Chemical content and rumen degradability of desert steppe pasture

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Summary

Desert, desert-steppe (Gobi) zone is the largest province by area (165,000 square kilometres) of Mongolia. The Gobi contains some 560 plant species, in 80 different vegetation associations (Swift, 1991). There are number of results of nutritive value of desert-steppe's pasture grass. Mongolia's dry climate means that pasture grasses have less moisture, and are richer in protein, carbohydrate, vitamin and minerals. Such an ecosystem is more typical of the Gobi zone than Khangai mountain zone (Tserendulam, 1980). However, have not been investigated seasonal changes of CP, NDF, ADF, Hemicellulose, and *in vitro* and *in sacco* degradability all together of desert-steppe's pasture grasses throughout the year. The objectives of this study were to determine the chemical content and the rumen degradability (*in sacco & in vitro*) of desert-steppe's 3 common pastures.

Our investigation demonstrated that, chemical content and *in vitro* gas production of desert-steppe's pasture grass were variable across a year depending on stage of the maturity of the plants. As example, CP content of pasture grass ranged 4.28-15.13%, NDF 55.05-71.96%, ADF 33.96-48.45%, hemicellulose 17.11-29.79%. Cumulative gas production after 70 h *in vitro* fermentation was accounted 143.10 ml/g to 266.19 ml/g. DMD was ranged 54.73- 77.71%, OMD was ranged 50.18- 77.97%. The potential (a+b) of *in sacco* degradation of pasture grass ranged from 58.7-76.8%. The rate constant (c) of degradation of dry matter was very changeable (0.0269-0.0934 %/h) throughout the year.

Key Words: Chemical content, rumen degradability, *in vitro* gas production, *in vitro* digestibility, Mongolian rangelands.

Materials and Methods

Three common pastures from desert-steppe were choosen. Pasture grass samples were obtained within 20-25 of February, April, May, June, July, August and September. Sampling data were relative to phenology which reported by Altanzul (1995). Sampling for plant biomass consisted of hand clipping, all species were clipped at 2 cm height from ground level, dried in a shadow place. From shrubs for sampling just clipped recent annual growth. All experimental sites were fenced. The samples were milled through a 1 mm sieve. For *in sacco* experiment samples were milled through a 2 mm sieve. Chemical content and *in-vitro* rumen degradability were determined on up to 16, for *in sacco* degradability was determined for 20 representative samples. Samples were analysed for dry matter (DM), organic matter (OM), crude protein (CP), acid detergent fibre (ADF), neutral detergent fibre (NDF) determined by AOAC (1984) methods. Hemicellulose was

calculated by difference (i.,e., %NDF- % ADF). *In vitro* gas production and digestibility were determined by Theodorou and et al. (1991) developed methods. Cumulative gas production data were corrected to 1g DM by ml. *In-vitro* dry matter (DMD), organic matter (OMD) digestibility was calculated assuming that all of the residual dry matter after 70 hours (h) fermentation was unfermented substrate. All chemical contents were reported as percentages (%) which were presented on a dry-matter basis. The rumen (*in sacco*) degradation characteristics determined by Nylon Bag Technique (Orskov et al. 1987). The information provided by the degradation of say DM is used to derive potential extent (asymptote) and rate of degradation of the sample using the following mathematical model:

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

Where: p= the degradation after time "t", a= the intercept of the degradation curve at time zero, b= the portion of the grass which will in time be degraded, c= the rate constant of degradation of "b", t= the time of degradation, (a+b) = the potential extent (asymptote) of degradation. Nylon bag washing loss (WL) of the pasture sample is also listed.

Study Area

Representative pastures of this zone were choosen in the territory of Bulgan sum, Omnogov aimag. The mean rainfall is about 114 mm, about 73.9% and occurs from June to August. The mean yearly temperature is 5.1° C and the frost-free period is about 150 - 170 days. The major soil types are desert brown rarely saline. The sample collecting sites belong to the desert-steppe region type of vegetation (Yunatov, 1950). The typical specific of the pasture desert-steppe is conservation in winter-spring time in standing died is from 25 to 40% of the maximum summer fresh yield. It indicated that, in the cold season forage yield of desert-steppe declined more in comparison to the rest of the zones of Mongolia. Over most of the desert-steppe's area, both shrubs and grasses are found in direct association or in adjacent communities, so a suitable diet is available for the livestock.

Bunch grasses-forbs dominant pasture: The study site was situated in the foothills of the Gurvan-saikhan Mountains on a 18 percent north-east facing slope at an elevation of 1700 m. One square meter of the experimental field counted 9 plant species. Degree of the plant coverage was about 35% in July-August. This pasture was dominated by *Stipa gobica (Roshev)* and *Allium polyrrhizum (Rge),* also *S. glareosa (P. Smirn), Agropyron cristatum ((Z.) Gaerth.), Artemisia frigida (Willd), Ajania achilloides ((Turcz.) Poljak)* contributed to build up this pasture grass.

***Allium polyrrhizum-Stipa gobica* dominant pasture:** The elevation of experimental site was 1450 m above the sea level on the wide valley. One square meter of the experimental field counted 7 plant species. Degree of the plant coverage was about 30% in July-August. The key species are *Allium pollyrhizum (Rge)* and *Stipa gobica (Roshev).* It also included *Ajania achilleodes ((Turcz) Poljark), Caragana leucophloea (Poljark).*

***Haloxylon ammodendron-Salsola passerina -Reamura soongaricum* dominant pasture:** This type of pasture mostly located at 1100 m above the sea level. The predominate vegetative cover was *Salsola passerina (Bge)* and followed by *Reamurea soongarica ((Pall,) Maxim), Haloxylon ammodendron (B(C.A.M.) Bge).* Canopy cover of the plants was about 10% in July-August. One square meter of the experimental field

counted 3 plant species. Xerophilous and saline shrubs are the predominating plants and semishrubs are the major forage plants. The pasture used mostly by camels.

Results and Discussion

Chemical content and *in vitro* gas production of pasture grass were variable depending upon the species, maturity of the plant and conditions of growth (Table 1). As plants age they tend to become more mature and generally decline in nutritive value. Mean CP of desert-steppe's pasture ranged from 4.28 to 15.29% depending on species composition and seasons. Generally, the high values of CP content for pasture grass were found in early summer to mid summer, the lowest values were found in winter and spring.

Table 1. Chemical content and nutritive value of desert steppe pasture.

Date (Year, month)	OM	CP	NDF	ADF	Hem	Gas	DMD	OMD
Bunch grasses-forbs dominant pasture								
94. 4	88.73	4.28	71.96	48.45	23.51	261.18	69.81	72.95
94. 5.	91.49	15.29	67.01	39.19	27.82	263.92	71.17	74.45
94. 6.	92.89	13.04	69.69	39.90	29.79	266.19	68.19	68.00
94. 7.	89.99	14.96	59.86	37.67	22.20	261.64	71.45	71.94
94. 8.	92.96	11.66	63.91	36.15	27.76	259.78	69.83	70.56
94. 9.	91.71	9.21	66.18	38.88	27.30	244.63	65.63	66.24
Allium polyrrhizum-Stipa gobica dominant pasture								
94. 4.	92.25	5.84	66.83	42.72	24.11	239.51	67.91	68.26
94. 5.	91.52	13.47	58.61	38.73	19.88	258.90	72.35	72.87
94. 6.	93.31	14.61	60.97	33.96	27.01	280.03	77.71	77.97
94. 7.	89.51	15.13	56.83	35.42	21.41	233.56	73.21	72.62
94. 8.	89.53	13.51	55.05	37.94	17.11	248.26	70.75	71.14
94. 9.	90.65	9.24	57.94	38.79	19.14	239.72	67.75	67.48
H. ammodendron- S. passerina (Bge) -R. soongaricum dominant pasture								
94. 4.	75.01	11.29	61.53	36.71	24.82	161.90	62.8	56.67
94. 5.	75.76	13.32	62.77	34.34	28.42	160.39	62.66	57.34
94. 6.	76.08	12.91	62.59	37.36	25.24	143.10	54.73	50.18
94. 8.	70.44	13.64	59.42	36.33	23.09	149.11	58.1	56.46

Note: Hem-hemicellulose (%), Gas - *in vitro* gas production over 70 hours incubation (ml/g dry sample).

Haloxylon ammodendron- Salsola passerina (Bge) - Reamura soongaricum's pasture contained more of the CP during the late fall and early spring than other pastures, because the living twigs of dormant browse plants make this range type more adequate for animal maintenance than other cold-weather ranges where the aerial plant parts are dead. On the other hand, the growing season of shrubs and semishrubs begins as early as the late of March. From the stand-point protein nutrition of the livestock, this pasture can be used in winter time or early spring when CP contents of other grass, grasslike plants or forbs are low. The chemical content of a particular type of pasture depends on the growth of the dominant and subdominant plant species as, for example, maximum CP content of *Allium pollirrhizum-Stipa gobica* dominant pasture was obtained at the end of July and this corresponds to the fresh growth of *Allium pollirrhizum*. NDF contents of the pastures varied from 55.05 to 71.96%, ADF varied from 33.96 to 48.45%.

Hemicellulose mostly occurs in lignified walls of forages and is insolible (Van Soest, 1983). Hemicellulose of desert-steppe's pasture grass ranged from 17.11 to 29.79% throughout the season. Lowest percentages of hemicellulose were obtained at the end of July for bunch grass-forbs dominated pasture, at the end of August for *Allium polyrrhizum-Stipa gobica* dominant and *Haloxylon ammodendron- Salsola passerina (Bge) -Reamura soongaricum* dominant pasture. These compoundes effectively influenced to *in vitro* digestibility and rumen degradability of pasture grasses.

Table 2. Rumen degradation characteristics (%) of desert steppe pasture.

Date (year, month)	WL	Incubation time						Parameters			
		6	12	24	48	72	96	a	b	c	a+b
Bunch grasses-forbs dominant pasture											
94. 4.	9.25	20.51	27.06	47.14	61.04	66	67.44	4.3	64.7	0.0426	69.0
94. 6.	17.67	24.47	30.29	42.79	54.59	59.72	66.22	16.6	52.4	0.0269	69.0
94. 7.	24.99	32.48	39.75	52.6	62.15	68.65	73	24.0	50.4	0.0319	74.4
94. 8.	23.73	28.66	38.02	50.11	59.7	65.18	67.78	18.4	49.6	0.0406	68.0
94. 9.	18.65	27.03	34.67	42.48	52.44	57.88	61.29	21.0	42.3	0.0292	63.4
95. 2.	13.74	23.6	28.17	42.66	58.7	62.46	69.35	13.3	59.3	0.027	72.6
Allium polyrrhizum-Stipa gobica dominant pasture											
94. 4.	9.45	21.68	30.12	42.82	60.4	63.72	68.6	10.3	60.2	0.0337	70.6
94. 5.	16.86	31.86	42.77	58.19	68.76	69.57	73.48	15.2	57.1	0.0565	72.4
94. 6.	19.49	31.92	41.92	61.22	71.76	74.66	77.15	13.5	63.3	0.0543	76.8
94. 7.	29.42	42.7	51.89	67.03	70.11	71.73	72.93	23.4	48.9	0.0802	72.3
94. 8.	28.99	39.8	49.69	61.45	68.41	69.17	70.64	24.4	45.8	0.0680	70.2
94. 9.	23.24	34.23	41.63	54.41	62.19	63.7	67.46	22.5	43.9	0.0506	66.4
95. 2.	14.11	24.81	32.14	49.12	63.49	65.71	67.77	9.5	59.3	0.0451	68.8
95. 4.	28.39	29.91	33.93	52.25	56.4	63.25	65.55	18.2	47.2	0.0425	65.4
H. ammodendron- S. passerina (Bge) -R. soongaricum dominant pasture											
94.4.	32.2	39.3	49.64	55.1	62.78	64.57	67.72	31.6	35.0	0.0496	66.6
94.5.	30.83	40.22	48.09	60.23	67.7	69.77	70.18	27.1	43.3	0.0580	70.4
94.6.	28.57	38.42	46.81	57.18	60.29	63.39	65.78	26.6	37.6	0.0643	64.2
94.8.	31.5	42.2	50.35	61.44	67.66	69.66	71.72	30.3	40.7	0.0577	70.9
95.2.	16.91	36.45	43.34	51.5	55	57.75	59.87	28.0	30.7	0.0560	58.7
95.4.	30.2	37.05	49.57	55.98	58.84	60.57	64.76	19.9	41.7	0.0934	61.5

Note: a,b, WL:%; c: /h

In-vitro DMD of the 3 pastures ranged from 54.73 to 77.71% and OMD ranged from 50.18 to 77.96%. OMD of bunch grass-forbs, *Allium polyrrhizum-Stipa gobica* dominant pasture were higher than DMD, but for *Haloxylon ammodendron- Salsola passerina (Bge) -Reamura soongaricum* pasture it seemed to be lower than DMD.

This demonstrated that OMD decreased only by 11.03-13.43% the year around compared to the summer maximum. After 70 hours incubation *in vitro* gas production of bunch grass-forbs dominant pasture was ranged from 244.63-266.19 ml/g. Maximum gas volume was noted at the end of June. In *Allium polyrrhizum -Stipa gobica* dominated pasture, highest *in vitro* gas production (280.03 ml/g) was obtained at the end of June. *In vitro* gas production of *Haloxylon ammodendron- Salsola passerina (Bge) -Reamura soongaricum* dominant pasture was lowest among the three pasture grasses analyzed. Thus, the shrubs and semishrubs species of desert-steppe's pasture are sufficiently high in protein to satisfy the animals' nutritional requirements, but they are low in energy values in comparison to grass and forbs in winter-spring time.

There are two possible main reasons for this. Firstly, it is clear that the proportions of leaves are lower in total yield of semishrubs and shrubs, leading to high lignin contents. The presence of anti-nutritive factors could account for the low gas production. Shrubs and semishrubs mostly contain high tanins and other aromatic oils in sage may resulting in limitation of number of the rumen floro-fauna.

Table 2 represents rumen degradability potential of desert-steppe pasture. In summer time, maximum level of "a" value were registered (water soluble fraction) and it in winter time generally declined up to sixfold. Maximum level of "b" value were obtained in standing died. In summer, in particular grass, forbs dominant pasture's "b" value mainly declined. But year round changes of "b" value was greater compared to "a" value. However, minimum "b" value of shrub, semishrub dominant pasture were obtained in winter. Year round changes of "b" value of bunch grasses-forbs dominant pasture decreased by 27.08- 34.63% compared to early spring maximum value.

Maximum level of "c" value of shrub dominant pasture were obtained in early spring, but grass or forbs dominant pasture were obtained in July or August. Maximum level of "a+b" value were obtained in the end of June (in *Allium polyrrhizum-Stipa gobica* dominant pasture), July (Bunch grasses-forbs dominant pasture), August (*H. ammodendron- S. passerina (Bge) -R. soongaricum* dominant pasture). Year round changes of "a+b" were decreased by 14.79- 17.21% compared to summer maximum level. Data in table 2 also indicate that, the potential degradability and effective degradability of desert-steppe's pasture grass were lower than high mountains pasture (Daalkhaijav, Lkhagvajav, 1997).

According to the procedure all samples of for *in sacco* experiment were ground through a 2 mm screen using a laboratory hammer mill, but depending on anatomical properties of shrubs and succulent plants, *H. ammodendron- S. passerina (Bge) -R. soongaricum* dominant pastures sample seemed to contain more finely ground particles than we expected (less than 45 microns (μ)). It was the cause to overestimation of the "a" value in this pasture. This suggests that, the *in sacco* method is not so meaningfully to determine rumen degradability of this pasture or should be to mill it by larger screen size than samples like straw and hay.

Conclusions

Chemical content of Desert-steppe's pasture grass varies widely according to species composition and growth rate. CP content of investigated pasture's grasses were ranged from 4.28 to 15.13%, NDF 55.05-71.96%, ADF 33.96-48.45%, hemicellulose 17.11-29.79%.

Cumulative gas production after 70 h *in vitro* fermentation were accounted from 143.10 to 266.19 ml/g. DMD were ranged from 54.73 to 77.71%, OMD were ranged 50.18- 77.97%. The potential (a+b) of *in sacco* degradation of pasture grass varied from 58.7 to 76.8%.

The potential (a+b) of *in sacco* degradation of pasture grass ranged from 58.7 to 76.8%. The rate constant (c) of degradation of dry matter was very changeable (0.0269-0.0934 %/h) during the year. These results would indicate that, the potential degradability and effective degradability of desert-steppe's pasture grass were lower than high mountains pasture grass.

The shrubs and semishrubs species of desert-steppe pasture are sufficiently high in protein to satisfy the animals's nutritional requirements, but they are low in energy values in comparison to grass and forbs in winter-spring time.

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ЦӨЛӨРХӨГ ХЭЭРИЙН БҮСИЙН ЗАРИМ БЭЛЧЭЭРИЙН УРГАМЛЫН НАЙРЛАГА, ГҮЗЭЭН ДЭХ ЗАДРАЛЫГ СУДАЛСАН ДҮН

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Цөлөрхөг хээрийн бүсийн 3 хэв шинжийн бэлчээрийн ургамлын химийн найрлага шингэц, гүзээний задралын хөдлөл зүйг судлав. Туршлагын талбайг Өмнөговь аймгийн Булган сумын нутагт сонгон авсан болно. **Үүнд:**

Үетэн-алаг өвст бэлчээр: Ам метр бэлчээрт 9 зүйл ургамал тааралдана. Ургамлын нийт бүрхэц 7 дугаар сарын сүүл, 8 дугаар сарын эхээр 35% хүрнэ. Ургамалшилд Stipa gobica (Roshev) болон Allium polyrrhizum (Rge) зонхилж, S. glareosa (P. Smirn), Agropyron cristatum ((Z.) Gaerth.), Artemisia frigida (Willd), Ajania achilloides ((Turcz.) Poljak) дагалдана.

Таана-хялганат бэлчээр: Ам метр бэлчээрт 7 зүйл ургамал бүртгэгдэж, ургамлын нийт бүрхэц 7 сарын сүүл, 8 дугаар сарын эхээр 30%

хүрнэ. Ургамалшилд Allium pollyrhizum (Rge), Stipa gobica (Roshev) зонхилж, Ajania achilleodes ((Turcz) Poljark), Caragana leucophloea (Poljark) дагалдана.

Заг-бор-,-улаанбударганат бэлчээр: Ургамалшилд Salsola passerina (Bge), Reamurea soongarica ((Pall,) Maxim) зонхилж, Haloxylon ammodendron (B(C.A.M.) Bge) дагалдана.

Зүйлийн бүрэлдэхүүн, зонхилогч урамлын хөгжлийн хэмээс хамааран цөлөрхөг хээрийн ургамлын химийн найрлага, шимт чанар ихээхэн хэлбэлзэнэ. Тухайлбал: нийт протейн 4.28-15.13%, саармаг уусгагчид уусдаггүй эслэг 55.05-71.96%, хүчилд уусдаггүй эслэг 29.37-33.96%, гемицеллюлоз 12.48-22.58% агуулагдана.

Бэлчээрийн ургамлын in vitro хийн бүтээмж нь 143.10-266.19 мл/г, хуурай бодисын in vitro шингэц нь 54.73-77.71% байна. Бэлчээрийн хэв шинж, ургамлын хөгжлийн хэмээс хамааран органик бодисын шингэц 50.18-77.97% байдаг нь бидний судалгаагаар тогтоогдов. Бэлчээр бүрийн органик бодисын шингэцийн зуны дээд хэмжээг 100% гэж үзвэл өвөл, хаварт хамгийн их буюу 11.03-13.43%-иар буурна. Заг-бор, -улаанбударганат бэлчээрийн ургамлын шингэц нь аль ч улиралд бусад бэлчээрийн ургамлынхаас бага байна.

Цөлөрхөг хээрийн бэлчээрийн ургамал гүзээнд хэрхэн задарч байгааг нийлэг уутны (in sacco) аргаар судалсан дүнгээр хуурай бодисын задралын хэмжээ 58.7-76.8% хүрэх ба задарлын хурд зонхилогч ургамлын хөгжлийн хэмээс хамааран нэлээд хэлбэлзэнэ (0.0269-0.0934%/ цаг). Ялангуяа бэлчээр хагдрахад задралын хурд буурдаг нь хагдны шимт чанар малын тэжээлд бүрэн ашиглагдахгүй байх нэг үндэс болно. Бэлчээрийн ургамлын гүзээнд уусах чадавхи нэлээд хувьсамтгай (4.31-31.6%), задрах чадавхи түүнтэй харьцуулбал тогтмолдуу нь тогтоогдлоо.

Бэлчээрийн ургамлын гүзээний задралын хамгийн дээд хэмжээг 100% гэж үзээд өвөл хаврынхыг түүнтэй харьцуулахад 14.79-17.21%-иар буурч байна. Цөлөрхөг хээрийн бүсийн бэлчээрийн ургамал малын гүзээнд задрах, in vitro нөхцөлд дарахад хий үүсгэх чадвараараа өндөр уулын бэлчээрийн ургамлынхад хүрдэггүй нь илэрлээ.