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The effect of supplementary feeds on the bodyweight of yaks in cold season

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Abstract

The present study was conducted to determine the effects of supplementary feeds, oat hay (OH), highland barley straw (HBS) and multi-nutrient blocks supplementation (UMMB) on reducing liveweight losses of both yak cows and calves grazed on low quality pastures during cold season. The trials of OH and HBS supplementation were conducted by using completely random design on 104 yak cows between 6 and 12 years of age as the following treatments: pure grazing (41 animals, body weight 230±67 kg) as control (CK); grazing+1.5 kg DM of OH per head daily (30 animals, body weight 216±28 kg); grazing+1.5 kg DM of HBS per head daily (33 animals, body weight 221±34 kg). The trial of UMMB was conducted on three types of yaks, 1-year calves (8–12 months old, body weight 61.1±6.9 kg), 2-year calves (18–24 months old, 98.0±11.3 kg) and yak cows (164.5±27.1 (S.D.) kg) with 20 animals in control group (CK) and 20 animals in supplement group for each type by using completely random design as the following treatments: pure grazing for CK group; grazing+150, 250 and 500 g UMMB per day averagely for 1-year calf, 2-year calf and cow at night. The results indicate that the animals supplemented with oat hay received body weight gain (32±20.7 g day^{-1}), while those supplemented with highland barley straw still suffered from body weight loss (−56.7±39.3 g day^{-1}); UMMB supplementation can decrease the body weight loss by 109.7%, 86.6% and 63.4% for the 1-year calves, 2-year calves and yak cows, respectively, as compared with pure grazing. Around US$1.60 output can be achieved on the basis of US$1 input for UMMB supplementation in the farming systems of the 1-year calves, 2-year calves and yak cows, while US$1 input can produce US$1.55 and 1.14 output for OH and HBS supplementations, respectively, in yak cows' farming system. It can be preliminary concluded that UMMB supplementation was the most economic way to alleviate body weight loss of grazing yaks over cold season, and the higher productive returns were obtained from OH supplementation for grazing yak cows during winter/spring months.

Keywords: Yak; Supplementation strategies; Reducing weight loss

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1. Introduction

Yak (*Bos grunniens*) is one of the most important grazing livestock found in the Himalayas and on the Qinghai–Tibetan Plateau. Due to herbage shortage in the long, harsh cold season (October–May), the yak has to suffer from inadequate feeds under the traditional farming system, resulting in big seasonal body weight variations, low milk production and low fertility. Liveweight of adult female yak normally ranges from 160 to 290 kg with 25–30% loss of the weight at the end of warm season, which then can be recovered during the following warm season, this pattern cycles year by year (Long et al., 1999; Gerald et al., 2003). The saying "alive in summer, strong in autumn, thin in winter and tired in spring" is a good description of yaks across Qinghai–Tibetan Plateau (Dong et al., 2003).

These situations suggest that there is a big potential to improve yak productivity through developing local supplement resources during the cold season, as most grazing animals are not given any supplement on dry grasslands. Many researchers (Wen et al., 1993; Liu and Cheng, 1994; Xie et al., 1997; Wang et al., 1997; Zhang, 1998; Long et al., 1999) have reported that additional feeds can elicit a response in terms of reduced weight loss, increased growth and production in yak farming system, and roughages like grass hay, forage oat, highland barley straw as well as concentrates like maize, rape cake, wheat bran, urea molasses multi-nutrient blocks (UMMB) can be supplied to meet the dry matter, protein and energy requirement for maintenance or growth by the animals grazing on the dry grassland of the Plateau in the cold season.

Although the positive effects of feed supplementation on the productive and reproductive performance of the yaks in cold season were well documented, few researches have been conducted to select the optimal supplementary strategy for the yak production system based on the productive and economic benefits. Therefore, the present study was envisaged to evaluate the profit-making potentials of different strategic feed supplementations existing in yak farming system, thus to recommend the best supplementary strategy for yak-producers.

2. Materials and methods

2.1. Study site

The study was done at Tianzhu Tibetan Autonomous County, western Gansu Province of China (N36°35, E102°46), situated at the Qilian Mountain of northeastern Qinghai–Tibetan Plateau. This area is over 3000 m above sea level and has a dry cold climate. The annual average temperature is −0.1 °C and the average yearly precipitation is 416 mm of rain. The pastures at lower site altitude are mainly alpine meadow (dominated by *Polygonum* spp. and *Kobresia* spp.) and alpine steppe (dominated by *Elymus* spp. and *Poa* spp.), at higher site are alpine shrub-meadow (dominated by *Potentilla* spp. and *Kobresia* spp.). The alpine meadow, steppe and shrub-meadow are grazed by the yaks and Tibetan sheep rotationally in winter and spring, summer, autumn, respectively, whole year round. The study lasted from November of 1998 to May of 1999, which are the coldest months of the year (the temperature varies from −5 to −20 °C).

2.2. Supplementation strategies and feeds composition

Two roughage supplementation regimes, oat hay (OH) and highland barley straw (HBS) supplementation, and one concentration supplementation strategy, urea molasses multi-nutrient blocks (UMMB) supplementation were investigated in this study. The trial of roughage supplementation was conducted by completely random design on 104 yak cows (body weight 230±67 kg) between 6 and 12 years of age randomly selected from the same herd of Yongfen yak farm, and concentration supplementation trial on three types of yaks, 1-year calves (8–12 months old, body weight 61.1±6.9 kg), 2-year calves (18–24 months old, body weight 98.0±11.3 kg) and yak cows (6–12 years old, body weight 164.5±27.1 kg), with 40 animals per type selected from the same herd of Nannigou yak

Table 1
Supplementation regimes in the study

Treatments	No. of animals	Supplement feeds(kg DM day^{-1})		
		HBS	OH	UMMB
Roughage supplementation on yak cows				
Grazing	41	0.0	0.0	0.0
Grazing+HBS	33	1.5	0.0	0.0
Grazing+OH	30	0.0	1.5	0.0
UMMB supplementation				
On 1-year-old calf				
Grazing	20	0.0	0.0	0.0
Grazing+UMMB	20	0.0	0.0	0.15
On 2-year-old calf				
Grazing	20	0.0	0.0	0.0
Grazing+UMMB	20	0.0	0.0	0.25
On yak cows				
Grazing	20	0.0	0.0	0.0
Grazing+UMMB	20	0.0	0.0	0.5

HBS, highland barley straw; OH, oat hay; UMMB, urea molasses multi-nutrient blocks.
On 14th of February a heavy snow occurred (over 25 cm deep), which lasted for about a week, and thereafter all the animals (including CK group) in UMMB supplementation trials received extra supplementation of oat hay ranging from 0.8 to 1.5 kg (air dry basis) per day as basal diets for about 3 weeks.

farm. The supplementation strategies of both trials are shown in Table 1. Compositions and costs of supplements, OH, HBS, UMMB (containing molasses, urea, bentonite, rape-seed meal, sesame-seed meal, dry hay meal, salt, wheat flour, wheat bran and mineral mixture in the proportions of 200, 100, 300, 100, 100, 90, 50, 30, 20 and 10 g/kg, respectively) and basic diets of the animals, the native alpine forages are presented in Table 2.

2.3. Measurement of body weight change

The calf was weighed every 30 days by using platform scale before grazing in the morning. Meanwhile, body weight (BW) of the cow was estimated by the following equation recommended by Cai (1989):

$$\mathrm{BW(kg)} = \text{body length(m)} \times [(\text{heart girth(m)})]^2 \times 70$$

Therefore, the daily weight gain (DWG) was calculated through two measurements.

2.4. Calculation of benefit

The productive benefit (PB) on the basis of body weight loss reduction can be estimated from the following equation:

$$\mathrm{PB} = \frac{\text{DWG of animals supplemented} - \text{DWG of animals unsupplemented}}{\text{daily intake of supplements}}$$

The economic benefit (EB) on the basis of body weight loss reduction can be estimated from the following equation:

$$\mathrm{EB} = \frac{(\text{DWG of animals supplemented} - \text{DWG of animals unsupplemented}) \times \text{value of beef}}{\text{amounts of supplements} \times \text{values of supplements}}$$

Table 2
Composition and cost of feeds

Feeds	Chemical compositions (g/kg DM)					Costs (US$/10 kg)
	Organic matter	Nitrogen	Acid detergent fiber	Calcium	Phosphorus	
HBS	890.4	9.3	674	2.9	1.3	0.5
OH	929.8	13.5	530	3.7	1.7	0.9
UMMB	611.8	57.8	49.3[a]	29.4	1.7	0.6
Native forages	890.4	11.8	316	10.5	1.1	–

HBS, highland barley straw; OH, oat hay; UMMB, urea molasses multi-nutrient blocks.
[a] Crude fiber.

Here, the value of beef is the purchase prices, which was obtained from market survey. In this study, Purchase price of beef is US$0.48/kg. The values of supplements, OH, HBS and UMMB are the costs for inputting these feeds, which are presented in Table 2. Although OH and HBS are home products, inputs of seeds, fertilizer, herbicide, labor, etc., are needed in planting and harvesting. Moreover, domestic supplies of these roughages are mostly insufficient for supplementing large herds of yaks in long cold season, the yak farmers have to purchase the supplementary roughages from local markets or crop farms.

2.5. Statistical analysis

Data collected from the experiment are presented as the means of the replicates in the tables or figures. Differences among the grazing, grazing+OH supplementation and gazing+HBS supplementation in the levels of animal body weight change were determined by ANOVA (SPSS10.0, Huang et al., 2001). Differences between the grazing and gazing+UMMB supplementation in the levels of animal body weight change were estimated by using Student's *T*-test. Monthly body weight change with UMMB supplementation was calculated for 1-year calves, 2-year calves and yak cows.

3. Results

3.1. Effect of roughage supplementation on reducing body weight loss

The initial body weights of the animals (kg) as well as the changes in body weight (g day^{-1}) in roughage supplementation trial are presented in Table 3. The data indicated that the body weight loss of the grazing yaks winter season can be significantly ($p<0.05$) reduced through supplementing them with OH or HBS. Compared with pure grazing, OH and HBS supplementation can minimize the body weight loss of the grazing animals by 111.1% and 80.4%, respectively. The effect of OH supplementation was much more significant than HBS supplementation on reducing body weight loss of the yaks. The animals supplemented with oat hay received body weight gain (32 ± 20.7 g day^{-1}), while those supplemented with highland barley straw still suffered from body weight loss (-56.7 ± 39.3 g day^{-1}).

3.2. Monthly body weight change of yak calves and cows with UMMB supplement

Data of monthly liveweight change of the 1-year calves, 2-year calves and yak cows are shown in Figs. 1–3, respectively. The results indicated that the monthly pattern of body weight of the animals shifted greatly. In January, all animals either in control groups or in supplementation groups showed gain in body weight, while the performances in growth rate of the animals in supplementation groups were much better ($p<0.01$). In contrast, the body weight gain for all animals was negative even when UMMB was offered through February till April except the 1-year calves supple-

Table 3
Effects of supplement strategies on liveweight change of yak calves and cows grazed on native pastures from 15th of January to 9th of May (mean±S.E.)

Feeding strategies	Roughage supplementation					UMMB supplementation			
Animal	Yak cows			1-year-old calves		2-year-old calves		Yak cows	
Treatments	Grazing	Grazing+ HBS	Grazing+ OH	Grazing	Grazing+ UMMB	Grazing	Grazing+ UMMB	Grazing	Grazing+ UMMB
Initial weight (kg)	230±67	221±34	216±28	62.3±2.6	59.9±2.9	95.3±7.0	100.7±2.2	163.1±7.0	165.9±8.1
Final weight (kg)	187±49	212±28	221±23	59.3±2.3	60.1±4.1	88.1±7.5	99.7±3.5	144.8±6.9	159.2±8.0
Liveweight gain (g d^{-1})	−289.3±77.3	−56.7±39.3	32±20.7	−27.2±2.3	2.6±0.6	−58.8±6.9	−7.9±1.4	−160.5±12.4	−58.8±4.7
Liveweight gain increment (%)		80.4	111.1		109.7		86.6		63.4
Productive benefit (g/kg)		155.1	214.2		198.7		203.6		203.4
Economic benefit (US$/US$)		1.55	1.14		1.59		1.63		1.63

mented with UMMB in April. The figures also noted that the maximum body weight loss for all grazing animals appeared in February, while the minimum loss in body weight was found in April for grazing calves.

In whole experiment period, reduction of body weight loss was appreciable ($P<0.05$) in the 1-year calves, 2-year calves and yak cows owing to supplementation of 125, 250 and 500 g day^{-1} UMMB at night apart from grazing. UMMB supplementation can decrease the body weight loss by 109.7%, 86.6% and 63.4% for the 1-year calves, 2-year calves and yak cows, respectively, as compared with pure grazing.

3.3. Productive and economic benefit of different supplementations

Data of productive benefit given in Table 3 showed that 1 kg OH and HBS supplements can make 155.1 and 214.2 g body weight gains in grazing cows in return. Data presented in Table 3 indicated that 198.7, 203.6 and 203.4 g body weight gains were obtained as a return of 1 kg UMMB supplement for the 1-year calves, 2-year calves and yak cows, respectively.

As far as economic benefit is concerned, US$1 input can produce US$1.55 and 1.14 output for HBS and OH supplementations, respectively, in yak cows'

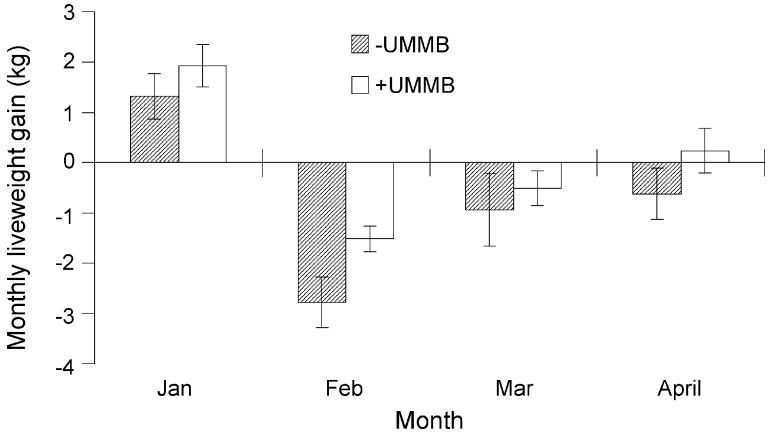

Fig. 1. Monthly gain in body weight of 1-year calves with (n=20) or without (n=20) UMMB supplemented (mean±S.E.).

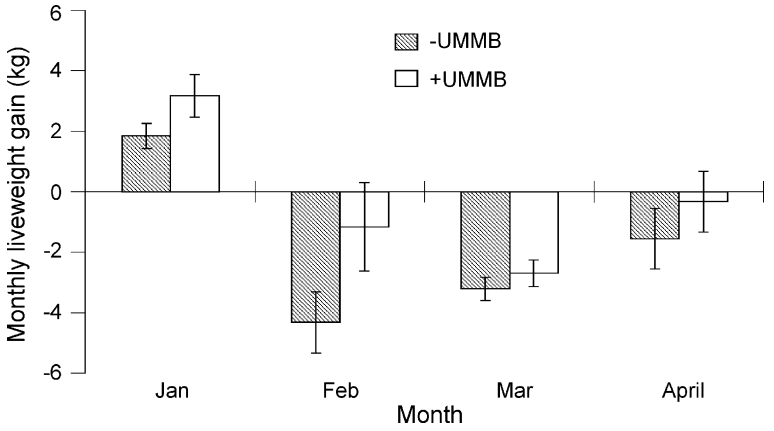

Fig. 2. Monthly gain in body weight of 2-year calves with (n=20) or without (n=20) UMMB supplemented (mean±S.E.).

farming system (Table 3). Around US$1.60 input can be achieved on the basis of US$1 input for UMMB supplementation in the farming systems of the 1-year calves, 2-year calves and yak cows (Table 3). The results indicated that UMMB supplementation was the highest, OH supplementation the lowest and HBS was in between in profit-making.

4. Discussion

Feed supplement have been widely used to balance nutrition of ruminants fed low quality forage based diets in tropical and sub-tropical areas (Leng, 1984; Kunju, 1986; Sudana and Leng, 1986; Sansoucy and Aartes, 1986; Tiwari et al., 1990; Sarkar, 1991; Toppo et al., 1997). Similarly, supplementary feedings of the roughages such as conserved grass, oat hay or highland barley straw and more recently the concentrates like UMMB were developed as a promising technology to improve the body conditions of grazing yaks or to prevent them from losing body weight during winter/spring months in the alpine region of the Qinghai–Tibetan Plateau (Zhang, 1989; Wen et al., 1993; Wang et al., 1997; Xie et al., 1997; Zhang, 1998; Long et al., 1999; Dong et al., 2003).

In agree with the result in the present study, Wen et al. (1993) reported the cows supplemented with conserved grass or oat hay lost less (p<0.05) weight over winter than the unsupplemented cows, Long et al.

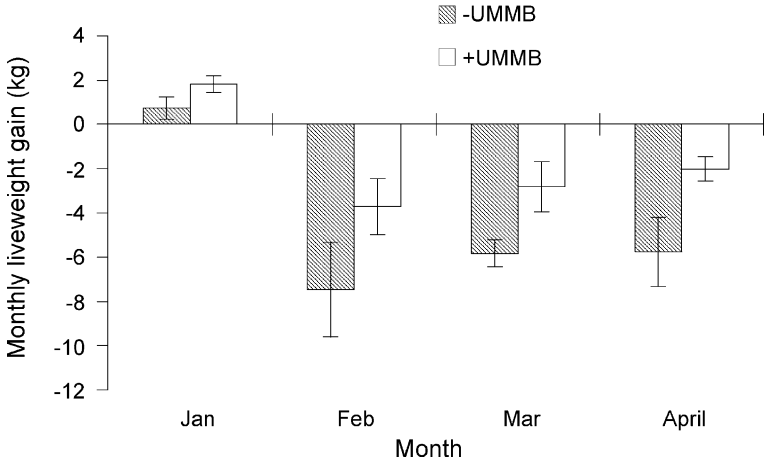

Fig. 3. Monthly gain in body weight of cows with (n=20) or without (n=20). UMMB supplemented (mean±S.E.).

(1999) found the liveweight loss of the unsupplemented cows in cold season was considerably higher than that of the animals supplemented with oat hay and highland barley. Decreases in liveweight loss of 15.9 kg for 2-year-old calves, 22.3 and 8.8 kg for yak cows over winter by UMMB supplementation recorded by Xie et al. (1997), Wang et al. (1997) and Zhang (1998) support the findings of positive effect of UMMB supplementation on reducing the body weight loss of both yak calves and cows in current study.

Being grazing animals, yaks shift their liveweight with the variation of forages supplied from pastures. Long (1995) reported that both quality and quantity of forages were dramatically decreased during cold season compared to those in the warm season, which resulted in reduced grazing intake about 1.6 kg DM day^{-1} only for adult cows on average from February to May. According to the results in the present study, supplements of 1.5 kg day^{-1} oat hay or its equivalent for a yak cow around 220 kg (liveweight) and 125 g day^{-1} of UMMB or its equivalent for a 1-year-old calf around 60 kg (liveweight) are enough to maintain their body weights over cold season when the animals grazed on the dry pasture, a bit more than 250 g day^{-1} of UMMB or its equivalent should be given to a 2-year-old calf around 100 kg (liveweight) besides being grazed on the dry pasture in order to maintain their body weight over cold season.

The maximum body weight loss of all grazing animals in February may be mainly caused by a heavy snow (over 25 cm deep) occurred on the 14th of this month, which heavily covered the grazing lands until the end of the month. Although 0.8–1.5 kg day^{-1} oat hay was supplemented to cows and calves, in additional to UMMB, the trends of reduction of liveweight were not effectively blocked. This implies that yaks can obtain more than the equivalent of 0.8–1.5 kg day^{-1} oat hay from native alpine meadows in winter. Basal diet of roughages is important for reducing body weight losses of grazing yaks in cold season. More roughage supplements should be offered to the grazing yaks when heavy snowstorm occurs on the Plateau.

The minimum loss in body weight found in April for grazing animals might benefit from the turning-green of sedges (*Carex* and *Kobresia*), the dominant grass on the natural pastures of the trial site at the end of April. The more significant effect of UMMB on performance of reduction in body weight in April than in February and March might reflect the maximized associate effect between the high quality roughage, the newly growing forages from the natural pasture, and UMMB supplements, the sources of both the non-protein nitrogen and soluble carbohydrates on the productivity of grazing animals.

Although the grass silages are very limited in yak production system due to the difficulties and costs involved in conserving grass, the roughage resources such as highland barley straw or oat hay are available in most yak-raising areas of the northeastern part of the Qinghai–Tibetan Plateau (Long et al., 1999). UMMB, a mixture of concentration, is being extended within yak-producing areas along the Plateau due to its positive effect on productive performances of yak herds and high profit (Dong et al., 2003). These feedstuffs can be optionally used as winter supplements for grazing yaks. From an economic point of view, in the present study, UMMB supplementation was the most efficient way to alleviate body weight loss of grazing yaks over cold season, while the higher productive returns were obtained from OH supplementation for grazing yak cows during winter/spring months.

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