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Nutritional Analysis of Locally Preferred Fodder Trees of Middle Hills of Nepal: A Case Study from Hemja VDC, Kaski District

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Abstract

The study on nutritional value of locally preferred fodder trees in the farmland of middle hills of Nepal was conducted in Hemja VDC of Kaski district. Primary information on distribution and frequency of fodder trees was obtained through key informants survey, group discussion and observation of the study area. The preference ranking of ten most abundant fodder trees was done on the basis of palatability, propagation easiness, growth rate and competition with agricultural crops. The nutritional value of fodder species was analyzed and compared with the farmers' preference ranking to examine association among them. The analysis correspond farmers' preference of fodder tree species to their nutritional values. The study revealed that *Ficus subinisa* was the dominant fodder tree however, the *Artocarpus lakoocha* was highly preferred trees for its palatability and nourishing values. Nutritional analysis of ten preferred fodder species with respect to moisture, ash, crude protein, crude fat, crude fiber and carbohydrate was carried out. The crude protein varied from 15-29%, in which, *A. lakoocha* to contained the highest amount of crude protein. Similarly, *F. lacor* contained highest crude fiber (42.07%), and *Machilus odoratissima* yielded highest amount of carbohydrate (21.92%).

Key words: crude protein, carbohydrate, nutritional analysis, palatability, preferred species

Introduction

Nepal is a hilly agricultural country where mixed crop-livestock farming system is predominated since centuries (Tulachan & Neupane 1999). Livestock has remained as an indispensable part of the traditional agricultural systems in hilly regions of Nepal (Devkota & Rerkasem 1994). It has played a major role in generating cash income through the production of milk, butter, meat, egg, hides, skin, wool, manure, and draught. Livestock farming has been considered as one of the fastest growing agricultural sectors of Nepal (APP 1995). However, the productivity of these native animals is very low. The major reason of low productivity of the livestock is insufficient and low quality feeds and fodders especially during the dry season (Tulachan & Neupane 1999, Keftara 1994, Pandey *et al*. 1998). Hence, fodder trees from forests, pastures and agricultural lands play major role to meet the defficiency of animal feeds in rural areas.

For the purpose of this paper, fodder trees can be defined as trees bearing leaves and tender twigs palatable to cattle and other animals. In Nepal, this is commonly known as *dale ghans*, a term being used for leaves coming from trees, shrubs, branches, woody vines and herbaceous climbers. Farmers in Nepal have a considerable knowledge of fodder trees and their nutritional qualities (Mahato & Subb 1988). The nutritional values of fodders differ according to species and season of the growth and, therefore, farmers prefer different species for different seasons, and animals to be fed. The traditional and experience-based choice of fodders species by farmers reflects their knowledge on nutritional values, cultivation easiness and seasonal variability of growth in local environments.

Fodder trees are indispensable resources of animal feed in Nepal mainly in the dry seasons (Rana *et al*. 1999). However, present level of fodder tree production is meeting only about 30% of the domestic needs (Miller 1993). In general, fodder tree leaves contain higher protein and calcium compared to grasses and straws (Rana *et al.* 1999) and a wide range of fodder trees have been utilized by the ruminants as a major source of feeding materials (Pandey & Osti 1995). This emphasizes the needs of promoting and developing ranges of fodder trees as important source of feeding materials especially for ruminants in mid hills of Nepal. Fodder trees provide nearly 40% of the total annual fodder requirement of the ruminants in the hills (Malla 2004).

Nutrient contents are fairly high in all fodder tree species however, their amount differs noticeably from one species to another (Subba 1998, Amatya *et al.* 1997, Mahato & Subba 1998). Differences in nutrient contents in an individual species also occur with the change in season (Malla 2004). About one hundred tree species varying greatly in their quality, palatability and preferences to the farmers are being used for this purpose (Pandey 1982). Of them, *B. purpurea, F. nimoralis, A. lakoocha, F. subinisa, F. calvata,* are valued by the farmers as highly nutritive fodders that increase milk and fat (Thapa 1994). They have crude protein up to 16% and are relatively low in tannins. Many fodder species are popular for Terai, Mid-hill and Himalayas. People have more indigenous knowledge towards these fodder tree but not much idea about their nutritive values.

Although nutritional value of some fodder tree species has been widely studied, there is still a lack of study in such values on many common fodder species around the country. More studies are focused on crude protein rather than on others such as carbohydrate, crude fiber, etc. So, this research is applied for evaluating different nutritional values of fodder tree species which help farmers to select useful species. Likewise, farmers will also be aware about the nutritional value of fodder tree species.

Methodology

This study was carried out in Hemja VDC of Kaski district, a mid hill area of central Nepal. The research was conducted from April to September, 2010. The study was undertaken in two stages: i) ranking of most abundant fodder tree of the study area and ii) nutrient analysis of the preferred species in the laboratory. List of fodder trees grown in the study area was obtained through field observation, participatory discussion with lead farmers, tree owners and other key informants. The most abundant species were listed to be used for further ranking exercises. Out of 1800 households of the VDC, 180 (10%) were randomly selected for i) assessment of fodder trees owned and used by the farmers and ii) preference ranking of fodder trees under different criteria. The nutrient analysis of preferred and high ranked species was undertaken in the laboratory.

For ranking of the fodder trees, criteria for preferring fodder species were developed by asking farmers to suggest important qualities of fodder of their choice. Out of several criteria provided, the farmers selected four (criteria) to be important and determinant for the preference of particular species over other. The criteria used were: i) palatability, ii) growth rates, iii) propagation easiness and iv) competition with agricultural crops of the fodder species. List of ten most abundant species were taken to respondents for ranking them from most preferred as ‘I’ to least preferred as ‘IX’ for each criterion. Field note was maintained for further explanation of fodder qualities during the formal and informal discussion in villages.

For nutritional analysis, foliage samples of ten most preferred species were collected. Among top ten most preferred trees, sample were taken from ten trees for each species within the study site and made them composite and used the required samples for the lab test. Each sample was properly labeled, packed in plastic bags and taken to the laboratory. The green samples were air-dried, crushed with plant grinder and 100g of each sample was used for nutritional analysis. The Samples were collected during July-August of the study year to get matured foliage samples from the tree. The analysis was carried out in the medicinal and Aromatic Plants Research Laboratory of the Institute of Forestry and in LI-BIRD Pokhara.

Nutritional analysis

The detailed nutritional analysis protocol has also been published by Magrati *et al.* 2011. A brief procedure is described below. All the nutritional values were reported in percentage (AOAC 1990).

Determination of moisture

One gram of each sample was taken in a petri-dish and placed in an oven at 100 °C for four hours. It was then cooled in desiccators and weighed. The samples were heated again in the oven for another two hours and the process was repeated, till a constant weight obtained. The moisture content was calculated by using the following formula. This process was repeated twice for getting precise data.

$$\text{Moisture (\%)} = \frac{\text{Weight of fresh sample} - \text{Weight of dried sample}}{\text{Weight of sample}} \times 100$$

Determination of ash

One gram dried sample of each species was taken in a crucible and charred over a low flame and kept in a muffle furnace set at 550 ˚C until white ash was obtained. The ash was moistened with water, dried on steam and then on hot plate. The crucible was again placed in the muffle furnace at 550˚C, till a constant weight was obtained. The percent ash was calculated as:

$$\text{Ash (\%)} = \frac{\text{Weight of sample after ash}}{\text{Weight of sample}} \times 100$$

Determination of crude fat

The dried sample of each species was taken and crushed. Two gram of the sample was taken in a paper thimble and connected to a soxhlet extractor. Then 300 ml of petroleum ether was poured on the flask and refluxed for 12 hours with a heating mantle. Crude fat was extracted in a flask. The flask was cooled in a desiccators and the weight was taken. Crude fat was determined by using the formula:

$$\text{Crude fat (\%)} = \frac{\text{Weight of flask with fat} - \text{Weight of empty flask}}{\text{Weight of original sample}} \times 100$$

Determination of crude fiber

One gram of the defatted plant material of each species were taken in beakers and boiled in 200 ml of 1.25% sulphuric acid for 30 minutes. The content was then filtered and washed with distilled water to neutralize the content. The content was transferred again to the beaker and boiled in 200 ml of 1.25% sodium hydroxide for 30 minutes. They were again filtered and washed with distilled water for neutralization. A Gooch crucible was prepared with an asbestos mat and the contents of the beakers were placed on the mat and washed with 15 ml of ethyl alcohol. The crucible was dried in an oven at 110˚C to a constant weight. The crucible having crude fiber was cooled and weighed (W1).

The content of the crucibles were ignited over a low flame until charred and then kept in a muffle furnace at 550˚C and weighed (W2).

The Percentage fiber was determined by the following formula:

$$\text{Crude fiber (\%)} = \frac{W1 - W2}{\text{Weight of sample}} \times 100$$

Determination of protein by micro Kjeldahl's method

Proteins were analyzed by Micro Kjeldahl's method described by Pearson (1976), involving digestion, distillation and titration of the samples.

Digestion

0.5 g of dried plant material of each species was taken in the digestion flask. To this, 1.0 g of the digestion mixture (copper sulphate and potassium sulphate, 1:18) and 7 ml of concentrated sulphuric acid was added. The solution was heated until it became clear and frothing ceased. It was then boiled gently for another 2 hours and then it was cooled down. This digested material was mixed with 30 ml of water with constant mixing. The digest was transferred to 100 ml volumetric flask and necessary amount of water was added up to the mark of the flask.

Distillation

The Parnas Wagner distillation assembly was arranged. 25 ml of 4% boric acid was taken and 1 drop of methyl red indicator was added, by which pink color could be observed. Then 5 ml of the digest was transferred to the distillation assembly and 10 ml of 32% sodium hydroxide solution was added on it. The distillation was completed in 10 minutes indicating the change of color of boric acid to yellow due to the formation of ammonium borate.

Titration

The boric acid having trapped ammonia was titrated with 0.1N hydrochloric acid, the colour of boric acid having ammonia changed again to pink. The percent protein was calculated by the formula:

$$\text{Protein (\%)} = \frac{1.4 \times 6.25 \times 0.1\text{N HCl} \times \text{Vol (used)}}{\text{Weight of sample}}$$

Where;
1.4 = Weight of nitrogen expressed in gram in the formula
6.25 = Protein factor

Determination of carbohydrate
Carbohydrate was determined by difference, using following formula:
Carbohydrate (%) = 100 - (moisture + crude fat + ash + protein)

The results of nutrient analysis was examined and correlated with farmers preference to analyze any causal relationship or association between preference ranks and the nutrient contents of fodder trees. Spearman's rank correlation and its significance by t-test was employed to analyze association between crude protein content with palatability preference of the fodder tree at 5% level of significance.

Results and Discussion

Preference of fodder trees
The result of farmers' preference status of ten most abundant fodder trees has been presented in Table 1. The study revealed that majority of the farmers agreed with *A. lakoocha* as being a highly preferred species and *F. hispida* as the lowest preferred species for palatability criteria. However, *F. subinisa* was found to be highly preferred species for its propagation easiness, fast growth and less competitive with agricultural crops. *B. hanila* was found very fast growing tree species of the study area. Other species like *F. roxburghii, F. glaberrima* and *B. hainla* were not preferred for their competition with agricultural crops.

Table 1. Most preferred fodder tree species by farmers in the study area

Species	Criteria used for preference ranking			
	Palatability	Propagation easiness	Growth rate	Competition with agricultural crops
A. lakoocha (Badhar)	I	IV	V	II
F. subinisa (Bedulo)	II	I	I	II
F. roxburghii (Nimaro)	III	VI	II	IX
F. semicordata (Khanayo)	III	V	V	VIII
L. monopetala (Kutmiro)	IV	IV	II	III
F. lacor (Kavro)	V	V	IV	IV
M. odoratissima (Kaulo)	VI	III	III	VII
F. glaberrima (Pakhuri)	VI	IV	II	IX
B. hainla (Chuletro)	V	II	I	IX
F. hispida (Tote)	VI	IV	V	VII

Note: I = Most preferred, IX = Least preferred

In the study area, it was found that *F. subinisa* was one of the most widely distributed species, mainly grown on the homestead, farmland, and bunds, edge of farmland and grassland. Majority of the farmers agreed that *A. lakoocha* was highly preferred species. However, farmer argued that this species was the most preferred species and they wanted to expand it as compared to *F. subinisa* which is widely distributed fodder of that site. They also reported that *A. lakoocha* contained high nutrient value, which is good for lactating animals. This fodder tree increases milk and fat production together with rapid growth, weight gain and good health of livestock. Farmers felt that *F. roxboughii* and *F. semicordata* were rough, which decrease milk production of the livestock. According to farmers, rough fodders like *F. roxboughii*, *L. monopetala* and *F. hispid* are generally harvested before maturity of their foliage to avoid their roughness for animals. Likewise, *F. glaberrima, M. odoratissima*, *B. hanila* and *F. lacor* were considered just for the survival of livestock and not for supply of nutrition.

Nutritional analysis
Nutrient values of the sampled foliages, which were collected from the study plots have been displayed with their marked variations in their crude protein (CP), crude fiber (CF), crude fat (CF) and carbohydrate in Table 2. The CP contents in these species varied from 15% to 29% with *A. lakoocha* containing the highest CP of 28.64%, while *M. odoratissima* having the lowest CP of 15.54%. CF content was high in *B. hanila* (3.22%) and low in *F. semicordata* (1%). Similarly, CF is high in *F. lacor* (42.07%) and low in *F. hispida* (23.03%), and carbohydrate content is high in *M. odoratissima*

(21.92%) and low in *F. hispida* (0.34%). Similar variations are also reported by other research groups (Rana *et al.* 1999 Brandis, 1978, Malla 2004, Kayastha *et al.* 1998 and Pandey *et al.* 2003).

Table 2. Nutritional values of ten preferred fodder tree species

S.N.	Species	Moisture (%)	Ash (%)	Crude Protein (%)	Crude Fat (%)	Crude Fiber (%)	Carbohydrate (%)
1	*A. lakoocha*	61.0	8.0	28.64	1.52	26.31	0.84
2	*F. subinisa*	59.8	11.5	24.88	1.84	30.07	1.98
3	*F. roxburghii*	66.4	11.5	18.13	2.34	26.31	1.63
4	*F. semicordata*	64.0	12.5	19.70	1.00	24.77	2.80
5	*L. monopetala*	66.0	5.0	26.70	1.14	30.72	1.16
6	*F. lacor*	67.1	4.0	17.61	1.91	42.07	9.38
7	*M. odoratissima*	54.2	5.5	15.54	2.84	41.39	21.92
8	*F. glaberrima*	66.6	14.0	17.11	1.24	27.40	1.05
9	*B. hainla*	61.3	8.5	25.16	3.22	26.95	1.82
10	*F. hispida*	59.0	17.5	21.11	2.05	23.03	0.34

In this study, the CP content of *A. lakoocha* was found to be higher (28.64%) than the reported value of 13.17% by Rana *et al*. (1999) and 16.00% by Brandis (1978). Likewise, CP content in *F. subinisa* (24.88%) was found to be consistent with the reported data by Brandis (1978), Malla (2004), Kayastha *et al.* (1998) and Pandey *et al.* (2003). The CP content of *F. roxburghii* was observed to be 18.13%, which was also consistent with the data reported by Malla (2004), but was higher (12.13%) than the value reported by Singh (1982). Similarly, CP content of *F. semicordata* (19.7%) was found to be lower than the reported value of 24.27% by Pandey *et al.* (2003). Similarly, CP content of *L. monopetala* (26.7%) was found to be higher than the values of 21.34%, 17.19% and 14.17% respectively, reported by Pandey *et al.* (2003), Rana (1999) and Jackson (1994). CP content of *F. lacor* (17.61%) was less than the reported value of 22.03% by Pandey *et al.* (2003). CP content of *F. glaberrima* (17.11%) was found to be similar to the value reported by Brandis (1978) and Pandey *et al.* (2003). Similarly, CP content of *B. hainla* (25.16%) was higher than reported by Kayastha *et al.* (1998) and Brandis (1978). CP content of *F. hispida* (21.11%) was higher than value reported by Kayastha *et al.* (1998). Literature evidences on CF of *F. subinisa* (32.23%) reported by Pandey *et al.* (2003) was almost similar (30.07%) to present study. Likewise, CF content of *L. monopetala* (47.15%) reported by Pandey *et al*. (2003) was higher than this study (30.72%). CF content of *F. semicordata* (36.94%) reported by Pandey *et al.* (2003) was also higher than our result (24.77%). The CF reported for *B. hainla* (32.26%) by Pandey *et al.* (2003) was also higher than our result (26.95%). The overall study and comparison with the literature indicated that the nutrient analysis was found to be within the ranges of other studies. But, the marked differences from other reported values could be associated with several attributes such as season and maturity stage of the foliage used for the analysis and the climatic conditions of the study sites compared to other studies.

The overall study indicated that fodder trees are important source of protein and other dietary supplements for livestock. The relation between proteins versus palatability is also compared. For this analysis, the crude protein value from the laboratory test and preference ranking data from the farmers were taken. It was found that there was association between farmers' preference for palatability and crude protein contents of the fodders. *A. lakkoocha* highly preferred by farmers was also found to have higher content of CF. It revealed farmers' experiences, subjective judgement and indigenous knowledge for fodder preferences can be constituent with its nutrient contents and are able to select high quality fodder for their livestock.

Farmers' preference ranking of different fodder trees was found to be associated with nutrient contents of the foliage from laboratory tests. The fodder trees were ranked based on four criteria: palatability, propagation esiness, growth rate and competition with agricultural crops. The highly preferred species were found to have high nutrient contents as shown by lab test. Farmers used their conscience to select species and harvesting season for particular species. Farmers value fodders that can have better nourishing quality for livestock. Due to this, despite the slow growth rate, farmers preferred *A. lakoocha* for its high nutritious value.

Likewise, *F. subnisa* was highly preferred species based on ease on propagation and fast growth. Hence, *A. lakoocha* and *F. subinisa* were highly preferred species based on competitive ability with agricultural crop because these two species has no shading and harmful effect for their agricultural crop.

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