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Nutritional Evaluation of Some Top Fodder Tree Leaves and Shrubs of District Chakwal, Pakistan in Relation to Ruminants Requirements

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Abstract: The aim of present research was to record out the nutritional evaluation of different fodder tree leaves and shrubs of district Chakwal, Pakistan. The climate of this range is characterized by a relatively low annual rainfall (350-500 mm). Temperature during winter is 4-25°C and during summer is 15-40°C. Top 15 tree leaves and shrubs, i.e *Acacia nilotica, Acacia modesta, Albizzia lebbeck, Capparis decidua, Elaeagnus angustifolia, Grawia optiva, Grewia populifolia, Melia azedarach, Gymnosporia royleana, Indigofera gerardiana, Morus alba, Prosopis cineraria, Panicum antidotale, Ziziphus mauritiana* and *Zizyphus mummularia* were identified and analyzed for proximate analysis, i.e; DM (Dry Matter), CP (Crude Protein), CF (Crude Fiber), Ash, EE (Ether Extract) and gross energy. The gross energy of the foliages is almost lies between 16.09 to 17.96 Mcal/kg. The DM, CP, CF, ash EE contents of the foliages varied from 66.17-40.38, 11.12-19.05, 13.91-30.50, 7.19-13.91, 1.44-6.45% of DM, respectively.

Key words: Nutritional evaluation, fodder tree leaves, gross energy

INTRODUCTION

The current status of animal protein deficiency in developing world is caused by lack of forage. Fodder trees and shrubs have always played a role in feeding livestock. Trees and shrubs are increasingly recognized as important components of animal feeding, especially as suppliers of protein. In difficult environmental conditions, where the available grazing is not sufficient to meet the maintenance requirements of animals for part of the year, the contribution from trees and shrubs is significant. Tree fodders contain high levels of crude protein and minerals and many show high levels of digestibility. They are readily accepted by livestock and presumably because of their deep-root systems, they continue to produce well into the dry season. However, antinutritive factors can be a problem in some species (Paterson *et al*., 1998).

Natural pasture and crop residues are major sources in the highlands. These feed resources are characterised by low digestibility, protein content and mineral composition (Seyoum and Zinash, 1998). Fodder tree and shrub species are mostly required as supplement to low quality feeds. Fodder tree and shrub species are considered important contributors to grazing animal nutrition in the highlands of Galessa-Jeldu areas. During the dry and crop-fallow season, farmers traditionally feed indigenous fodder species to meet nutritional requirements of the grazing animals. So far, very little work has been done on the identification, prioritization and characterization of indigenous fodder and soil improving trees and shrubs in high altitude areas of Galessa-Jeldu areas of Rawalpindi. Similarly, farmers' local knowledge on indigenous fodder trees and shrub species are not strongly supported by scientific investigations. Grazing livestock in warm climates have to depend largely upon forage to fulfill their mineral requirements. Forages rarely satisfy all of the needed mineral requirements of grazing livestock (McDowell, 1977). It has been reported that mineral concentrations in both soils and plants affect the mineral status of grazing livestock (Towers and Clark, 1983). At the same time litter is known about the energy, proximate and cell wall composition of fodder tree leaves.

Lefroy *et al*. (1992) documents the importance of trees, shrubs and herbs for their nutrition capacity for browsing and grazing animals, especially in areas of poor quality pastures for longer period of time. Compared to grasses, fodder trees, shrubs and herbs have relatively higher concentrations of CP, minerals, neutral detergent fiber, while their average concentration in acid detergent fiber, as well as their average dry matter, were both lower. These nutrients contents were subject to less variation than with grasses and this particularly enhances their values as dry season feeds for livestock (Wilson, 1969; Ibrahim, 1981). During the first growth of the grass species, energy content varied mainly with age, whereas during re-growth and in legumes the affect is smaller (Daccord *et al*., 2002). Significant variations existed between species for mineral concentrations which range from inadequate to toxic levels for the production of livestock.

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In the past, research efforts on alternative feed resources for ruminants have concentrated more on a limited number of the available plant foliages with little information on the nutrient status of the various other foliages in relation to their being utilized as feed for ruminants. The present study was therefore undertaken to explore nutrient contents of 6 fodder tree leaves available in the district Cahwal Rawalpindi Pakistan consumed by ruminants. The experimental foliage species were selected because they are abundantly available and highly preferred by ruminants in its natural habitat and because farmers strongly believe that these foliage species are highly nutritious.

MATERIALS AND METHODS

Location and climate: Chakwal is located in the south of Rawalpindi at a distance of 97 km. It lies between 32° 56' north and 72° 54' east. The environment is cool with subhumid climate. The colour of the soil of this area is brown. Almost 90% population lives in rural areas. Vegetation of Chakwal is scrubby (Anonymous, 1987). The rainfall mostly received during monsoon season in between mid of July to the mid of September with the range of 350-500 mm. The winter rain begins in January and persists up to beginning of March. The mean monthly temperature ranges 5.9-38.4°C, whereas January being the coldest and June the hottest month of the year. Temperature during summer is 15-40°C and during winter is 4-25°C. In winter the temperature often drops below zero, usually in December and January.

Study area: The study was carried out in the Pothwar Scrub rangeland of Chakwal to investigate the seasonal variations of nutritional characteristics of different fodder tree leaves and shrubs. Chakwal lies in the subtropical region and its climate is typical of the area, with the exception that it varies a little on the cooler side, owing to its elevation, from central Punjab.

Fig. 1: Location map of study area

Sample collection: Most dominant fodder tree leaves and shrubs in the region, which are being used for feeding ruminants locally, were *Acacia nilotica*, *Acacia modesta*, *Albizzia lebbeck*, *Capparis decidua*, *Elaeagnus angustifolia*, *Grawia optiva*, *Grewia populifolia*, *Melia azedarach*, *Gymnosporia royleana*, *Indigofera gerardiana*, *Morus alba*, *Prosopis cineraria*, *Panicum antidotale*, *Ziziphus mauritiana* and *Zizyphus mummularia*. The green leaves were rinsed in distilled water to remove dust and stored in a refrigerator to be freeze dried as soon as possible after collection. All the foliages were cut into small pieces so as to facilitate easy handling and uniform sampling for analysis. Samples were dried in the hot air oven at 65°C for 24 h and ground to pass through 1-mm sieve, grinded and stored in polythene bags at room temperature. All samples were collected within 25 days to minimize effects of sampling time on nutrient composition. These samples were analyzed chemically. The procedures followed are described below:

Foliages samples were air dried until the weight of dry matter became constant. The moisture will be determined by drying the sample at 75°C to a constant weight. The difference between the fresh and dry weight will be used for calculation of moisture content of the sample. The dry matter percentage was calculated by following formula:

$$\text{Dry matter (DM) \%} = \frac{\text{Dry weight of the sample}}{\text{Fresh weight of the sample}} \times 100$$

The air dried foliages samples were oven dried at 100°C for 24 h for chemical analysis.

Chemical analysis: Dry Matter (DM), Crude Protein (CP), Crude Fiber (CF), Ether Extract (EE) and ash of the samples were determined according to AOAC (1990). The dry matter was determined by drying the samples at 80°C till constant weight. Crude protein was estimated by micro kjeldhal method. Oven dried sample was digested with H_2SO_4 in the presence of catalyst mixture containing K_2SO_4 and $CuSO_4$. A known aliquate of the diluted sample was distilled in the presence of 10 ml of 2% boric acid solution and titrated against standard 0.1 N H_2SO_4. The percent of nitrogen was calculated for the estimation of CP. The ether extract in a sample was determined by extracting with diethyl ether at 60°C in soxhlet's apparatus. For crude fiber, sample was reflexed first with 1.25% H_2SO_4 and subsequently with 1.25% NaOH for 30 min each to dissolve acid and alkali soluble component present in it. The residue containing CF was dried to a constant weight and the dried residue was ignited in muffle furnace, loss of weight on ignition was calculated to express it as CF. For ash, sample was ignited in muffle furnace at 550°C to burn all the organic matter and leftover was weighed as ash. The Nitrogen

Free Extract (NFE) was calculated by subtracting the sum of CP, EE, CF and ash from sample weight on dry matter basis.

Nitrogen-free extract: Nitrogen-free extract was determined on dry matter basis as:

$$\% NFE = 100 - (\%CP + \%CF + \%EE + \%ash)$$

For gross energy calculation, dried ground material (0.5 g) was taken in crucible the crucible was put in the vessel. For firing, 80 mm length of pure cotton is huge over the firing wire (a 40 mm of 0.4 nichrome wire) with its tail touching the sample. 3000 kpa pressure was filled in the vessel. The vessel is ready for gross energy calculation. Gross energy of the samples also calculated by the help of bomb calorimeter (CAL^{2k} calorimeter, USA) according to methods suggested by the manufacturer. A benzoic acid standard was used for calibration of bomb calorimeter.

Statistical analysis: Detail statistical analysis was not carried out but the average figure with their standard derivation has been given with the help of Minitab version 15. This was just an idea about the nutrititive value of the leaves from Chakwal district fodder tree leaves. A minimum of five observations were polled for each of the species to calculate the average values.

RESULTS AND DISCUSSION

Dry Matter (DM) is the actual amount of feed material leaving water and volatile acids and bases if present. The DM contents of various foliages used for feeding livestock in the study area varied from 66.17 to 40.38% and the mean was 50.03±2.11%. Most of the samples contained DM more than 40%, while only few of them contained more than 60% DM (Table 1). The highest DM value was observed for *Grawia optiva* followed by *Indigofera gerardiana*, *Elaeagnus angustifolia*, *Morus alba*, *Acacia modesta*, *Ficus religiosa*, *Zizyphus mummularia*, *Albizzia lebbeck*, *Prosopis cineraria*, *Grawia popolifdia* and *Acacia nilotica* respectively. *Gymnosporia royleana*, *Melia azedarach* and *Ziziphus mauritiana* were observed lower DM value. High DM content could be due to the time of sampling between November and January, after 6 months of little new growth. Moreover farmers start harvesting of the foliages somewhere in October when other sources of green forage are declining and it continues till the end of March /April. Actual harvesting time and its duration, however, depends on the availability of fodder in the tree and numbers of ruminants a farmer owns. Nevertheless, it indicated that they constitute an important, reasonable and reliable source of DM, beside other nutrients, for feeding ruminants in the Chakwal. The CP contents of fodder varied from 11.12-19.05% and the mean was 14.51±0.727%. The highest CP value was observed for *Albizzia lebbeck* followed by *Grawia optiva*, *Acacia modesta*, *Gymnosporia royleana*, *Morus alba*, *Prosopis cineraria*, *Grawia popolifdia*, *Ziziphus mauritiana*, *Melia azedarach* and *Indigofera gerardiana* respectively. *Zizyphus mummularia*, *Ficus religiosa*, *Acacia nilotica* and *Elaeagnus angustifolia* were observed lower DM value. This has been demonstrated in other tree legume browse in various studies (Abdulrazak *et al*., 1997; Ben Salem *et al*., 1997; Ondiek *et al*., 1999; Abdulrazak *et al*., 2000; Ondiek *et al*., 2000; Abdulrazak *et al*., 2001; Adjorlolo *et al*., 2001; Nantoume *et al*., 2001). The findings of this study were in line with those of Bakshi and Wadhwa (2004) they also reported an high CP in the *M. azedarach* and *M. alba*. Srivastava *et al*. (2006) reported high CP contents of *M. alba*, 15.31-30.91% on DM basis. Similar findings were reported by Ba *et al*. (2005) who reported high CP contents, 18 to 25% on DM. Therefore mulberry leaves have a high potential as a protein-rich forage supplement for animal production (Benavides, 2000). Proteins of mulberry leaves are of high quality and used with wheat flour to make parathas in the sub-continent. Distel *et al*. (2005) reported that CP contents in different forage species declined with time. CP contents of all the species of this study were higher than 10%, sufficient for medium level of production from ruminants (Subba, 1999). Subba (1999) has reported that a higher proportion of the CP in the fodder tree leaves is actually in the form available to ruminants. The fodder tree leaves like etc. are higher perforred by the farmers for their palatability and performance of the animal.

Dry matter and crude protein contents of different fodders showed wide variations. These variations could be a result of agronomic factors such as application of various levels of nitrogen fertilizers, time of harvest, ensiling, field drying and storage. Similar findings have been reported in Italian rye grass for its dry matter yield, which varied from 18.8-75.5% mainly due to different harvesting time (Bittante and Andrightto, 1982). Like DM and CP, other nutrients could also vary in different feeds due to agroclimatic conditions, cultural practices and post-harvest processing and storage conditions. The crude fibre contents varied from 13.91-30.50% and the mean was 22.73±1.28%. The highest fibre content value was for *Gymnosporia royleana* followed by *Elaeagnus angustifolia Grawia popolifdia*, *Ziziphus nauritiana*, *Albizzia lebbeck*, *Ficus religiosa*, *Indigofera gerardiana*, *Acacia modesta*, *Zizyphus mummularia*, *Melia azedarach*, *Morus alba*, *Prosopis cineraria* and *Grawia optiva* respectively. The lowest value was observed for *Acacia nilotica*. The ash contents varied from 7.19 to 13.91% and the mean was 9.76±0.64%. The highest ash value was for *Grawia optiva* followed by *Ficus religiosa*, *Morus alba*, *Ziziphus mauritiana*, *Elaeagnus angustifolia*, *Albizzia lebbeck*, *Grawia popolifdia*,

Table 1: Description of the fodder tree leaves and shrubs of District Chakwal, of Pakistan

Scientific name	Common name	Family	Description
Acacia modesta	Phulai	Mimosaceae	Deciduous tree; height 10-12 m; Green Biomass Yield (GBY) up to 180 kg/tree/cutting FB (fresh basis); 2-3 cuttings/year, The tree yields a gum, which is restorative.
Acacia nilotica	Kiker	Mimosaceae	Extract from wood is used as astringent in diarrhea and applied in spongy gums.
Albizzia lebbeck	Siris	Mimosaceae	The root is sued in hemicramia. The bark is bitter, cooling, alexiteric, anthelmintic. It cures leucoderma, itching, skin diseases, piles, excessive perspiration and inflammations. The leaves are good for opthalmia. The flowers are given for asthma and snake bite.
Elaeagnus angustifolia	Ghonair	Elaeagnaceae	Leaves are chief source for fodder and Fruits are also used for the dysenteric problems of the cattles.
Grewia optiva	Peepal	Moraceae	A small tree, sometimes reaching up to 15 m in height, trunk with ashy-white bark. Branches spreading, young shoots divaricate, rough with stellate tomentum. Leaves with 4-10 mm long, scabrous petiole; lamina stellate-tomentose on both sides, rough, ovate to broadly ovate, 3.5-10 cm long, 2-6.5 cm broad, 3-costate, oblique or obtuse at the base, margin glandular-crenate, acute to acuminate; stipules subulate, c. 4-5 mm long, densely hairy, caducous. Cyme 2-8-flowered, antiphyllous, very rarely axillary, peduncle solitary, 2-3.5 cm long, densely hairy to almost glabrous.
Grewia populifolia	Dhaman	Tiliaceae	A suberect to erect shrub, up to 3 m tall. Stem with ash-grey bark, young twigs stellate hairy. Leaves 3-5-costate, almost glabrous to sparsely or densely stellate hairy on both sides, ovate-elliptic or obovate to almost orbicular, 0.6-4.5 cm long, 0.4-4 cm broad, sharply serrate, cuneate at the base, acute to obtuse, rarely emarginate at the apex; petiole 2-14 mm long, hairy; stipules linear-lanceolate, caducous. Flowers solitary or rarely paired, on solitary, antiphyllous, (0.6-) 1.2 cm long, hairy peduncle, white, rarely yellowish-white, 2-2.5 cm across; pedicel c. half as long as peduncle, stellate tomentose. Sepals linear-oblong, (1-) 1.4 (-1.6) cm long, c. 3-4 mm broad, stellate hairy outside.
Capparis decidua	Gunger	Malvaceae	Low shrubs to small trees with leafless green crooked spiny branches, up to 5 m (rarely more) high. Leaves present on young twigs, caducous, linear, 4-20 mm long, 1-3 mm broad, often spine-tipped, subsessile; stipular spines 1-6 mm long, straight or slightly curved, yellow or brown.
Indigofera gerardiana	Kander	Celastraceae	Shrub, 1.8-2.5 m tall. Leaflets 9-17, c. 1.0-1.3 cm long. Inflorescence 2.5-12.5 cm long, a pedunculate raceme. Fruit c. 2.5-5.0 cm long.
Melia azedarach	derek	Meliaceae	Deciduous tree. The adult tree has a rounded crown and measures between 7 and 12 metres in height. The leaves are up to 50 cm long, alternate, long-petioled, 2 or 3 times compound.
Morus alba	Toot	Oleaceae	These are also best fodder for livestock. Stem and branches are used for making handles of agricultural tools. Roots are used for diabetes and fruits are used as general tonic and sore throat.
Prosopis cineraria	Jandi	Fabaceae	Small thorny, irregularly branched tree, 5-10 in high. Evergreen or nearly so, it forms an open crown and has thick, rough gray bark with deep fissures. The leaves are an available, excellent and nutritious fodder, readily eaten by many animals including camels and goats.
Ziziphus mauritiana	Berry	Rhymnaceae	Spiny, evergreen shrub or small tree up to 15 m high, with trunk 40 cm or more in diameter; spreading crown; stipular spines and many drooping branches. Medium sized tree that grows vigorously and has a rapidly developing taproot, a necessary adaptation to drought conditions. In parts of world, the leaves of ber are used as nutritious fodder for sheep and goats. Tree, 9-15 m or large shrub, branches spreading and drooping, young branches softly tomentose, longer stipular spine, c. 5-7 mm long, sometime without spines.
Zizyphus nummularia	Jharber	Rhymnaceae	The leaves provide excellent fodder for livestock. The leaves are collected dried and stored. It is a shrub up to 2 meters high, branching to form a thicket. The dried leaves, called pala, are used as fodder for goats and cows.

Indigofera gerardiana, *Prosopis cineraria*, *Acacia modesta*, *Zizyphus mummularia*, *Gymnosporia royleana*, *Acacia nilotica* respectively. The lowest value was observed for *Melia azedarach*. The ether extract varied from to 1.44-6.45% and the mean was 3.00±0.38%. The highest ether extract value was for *Morus alba* followed by *Albizzia lebbeck*, *Elaeagnus angustifolia*, *Melia azedarach*, *Grawia popolifdia*, *Ficus*

Table 2: Proximate composition (% in DM) of fodder tree leaves and shrubs of District Chakwal of Pakistan

Fodder tree leave*	DM	CP	CF	Ash	EE	NFE
Acacia modesta	53.43	16.26	22.80	8.08	2.13	50.73
Acacia nilotica	44.78	11.81	13.91	7.86	2.73	63.69
Albizzia lebbeck	37.24	19.50	26.45	10.41	5.04	38.60
Elaeagnus angustifolia	58.12	11.12	27.21	11.23	4.09	46.26
Ficus religiosa	50.50	11.70	26.16	12.90	2.90	46.34
Grawia optiva	38.17	19.37	17.83	13.91	2.52	46.37
Grawia popolifdia	45.20	15.07	26.64	10.05	3.19	50.05
Gymnosporia royleana	40.86	15.67	30.50	7.88	1.58	44.37
Indigofera gerardiana	60.90	12.20	24.25	9.00	1.69	52.86
Melia azedarach	21.70	14.09	18.96	5.3	4.04	57.61
Morus alba	54.69	15.43	18.49	12.17	6.45	47.46
Prosopis cineraria	46.15	15.23	18.19	8.16	1.85	56.57
Ziziphus mauritiana	40.38	14.21	26.60	11.88	2.41	44.90
Zizyphus mummularia	23.28	11.48	20.21	7.93	1.44	58.94
Mean	50.03	14.51	22.73	9.76	3.00	50.34
SE	0.727	0.72	1.28	0.64	0.38	1.83

DM = Dry Matter, CP = Crude Protein, CF = Crude Fiber, NFE = Nitrogen Free Extract, TDN = Total Nutrient Digestibility, SD = Standard Deviation; CV = Coefficient of Variation. *Value represents assays of single sample collected from a single tree

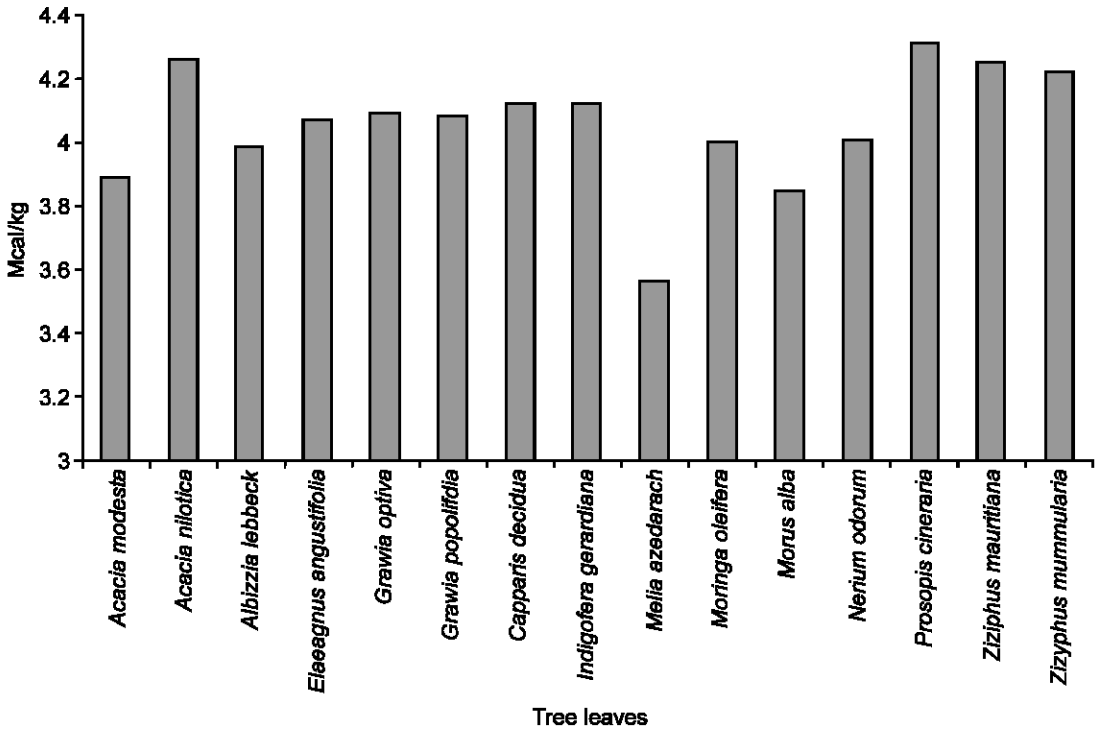

Fig. 2: Energy (Mcal/kg) of fodder tree leaves and shrubs of district Chakwal of Pakistan

religiosa, *Acacia nilotica*, *Grawia optiva*, *Ziziphus mauritiana*, *Acacia modesta*, *Indigofera gerardiana*, *Gymnosporia royleana*, *Prosopis cineraria*, The lowest value was observed for *Melia azedarach*. The NFE contents varied from 13.91-30.50% and the mean was 22.73±1.28%. The highest NFE value was for *Morus alba* followed by *Albizzia lebbeck*, *Prosopis cineraria*, *Acacia modesta*, *Zizyphus mummularia*, *Acacia nilotica* respectively. The lowest value was observed for *Melia azedarach*. The gross energy of foliages varied from 16.09-17.96 Mcal/kg.

Conclusion: Our current investigations on nutritional evaluation of foliages have revealed that these plants are good source of nutrients (proteins, fats, carbohydrates, fiber and minerals) and can be used as substrates deficit in either of these nutrients for livestock grazing in this specific district.

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