH (40%) (table 1). Laboratory analyses were performed in 3 replications. Crude protein was determined by using a macro-Kjeldahl apparatus (AOAC, 1990). Gross energy was measured with a bomb calorimeter. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were done according to Goering and Van Soest (1970). Tannin was analysed according to Folin-Denis (McLeod, 1974). The amount of dry matter intake was determined by subtracting the residue diet from the provided diet.

A completely randomized design was used to detect the statistical significance by using a SAS statistical program. The least significant difference procedure at $p<0.05$ was used to compare means when a significant F-test was observed.

RESULTS AND DISCUSSION

Dry matter yield

Dry matter (DM) yields at each stage are shown in table 2. The DM yield increased from vegetative to ripe seed stage ($p<0.05$). According to Kim et al. (1968), Korean lespedeza shows a late growth pattern in early growth stage, due to its intrinsic nature as a temperate plant. The DM yield (4,229 kg-9,376 kg) obtained from this experiment tended to be high, compared with DM yields (2,730 kg) of Kim et al. (1968) and 2,700 kg/ha at pre-anthesis and 5,925 kg/ha at post-anthesis of Roberts (1966). However, the DM yield was found to be very close to Lee et al. (1971a). Also, comparing to wild birdsfoot trefoil (Shin, 1998), no difference in mean DM yield was found. Futhermore, the DM yield of this experiment was not low compared to that of perennial legume forage shown by RDA (1989, 1992). Especially, since the DM yield in this experiment was obtained under the condition of no fertilizer, we can expect more DM yield when fertilizer is applied.

Chemical composition

Chemical composition at each stage is shown in table 3. The crude protein (CP) content of Korean lespedeza was significantly reduced when the stage advances. The CP content was high at the vegetative stage (15.8%), but it was low at the ripe seed stage (8.7%) ($p<0.05$). The content of NDF, cellulose and lignin was significantly increased as the growth progressed ($p<0.05$). Changes in CP and fibrous compound levels, probably associated with the maturation process, are generally in agreement with other reports (Kim

Table 1. Chemical composition (DM, %) of feed components of experimental diets fed to Korean native goats

Diet	CP	NDF	ADF	Lignin	Gross energy	Tannin
MH 100%	14.4[b]	68.6[a]	34.6[a]	8.7[b]	4.365[c]	19.2[c]
MH 80%+LH 20%	14.9[a]	67.8[b]	34.2[b]	9.1[a]	4.372[b]	30.2[b]
MH 60%+LH 40%	15.1[a]	67.1[c]	34.0[bc]	9.2[a]	4.457[a]	43.9[a]

[a,b,c] Means in the same column with different letters were significantly different ($p<0.05$).
MH; Mixture hay, LH; Wild Korean lespedeza hay.
LH; CP 15.8%, NDF 66.0%, ADF 33.5%, Lignin 9.3%, Gross energy 4,596 Mcal/kg, Tannin 54.5 mg/g.

Table 2. Dry matter (DM) yields of wild Korean lespedeza (*Lespedeza stipulacea* Maxim.) at different harvesting stages in 1998

	DM (kg/ha)				
	Vegetative	Bud	Bloom	Ripe seed	Mean
Wild Korean lespedeza	4,229[d]	7,063[c]	8,675[b]	9,376[a]	7,336

[a,b,c] Means in the same row with different letters were significantly different ($p<0.05$).

Table 3. Chemical composition (DM, %) of wild Korean lespedeza at different growing stages in 1998

Harvesting	CP	NDF	ADF	Hemicellulose	Cellulose	Lignin	Gross	Tannin
Vegetative	15.8[a]	66.0[c]	33.5[d]	32.5[a]	25.3[d]	9.3[d]	4.596[b]	54.5[b]
Bud	14.3[b]	66.3[c]	35.3[c]	31.0[b]	26.2[c]	11.4[c]	4.619[b]	64.7[a]
Bloom	11.7[c]	70.8[b]	42.4[b]	28.4[c]	30.2[b]	14.4[b]	4.615[b]	46.6[c]
Ripe seed	8.7[d]	73.7[a]	50.3[a]	23.4[d]	33.5[a]	15.7[a]	4.761[a]	26.8[d]

CP; Crude protein, NDF; Neutral detergent fiber, ADF; Acid detergent fiber.
[a,b,c,d] Means in the same column with different letters were significantly different ($p<0.05$).

et al., 1968; Han et al., 1970; Lee et al., 1971b; Han et al., 1971a,b,c). Gross energy levels also increased as growth progressed. However, tannin contents were higher at the bud stage than that at the ripe seed stage. Changes in tannin compounds, probably associated with maturation process, are generally in accordance with findings reported by Kim and Lee (1994).

DM intake and digestibility

Dry matter (DM) intake and digestibility by Korean native goats are shown in table 4. No difference in DM intake by goats among diets was detected. DM digestibility of Korean lespedeza containing diets was higher than that of MH 100% (control) ($p<0.05$), but there was no significant difference between LH 20% diet and LH 40% diet. The tendency, as shown in table 1, indicates that because CP content of LH was higher than that of MH, but fibrous compound was lower than that of MH, the DM digestibility increased with the increasing LH levels. The digestibility of cellular constituents and NDF appeared to increase with increased levels of LH and so there was significant difference between LH 40% and MH 100% diets ($p<0.05$). The digestibility of ADF tended to increase with increased levels of LH, but there was no significant difference among diets. This result suggested that the LH in diet, which was higher in the CP content and lower in the fibrous compounds compared with MH, tended to increase voluntary intake and digestibility by goats. Lee et al. (1987, 1998) also reported that providing legume forage, compared with grass forage which has a high CP and digestibility, improves DM intake and digestibility. Since our result indicates that providing LH as a legume source improves DM intake and digestibility it could be proposed that LH has enough value as a potential roughage source.

Nitrogen utilization

Nitrogen utilization by Korean native goats is shown in table 5. Consumed dietary N by goats tended to be higher in the LH containing diets than that of MH. There was a significant difference between LH 40% diet and MH 100% diet ($p<0.05$). Fecal N generally increased with higher level of LH in diets ($p<0.05$), while urinary N decreased. This result indicates that tannin compounds in LH can consolidate the dietary proteins forming complexes which are resistant to ruminal degradation. Thus, they lead to the phenomenon of "protected protein", which probably contributed to the increase in fecal N excretion (Nastis and Malecheck, 1981; Lee et al., 1996). On the other hand,

Table 4. Dry matter (DM) intake and digestibility (%) of the chemical components in the experimental diets consumed by Korean native goats

Diet	Intake (DM, g/BW kg/day)	Digestibility			
		DM	Cellular Constituents	NDF	ADF
MH 100%	31.2[a]	69.1[c]	73.0[bc]	62.4[c]	52.5[a]
MH 80%+LH 20%	31.6[a]	69.7[ab]	73.6[b]	63.6[ab]	53.1[a]
MH 60%+LH 40%	31.8[a]	70.4[a]	74.4[a]	64.4[a]	54.8[a]

[a,b,c] Means in the same column with different letters were significantly different ($p<0.05$).
BW: Body weight, MH: Mixture hay, LH: Wild Korean lespedeza hay.

Table 5. Average daily nitrogen balance of experimental diets consumed by Korean native goats

Diet	Consumed	Fecal	Urinary	Apparently digested		Retained		Retained % of the absorbed
	(g)	(g)	(g)	(g)	(%)	(g)	(%)	
MH 100%	7.461[b]	2.648[b]	2.934[a]	4.813[a]	64.5[a]	1.879[b]	25.2[b]	39.0[b]
MH80%+LH20%	8.150[ab]	2.992[ab]	2.916[a]	5.158[a]	63.3[a]	2.242[a]	27.5[b]	43.5[b]
MH60%+LH40%	8.847[a]	3.266[a]	2.663[b]	5.581[a]	63.1[a]	2.918[a]	33.0[a]	52.3[a]

[a,b] Means in the same column with different letters were significantly different ($p<0.05$).
MH: Mixture hay, LH: Wild Korean lespedeza hay.

Table 6. Average daily energy balance of experimental diets consumed by Korean native goats

Diet	Consumed (Mcal)	Fecal (Mcal)	Urinary (Mcal)	Apparently digested		Apparently digested	
				(Mcal)	(%)	(g)	(%)
MH 100%	1.414[b]	0.460[a]	0.021[b]	0.954[a]	67.5[a]	0.933[b]	66.0[a]
MH 80%+LH 20%	1.498[ab]	0.492[a]	0.028[a]	1.006[a]	67.2[a]	0.978[ab]	65.3[a]
MH 60%+LH 40%	1.632[a]	0.519[a]	0.029[a]	1.113[a]	68.2[a]	1.084[a]	66.4[a]

[a,b] Means in the same column with different letters were significantly different ($p<0.05$).
MH: Mixture hay, LH: Wild Korean lespedeza hay.

urinary N excretion decreased due to the high phenolic materials (Dick and Urness, 1991). The percentages of retained N and retained N of the absorbed in LH 40% diet were higher than shown in other diets. This result, as reported by Lee et al. (1998), shows that the diets supplemented with legume forages which contained tannin and high crude protein improved the utilization of nitrogen compared with grass forage diets. In contrast, when legume and oak browse diets with low crude protein and high tannin were fed, probably as a result of tannin+protein, sediment and fiber bound protein, a low level of nitrogen utilization by goats was found (Nastis and Malecheck, 1981). Therefore, in the case that tannin containing diets which contain a low level of protein it is suggested to provide complementary diet with high CP content in order to improve the utilization of nitrogen. In this experiment diets with supplementary LH were effective in improving the nitrogen utilization by goat, and a corresponding trend was reported by Lee et al. (1996, 1998).

Energy utilization

Consumed energy by goats in LH containing diets was higher than that in MH 100% because of a higher DM intake, but there was no significant difference in energy of fecal loss among diets. As shown in table 6, the percentage of apparently digested and apparently digested minus urinary losses energy were not significantly different among diets, because LH was probably not effective in energy utilization improvement, though it was effective in nitrogen utilization improvement. In this trial, all diets supplied amounts of digestible and metabolizable energy, ranging from slightly to greatly in excess of recommended allowances for maintenance and gain of goats.

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