Small Ruminant Research 96 (2011) 140–143

Contents lists available at ScienceDirect

Small Ruminant Research

journal homepage: www.elsevier.com/locate/smallrumres

Short communication

In vivo degradation kinetics of *Elymus nutans* from the Tibetan plateau

Jun Wei[a], Zhong-Hua Cao[b,c,*], Yan Jing[d], Zhong-yue zhang[b]

[a] School of Science, Tibet University, Lhasa, Tibet 850000, People's Republic of China
[b] College of Animal Science, Northwest A&F University, Yangling, Shaanxi 712100, People's Republic of China
[c] Department of Agriculture & Animal Husbandry of Autonomous Region in Tibet, Lhasa, Tibet 850000, People's Republic of China
[d] School of Medicine, Tibet Nationalities Institute, Xianyang, Shaanxi 712082, People's Republic of China

ARTICLE INFO

Article history:
Received 7 January 2010
Received in revised form 7 October 2010
Accepted 8 October 2010
Available online 5 November 2010

Keywords:
Wildrye
Degradability
Rumen

ABSTRACT

A digestion trial using six sheep wethers surgically fitted with ruminal cannulae was carried out to evaluate chemical composition and ruminal degradation characteristics of six wildrye (*Elymus nutans*) populations from Tibet. Nylon bags containing forage were incubated in duplicate for 3, 6, 12, 24, 48 and 72 h. Differences were observed in the rapidly soluble fraction, potential degradable fraction, degradation rate and effective degradability between the six populations. The rapidly soluble organic matter (OM), crude protein (CP) and neutral detergent fibre (NDF) fractions ranged from 9.76 to 21.22%, 24.27 to 34.67% and 5.93 to 12.22%, respectively. The potentially degradable OM, CP and NDF fractions ranged from 59.48 to 86.75%, 56.15 to 70.89% and 52.17 to 67.48%, respectively. The effective degradability (ED) of nutrients was also different ($P < 0.01$) among the altitudes. The samples collected from high altitudes had a relatively high content of CP and low content of NDF, and showed a high degradability of nutrients.

1. Introduction

The Tibetan Plateau covers an area of about 2.5 million km^2 with an average altitude of more than 4000 m. About 35% of its area is occupied by alpine meadows (Zheng, 2000). The cold and arid continental climates have resulted in most regions of Tibet being treeless, with sparse, low-height (10–15 cm) vegetation. The native grass contains slightly higher crude protein (78.5–130 g/kg dry matter) compared to other forages (Long et al., 1999; Yue et al., 2009). Wildrye (*Elymus nutans*) is a perennial cool-season grass native to alpine meadow of Tibetan Plateau that grows in most rangelands, and has been traditionally used as typical native forage and has often been collected and dried as long cool season (Chen and Jia, 2002).

The determination of forage digestibility characteristic after the elucidation of botanical and nutrient composition is essential to develop feeding strategies. The nylon bag technique offers an easy, fast, economical, and effective method to determine nutrient fractions (Bhargava and Ørskov, 1987). Even though forage nutrients may be utilized differently in vivo, variation in *in sacco* (Tolera and Sundstøl, 2001). However, there have not yet been any studies on the degradability characteristics of forages from the Tibetan plateau. The objective of the present study was to characterize the value and degradation kinetics of *Elymus* collected from different altitudes.

2. Materials and methods

2.1. Sample collection

The alpine meadow, where the six samples were collected, is located in northern Tibet (latitude 28°57′ to 31°28′N, longitude 90°15′ to 92°03′E) at an altitude ranging from 3624 to 4527 m above sea level. July is the warmest month and the frost-free period is only 60–120 days of the year. A brief summary of each collection site is given in Table 1. All wildryes were collected on 10 July, 2008. Each sample (2 kg) was cut using scissors

* Corresponding author at: College of Animal Science, Northwest A&F University, Yangling, Shaanxi 712100, People's Republic of China.
Tel.: +86 891 6323678; fax: +86 891 6323678.
E-mail address: caohua73@yahoo.cn (Z.-H. Cao).

0921-4488/$ – see front matter.
doi:10.1016/j.smallrumres.2010.10.008

Table 1
Details of location where *Elymus* plants were collected.

Population	Altitude	Latitude and longitude	Locality	Rain falls (mm)	Mean temperature (°C) in July
E1	4527 m	31°28′09″N, 92°03′71″E	Naqu County	421.9	8.5
E2	4480 m	28°57′53″N, 90°23′70″E	Langkazi County	376	9.2
E3	4316 m	30°29′71″N, 91°04′15″E	Dangxiong County	456.8	10.4
E4	4108 m	29°16′33″N, 90°15′12″E	Renbu County	400	11.7
E5	3943 m	29°43′69″N, 90°43′87″E	Duilong County	440	13.1
E6	3624 m	29°33′65″N, 91°10′33″E	Linzhou County	531.6	14.8

Note: The letters E1–E6 mean six populations.

at a 2-cm stubble. The samples were dried at 65 °C for 48 h and then ground to pass a 1 mm screen for chemical analysis, and a 2 mm screen for *in sacco* rumen degradability study.

2.2. Animals and feed

Six Pengpo sheep wethers, aged 15 months old, weighing 35 ± 3 kg and fitted with a rubber rumen cannula, were used to determine the degradability of wildryes using the nylon bag technique. As diet adaptation, wethers were fed for 14 days prior to ruminal incubation with a diet consisting of 67% hay and 33% concentrate. The particle size of hay is 5 cm. The chemical composition of the diet was, on a dry matter (DM) basis, 12.45% crude protein (CP), 36.88% neutral detergent fibre (NDF), 24.89% acid detergent fibre (ADF), 3.0% Ca, 1.5% P and with 7.82 kJ/kg metabolic energy (ME). The sheep were fed twice daily (at 08:00 and 17.00 h). The dry matter intake of the animals was 1.1–1.2 kg/d. Water was available at all times.

2.3. Rumen incubations and chemical analysis

Throughout the experimental period, nylon bags (8 cm × 16 cm; pore size 45 μm) were filled with 2 g of dry samples. Each forage sample was incubated in duplicate in each sheep for each of the testing time periods: 3, 6, 12, 24, 48 and 72 h. Six bags incubated inside a rumen simultaneously each time. Nylon bags were sealed using rubber bands, and soaked in water at 39 °C for 20 min prior to ruminal incubation. After extraction, the nylon bags were washed in cold running water until the washing ran clear and colourless. The bags were oven dried in an air-forced oven for 48 h at 65 °C, weighed and then used for analysis of nutrients. OM concentration by ashing at 600 °C for 2 h. The CP (Kjeldhal N × 6.25) according to method with $CuSO_4$ as catalyst of AOAC (1990), as well as for NDF (assayed without sodium sulphite; Van Soest et al., 1991) and ADF (Robertson and Van Soest, 1981). The Ca, P and ME for mixture of hay and concentrate were measured according to the method of Yang (1999).

Rumen degradation kinetics for OM, CP and NDF were calculated using the nonlinear model proposed by Ørskov and McDonald (1979): $y = a + b(1 - e^{-ct})$. Where y = percentage of degradability for response variables at t_i, t = time relative to incubation (h), the a = soluble fraction, while b is the non-soluble degradable fraction, and c = fractional degradation rate. The effective degradability (P) value of nutrients was calculated using the equation described by Ørskov and McDonald (1979): $P = a + (b \times c)/(c + k)$, where P is the effective degradability of nutrients, and k = rate constant of passage. Effective OM, CP and NDF degradabilities were calculated with an assumed passage rate (k) of 0.02 h^{-1} and 0.05 h^{-1} (Bhargava and Ørskov, 1987).

2.4. Statistical analysis

Chemical composition, in sacco rumen OM, CP and NDF degradabilities data were subjected to analysis of variance (ANOVA) using the General Linear Model procedure of MATLAB 7.01. The model used for chemical composition analyse was $Y_{ij} = u + F_j + e_i$, where Y is the concentration of chemical constituents, u is the overall mean, F is the effect of the forage and e_i is the random residual error. The model for the nylon bag data was $Y_{ijk} = u + F_i + P_j + A_k + e_{ijk}$, where Y is the dependent variable, u is the overall mean, F is the effect of the forage, P is the incubation time of the treatment, A is effect of t the animal and e_{ijk} is the random term. The forage types were fixed effects, and the sheep was treated as a random effect in the linear model. The statistical significance ($P < 0.05$) of differences between samples was tested by using the SPSS 13.0 software.

3. Results and discussion

3.1. Chemical composition

The chemical compositions of six wildryes populations were shown in Table 2. Crude protein (CP) content ranged from 92 g/kg DM for E6 to 174.4 g/kg DM, for E1. Organic matter (OM) ranged from 883.6 to 942.6 g/kg DM. Neutral detergent fIbre (NDF) content of six samples ranged from 473.3 g/kg DM for E1 to 655.3 g/kg DM for E6. The average acid detergent fibre (ADF) content of six populations was 206.3 g/kg DM. The data clearly indicates that there are population differences in wildrye chemical composition even when they are harvested at the same stage of maturity. The population in higher altitude tended to have a higher CP content and a lower NDF and ADF content except for E2 population. As the altitude increases, the average temperature drops, atmospheric pressure decreases, while light intensity increases (Friend & Woodward, 1990), an important influence will be exerted forcefully on the leaf morphology and physiology (Hovenden & Brodribb, 2000). This is one reason why E1 produced higher crude protein and lower ADF than any of the others and could be attributed to populations of wildrye at high elevations and lower temperatures tending to be of higher quality than those produced at lower elevations. Both

Table 2
Chemical composition of wildryes from six altitudes used for the in situ experiment (g/kg DM).

Population	Crude protein (CP)	Organic matter (OM)	Neutral detergent fibre (NDF)	Acid detergent fibre (ADF)
E1	174.4	942.6	473.3	150.6
E2	133.1	934.3	505.4	214.0
E3	167.8	931.5	516.3	196.0
E4	112.6	929.8	534.8	229.9
E5	103.8	923.0	554.3	258.9
E6	92.0	883.6	655.3	294.1

Note: The letters E1–E6 mean six populations.