

Chemical composition, *in situ* degradability and *in vitro* digestibility of several shrubs from sandy soils

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ABSTRACT

Chemical compositions, *in situ* degradability and *in vitro* digestibility at the post-fruiting period of five sand-banding shrubs, which include *Caragana intermedia*, *Caragana korshinskii*, *Hedysarum scoparium*, *Hedysarum laeve* and *Salix psammophylla* were determined. According to nutritive value, the five shrubs can be used as feedstuffs. Among them, *C. intermedia* is the first choice as feedstuff for realizing the sustainability of ley farming and improving the production of livestock.

KEY WORDS: shrubs, sandy soils, chemical composition, *in situ* degradability, *in vitro* digestibility

INTRODUCTION

With the advance of sand fixation, large areas of sandy grassland mainly with shrubs have been established in Mu Us sandy land. On the premise of improving ecological environments (Stockton and Gillette, 1990), sand-banding shrubs which have high biomass and certain nutritive value have also been widely used as feedstuffs (Wang et al., 1999) and play an important role in the nutrition of grazing animals during withered season and droughty year. Developing and using these species of shrubs will solve the imbalance of the animals and grasses quantity. The ultimate aim is effective utilization of sandy land resources to acquire optimum ecological and economic benefits.

Some reports have indicated that sand-banding shrubs are feedstuffs with high quality by mensurating their biomass and chemical composition (Sun,

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1995). Several researchers have investigated the dynamics of nutrient contents of sand-banding shrubs (Kang et al., 2001). There were few reports concerning degradability and digestibility of the sand-banding shrubs. For comparison, samples of *Medicago sativa* and maize stalk which present high and low quality of local forages were subjected to the same range of analyses as the five species of shrubs at the post-fruiting period.

The objective of this paper is to evaluate the nutritive value in terms of chemical composition, *in situ* degradability and *in vitro* digestibility of several shrubs in Mu Us sandy land and provide sound basis for feasible utilization of shrubs from sandy soils.

MATERIAL AND METHODS

Sample collection and preparation

Five species of shrubs which are abundant and widespread in Mu Us sandy land were selected. These were *Caragana intermedia*, *C. korshinskii*, *Hedysarum scoparium*, *H. laeve* and *Salix psammophylla*. Shoots of less than 3 mm diameter with leaves of 15 fixed plants for each species of the five shrubs were harvested by hand at the post-fruiting period. The samples were dried in an oven at 60°C to constant weight and ground to pass through 1-mm screen prior to laboratory analysis.

Chemical analyses

Kjeldahl nitrogen (N) was analysed according to standard procedures (AOAC, 1990), neutral-detergent fibre (NDF), acid-detergent fibre (ADF) and lignin were determined by the methods of Goering and Van Soest (1970).

Estimates of in situ degradability and in vitro digestibility

In situ dry matter (DM) and organic matter (OM) degradability (DMD, OMD) of all plants were determined by the nylon bag technique using eight fistulated Tan sheep. The sheep were fed with lucerne hay and concentrate supplement on DM basis at 1.2 maintenance level. The initial solubilization of substrates was accounted for by using zero time measurement. The nylon bags were of the type described by Ørskov et al. (1980). Duplicate samples of each plant were incubated for 6, 12, 24, 36, 48, 72 and 96 h. The bags were put in at the same time and were taken out at different hours. The model of DM or OM disappearance prepared by Ørskov and McDonald (1979) was fitted to summarize the data and derive the degradation parameters:

$$P = a + b(1 - e^{-ct})$$

where: P is the degradability at time t ; a is intercept indicating the more soluble fraction; b is potentially degradable fraction; c is rate of degradation. The asymptote ($a+b$) represents the total potential degradability.

In vitro DM and OM digestibility (IVDMD, IVOMD) were determined by the two-stage technique of Tilley and Terry (1963) using rumen fluid of Tan sheep.

Statistical analyses

The mean and standard error values for each parameter were analysed by ANOVA obtained using SPSS 12.0 software to determine the statistical differences among different plants.

RESULTS AND DISCUSSION

Chemical compositions of the five shrubs are presented in Table 1. *C. intermedia* had the greatest level of CP, followed by *C. korshinskii*, *H. laeve*, *H. scoparium* and *S. psammophylla*. This agreed with the earlier findings of Wang et al. (1999). CP concentrations of all the shrubs were significantly lower than that of *M. sativa* and higher than that of maize stalk ($P < 0.05$). The NDF, ADF and lignin concentrations of *H. laeve* and *C. intermedia* were low, and those of *C. korshinskii* and *S. psammophylla* were higher ($P < 0.05$) than in other shrubs. Overall, the NDF and ADF contents of all shrub species were higher than those of *M. sativa* and lower than those of maize stalk ($P < 0.05$). The lignin concentrations of all the shrubs were significantly higher than those of *M. sativa* and maize stalk ($P < 0.05$) except for *H. laeve*.

Table 1. Chemical compositions of the five shrubs and the comparison forages, g kg⁻¹DM

Plant	CP	NDF	ADF	Lignin
<i>Caragana intermedia</i>	187.0 ^b	418.9 ^d	296.1 ^e	87.7 ^c
<i>Caragana korshinskii</i>	132.5 ^c	528.9 ^b	406.0 ^e	111.4 ^b
<i>Hedysarum scoparium</i>	113.0 ^d	481.7 ^c	331.5 ^d	90.4 ^c
<i>Hedysarum laeve</i>	128.8 ^c	417.8 ^d	272.9 ^f	78.2 ^d
<i>Salix psammophylla</i>	71.4 ^e	527.7 ^b	423.4 ^b	165.7 ^a
<i>Medicago sativa</i>	195.9 ^a	324.3 ^e	216.7 ^f	77.2 ^d
Maize stalk	34.5 ^f	809.0 ^a	523.4 ^a	66.9 ^e
SEM	13.1	38.2	24.4	8.2

CP - crude protein; NDF - neutral-detergent fibre, ADF - acid-detergent fibre

^{abc} the values followed by different letters in the same list are significantly different ($P < 0.05$)

Table 2. *In situ* DM and OM degradability of the five shrubs and the comparison forages, % DM

Parameter	<i>Caragana intermedia</i>	<i>Caragana korshinskii</i>	<i>Hedysarum scoparium</i>	<i>Hedysarum laeve</i>	<i>Salix psammophyla</i>	<i>Medicago sativa</i>	Maize stalk	SEM
a	41.66	44.40	43.24	42.08	38.31	50.13	25.76	
b	34.15	21.90	26.09	32.73	30.35	37.96	37.81	
DM	c	0.06	0.03	0.02	0.03	0.03	0.03	
k	0.04	0.03	0.03	0.03	0.03	0.04	0.03	
DMD	62.42 ^a	55.35 ^b	56.07 ^b	55.55 ^b	53.49 ^b	65.57 ^a	37.78 ^c	2.37
a	39.54	42.33	41.40	39.63	37.55	47.29	21.12	
b	35.00	22.41	49.56	35.16	28.95	40.84	45.30	
OM	c	0.06	0.02	0.02	0.03	0.03	0.01	
k	0.04	0.03	0.03	0.03	0.03	0.04	0.03	
OMD	60.82 ^a	53.35 ^b	59.99 ^a	53.70 ^b	52.27 ^b	65.12 ^a	33.27 ^c	2.59

^{a,b,c} the values followed by different letters in the same row are significantly different (P<0.05)

Table 3. *In vitro* DM and OM digestibility of the five shrubs and the comparison forages, % DM

Parameter	<i>Caragana intermedia</i>	<i>Caragana korshinskii</i>	<i>Hedysarum scoparium</i>	<i>Hedysarum laeve</i>	<i>Salix psammophyla</i>	<i>Medicago sativa</i>	Maize stalk	SEM
IVDMD	68.20 ^b	61.41 ^c	60.12 ^d	55.17 ^e	50.27 ^f	75.76 ^a	43.74 ^g	2.72
IVOMD	68.13 ^b	62.16 ^c	60.00 ^d	54.66 ^e	50.47 ^f	75.59 ^a	42.51 ^g	2.67

^{a-g} the values followed by different letters in the same row are significantly different (P<0.05)

DMD and OMD of the five shrubs were ranked as *C. intermedia*, *H. scoparium*, *H. laeve*, *C. korshinskii* and *S. psammophylla* ($P<0.05$) (Table 2). Even for *S. psammophylla*, they were up to 53.49 and 52.47%, respectively, and significantly higher than that of maize stalk ($P<0.05$). IVDMD and IVOMD of all shrub species exceeded 50% (Table 3). Although they were lower than those of *M. sativa*, they were still significantly higher than those of maize stalk ($P<0.05$). The results indicated that the twig and leaves of the shrubs were feasibly digested.

From these results, the five species of shrubs were considered to be nutritionally acceptable feed for grazing livestock. And that *C. intermedia* exhibited higher nutritive value relative to other shrubs.

CONCLUSIONS

According to chemical composition, *in situ* degradability and *in vitro* digestibility, the five shrubs were all better than maize stalk. Among them, *C. intermedia* was the best in nutritive value. Therefore, it is the first choice as feedstuff for realizing the sustainability of ley farming.

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