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Investigations into chemical composition and in-sacco degradability of sea-buckthorn leaves for ruminant livestock in Gilgit-Baltistan, Pakistan

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Abstract

Comparative quality assessment of Sea-buckthorn and Lucerne against nutrient composition, neutral detergent fiber, in-sacco dry matter degradability and in-sacco nitrogen degradability revealed higher efficiency of Sea-buckthorn leaves as forage for ruminant livestock. Besides, other parameters, nutrient composition valuation was made against ash, organic matter, crude protein and acid detergent fiber (ADF). Low N degradability and ADF contents in sea-buckthorn leaves enable ruminants efficient nutrient utility. However, there was no significant variation across all the parameters except ash content and in-sacco nitrogen degradability. Study results suggest that feeding of sea-buckthorn leaves as a supplement is highly valued that would increase productive performance of the animals.

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Introduction

Sea-buckthorn (*Hippophae rhamnoides* L.) is a deciduous spiny shrub or small tree between two to four meter high, widely distributed throughout the temperature zones of Asia and Europe (Lu, 1992) and subtropical zone of Asia at high altitude ranging from a few meters to 5200 meters (Rongsen, 1992). The plant is hard, drought and usually cold tolerant, useful for the land reclamation and farmstead protection (Zhang, 2000).This genus belongs to the family *Elaeagnaceae* that consists of six species and ten sub species, among which the most economically important one is *Hippophae rhamnoides* L., commonly known as sea-buckthorn. Because it is mainly this species that has been used for economic and biological purpose. The only subspecies *H. rhamnoides* ssp. *turkestanica*, found in the Gilgit-Baltistan and Chitral of Pakistan. Normally it is spread throughout the Karakorum and Himalayan ranges at altitudes of 1500-3500 m. According to a Chinese expert, Professor Rongson, there are about 3000 hectares of *H. rhamnoides* forests in Pakistan, annually producing 1200-1500 tons of sea buck thorn, and various industries producing jams, jellies and capsules at small scale and exporting the berries abroad (Khan, 1999).

Sea-buckthorn is popular due to its high nutritional contents in the berries. The fruit contains 60-80% juice rich in sugar, organic acids, amino acids and vitamins. Vitamins C contents is 200 to 1 500 mg 100 g-1 which is five to 100 times higher than any other fruit or vegetable known (Ahmad and Kamal, 2002). Thus, the sea-buckthorn fruit is being used as a raw material for producing food, medicines and cosmetics. In addition, the sea-buckthorn plant is a good source of firewood and the leaves of sea-buckthorn are good for forage.

Gilgit-Baltistan is spread over an area of 72,496 sq. km populated by about two million people. The per capita land holding is 0.124 hectare. About 57,700 hetares of land is under cultivation of which 46,300 hectares are under cereals, 10,000 hectares under fruits and 1400 hectares under vegetable. The forests occupy some 1100 square kilometer. Most of the animals and poultry birds raising in Gilgit-Baltistan is undertaken on small landholdings. Because of the shortage of cultivable land for fodder, most of the small ruminants are grazed on summer pastures and winter rangelands. Currently, the livestock production exceeds the available feed resources. The production performance in the area is characterized by high mortality and low productivity.

Most of the areas of Gilgit-Baltistan are barren and there is little vegetation on the slopes of the mountains. Due to very low rainfall, thin soil layer and frequent erosion hazards, the opportunities for vegetation rehabilitation are difficult. But still it is the only option to rehabilitate the barren slopes of the mountains. Plants species that are capable of binding soil, providing quick surface cover, fixing nitrogen and tolerate of drought and cold are most desired plants to be grown in the area. In addition, these plants should have a significant value as fodder, food, fuel and medicinal plants, which are particularly favored by the farmers.

Traditional use of sea-buckthorn include fencing of field crops, protecting fruit trees and timber plants, fuel wood production and forage for livestock. However, local people had never thought of planting sea-buckthorn on large scale to play a vital socio-economic role in the development of poor mountain communities.

Present study is conducted for the first time to assess the qualitative valuation of Sea-buckthorn in Gilgit-Baltistan, Pakistan. Sea-buckthorn is one of the common plant species found in the area. Study will help to exploit rich forage resource for ruminant livestock. More than 85% of populations in the area are dependent on subsistence agriculture where livestock plays vital role in the lives of rural communities. Study will also serve as a baseline for future research besides bridging the gap between human and livestock consumption of Sea-buckthorn. Literature is deficient of such information. It will also help in improving livestock nutrition in the area, especially with reference to development of feed supplementation, which will considerably contribute to the sustainability of livestock production in the mountainous region.

Materials and methods

Sample collection

The present study was undertaken to determine the nutritive value of sea-buckthorn leaves, which are commonly used in Gilgit Baltistan for livestock feeding. Sea-buckthorn leaves at their maturity were manually and randomly collected from two locations (Hunza and Gilgit) in September, 2012. Simultaneously, samples of lucerne were also collected for comparison.

Processing of samples

The samples were air dried in shade for 4-7 days. The samples were packed in cloth bags. The air dried samples were ground in a laboratory mill through 1mm screen and were stored in clean labeled bottles for further analysis.

Fig. Map of study area (Gilgit-Baltistan), Pakistan.

Chemical analysis

The ground samples in triplicate were analyzed for dry matter (DM), ash and crude protein (CP) according to the standard procedure of AOAC (1990). The dry matter was determined by drying the samples in a laboratory oven at 100°C for 18 hours. The crucibles containing dried samples after determination of dry matter were further processed for the analysis of ash contents and were incinerated in a muffle furnace at 550°C for 6 hours. Organic matter content in the sample was calculated by subtracting ash from the DM. Crude protein was estimated by the Kjeldhal method. The percent of nitrogen was calculated for the estimation of CP by multiplying it with the factor 6.25. Acid detergent fiber (ADF) and neutral detergent fiber (NDF) were determined as described by Van Soest *et al.* (1991). The in-sacco technique used in the present study was based on the method described by Cottrill and Evans (1984). Dacron bags containing samples were incubated in the rumen of fistulae steer for 24 hours. The loss in weight of the sample after incubation was assumed as degraded in the rumen. After weighing, residues of the triplicate bags were pooled, ground and stored in labeled bottles and analyzed for nitrogen as described earlier.

Statistical analysis

The data were analyzed with the analysis of variance procedure using SAS package (2000). The model included main effects of forage type and location. Means were compared for significance of difference with the LSD procedure described by Steel and Torie (1980).

Results and discussion

Results of chemical composition, in-sacco dry matter degradability and nitrogen degradability of sea-buckthorn and lucerne are summarized in Table 1. Ash represents mineral contents in plants. In the present study the mean ash contents in sea-buckthorn leaves and lucerne were 8.56 and 11.79g/100g on dry matter basis (DM) respectively and statistically significant different was observed at$p<0.0001$.

The finding consistent with the results of the Rongsen (1991) who reported the mean ash content in the leaves of sea-buckthorn range from 3.36 -9.02g/100g with an average value5.10g/100g on dry matter basis. There is a significant variation in ash content among the different species and subspecies (Rongsen (1991). Mean organic matter contents in sea-buckthorn and lucerne was 91.44 and 88.21g/100g on dry matter respectively.

Table 1. Chemical composition, ISDMD and ISND (g/100g) of Sea-buckthorn and Lucerne leaves.

Forage	Ash	Organic Matter	Crude Protein	Acid Detergent Fiber	Neutral Detergent Fiber	ISDMD	ISND
Sea-buckthorn	8.56±0.07*	91.44±0.07*	2.65±0.38*	16.73±0.24*	41.22±6.60ns	54.65±0.20*	29.89±2.00*
Lucerne	11.79±0.32*	88.21±0.32*	22.81±0.75*	22.24±0.75*	43.97±2.27ns	73.24±3.66*	82.47±3.24*

Mean value± SE on dry matter basis.

* and^{ns} indicate the mean values within column are significant and non-significant different with respective to forage at $p < 0.001$.

ISDMD and ISND are represented in-sacco dry matter degradability and in-sacco Nitrogen degradability.

Mean crude protein contents in sea-buckthorn and lucerne were 12.65 and 22.81g/100g DM, respectively. The present results are in line with Rahim (1998) and Hayyat (1998) who reported that crude protein content in tree leaves ranged from 6 to 23g/100g DM significantly varied due to species. Similarly, Rongsen (1991) also determined the protein content in leaves of some species and subspecies of Hippophae China and reported that all species and subspecies were rich in protein. Among them, Hippophae rhamnoides species contained the highest amount of protein (22.92%) and the lowest contents of protein (11.47%) occurred in *Hippophae neurocarpa*. The results are comparatively lower that the Rongson. This may be due to variation in species, physiography, and growth stage of plant material at the time of harvesting attribute to variation in their crude protein contents (Gohl, 1981; Torrie, 1983).

In the present study, leaves of sea-buckthorn were collected at maturity and may explain the lower protein contents. Nevertheless, the present results suggested that mean crude protein contentsin sea-buckthorn were markedly lower than lucerne (12.65 vs 22.81% in DM). However, protein in sea-buckthorn may be more efficiently utilized than lucerne, when fed to a ruminant animal. Moreover, the biological value of protein in sea-buckthorn has been reported high due to its balance composition of amino acids. Zhang *et al.* (1989) reported that sea-buckthorn was rich in essential amino acids. The present results agree with Dicko and Sikena (1992) who reported that concentrations of crude protein in the leaves of the majority of fodder tree and shrubs were above 10%.

In ruminant nutrition, crude fiber analysis is now increasingly replaced by fractioning cell wall contents in to acid detergent fiber (ADF) and neutraldetergent fiber (NDF). Mean ADF contents in sea-buckthorn leaves and lucerne were 16.73 and 22.24g/100g DM, respectively and the difference was statistically significant at $p<0.0001$). Mean NDF contents in sea-buckthorn leaves and lucerne were 41.22 and 43.97g/100g DM, respectively and the difference was statistically non-significant. ADF content was not affected while NDF content was significantly influenced ($P<0.05$) by different locations in sea-buckthorn leaves (Table 2).

Table 2. Chemical composition, ISDMD and ISND (g/100g) of Sea-buckthorn in relation to location.

Location	Ash	Organic Matter	Crude Protein	Acid Detergent Fiber	Neutral Detergent Fiber	ISDMD	ISND
Hunza	8.69±0.02*	91.31±0.02ns	12.05±0.35ns	16.98±0.02ns	29.98±2.98*	54.55±0.41ns	26.44±0.48*
Gilgit	8.43±0.03*	91.57±0.03ns	13.24±0.17ns	16.48±0.48ns	52.45±0.50*	54.75±0.21ns	33.33±0.34*

Mean value± SE on dry matter basis.

* and^{ns} indicate the mean values within column are significant and non-significant different with respective to forage at $p < 0.001$.

ISDMD and ISND are represented in-sacco dry matter degradability and in-sacco nitrogen degradability.

The lower ADF contents in sea-buckthorn than lucerne may suggest better fiber quality of sea-buckthorn for animals. Hayat (1998) ranked tree leaves superior to berseem on the basis of lower ADF and NDF contents in tree leaves. The low ADF value in sea-buckthorn may be due to low concentration of lignin. Bailey and Harkin (1973) reported that tree leaves have generally less lignin than other forage types.

Results of in-sacco dry matter degradability (ISDMD) and in-sacco nitrogen degradability (ISND) of the two forages are presented in Table 1. Mean ISDMD in sea-buckthorn leaves and lucerne were 54.65 and 73.24%, respectively. While mean ISND in sea-buckthorn and lucerne were 29.89 and 82.47%, respectively. Both degradability estimates were significantly influenced by forage type ($P<0.0001$). The difference due to location was non-significant for ISDMD and was significant for ISND ($P<0.01$) in sea-buckthorn leaves (Table 2).

The lower digestibility results in sea-buckthorn leaves may be attributed to their maturity. Other factors such as tannin may have also constrained the accessibility of rumen microbes of leaf protein as discussed by Pitchard *et al.* (1985). The findings of Chen *et al.* (1996) indicated that tannins and polyphenols were present in variable concentration in sea-buckthorn. It is important that protein in tree leaves should be potentially degradable in the rumen to optimize rumen fermentation when used as a sole feed or as a supplement with low nitrogen basal diet. However, due to low ISND in sea-buckthorn, relatively more nitrogen would escape rumen fermentation to small intestine for digestion and absorption. Thus, the bypass value of protein in sea-buckthorn could be ranked higher than lucerne. On the other hand, the high degradability of nitrogen in lucerne (82.47%) indicates its extensive fermentation in the rumen and there will be very little nitrogen that could escape to lower tract.

The resulting ammonia from nitrogen degradation in the rumen may not be utilized completely by the rumen microorganism and large amount in excess of microbes requirement will be excreted as urea from the animal body. It is assumed that animals grazing local range vegetation in Gilgit-Baltistan would not suffer from rumen ammonia deficiency. Feeding of sea-buckthorn leaves as a supplement is highly valued, because the undegraded protein of sea-buckthorn reaching small intestine will complement to increase the availability of total protein for absorption and thus would increase productive performance of the animals. Preston and Leng (1987) reported that dietary protein escaping rumen is more efficiently utilized by the ruminant animal. It is argued that the biological value of protein in sea buckthorn for ruminants would be markedly high. Further studies are also suggested to investigate the nutritive value of sea-buckthorn with reference to productive performance in grazing animals, especially sheep and goats.

Conclusion

At the end of the study we conclude that feeding of sea-buckthorn leaves as a supplement is highly valued because it would increase productive performance of the animals.

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