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Comparative nutritional evaluation of forest tree leaves and wild grasses of semi hilly arid zone in Punjab

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ABSTRACT

Samples of 26 species of forest tree leaves and 10 species of wild grasses commonly fed to livestock in the semi-hilly arid zone of Punjab State were collected at 30 day interval for 12 months. The tree leaves as compared to grasses had higher CP, EE and acid detergent lignin content, while reverse trend was observed with respect to NDF, ADF, cellulose and hemicelluloses content. The mineral profile revealed that calcium, magnesium and copper content was higher, while zinc content was lower in tree leaves as compared to grasses. But the phosphorus, iron, manganese and cobalt content was observed to be statistically comparable. The calcium and magnesium content in both the tree leaves and grasses was much higher than the requirements for dairy cattle, but both were highly deficient in P, and most of the trace elements. The antimetabolites like total tannins, condensed tannins and hydrolysable tannins were higher in tree leaves as compared to grasses by 83.2, 98.8 and 75.7%, respectively. The condensed tannins as per cent of total tannins were higher in tree leaves, while hydrolysable tannins as per cent of total tannins were higher in wild grasses. The water soluble oxalate content was comparable in tree leaves and grasses, but the concentration was much lower than the toxic level of 4%. The digestion kinetic parameters for DM and NDF also revealed that tree leaves were degraded at faster rate and had higher effective and true degradability. The rumen fill was lower in tree leaves as compared to grasses predicting higher voluntary dry matter intake in tree leaves. It was concluded that the tree leaves had greater potential as alternate feed resources as compared to wild grasses.

Key words: Digestion kinetics, Forest tree leaves, *In-sacco* degradability, Mineral profile, Tannins, Wild grasses

In India, out of 190.77 million(m) ha total cropped area, 10.43 and 8.14 mha area is under permanent pasture, other grazing land (Annonymous 2007) and fodder production (Annonymous 2006) constituting only 5.5 and 4.3% respectively. The diet of the animals in semi hilly arid region of Punjab was found deficient in nutrients (Hundal *et al.* 2009). Majority of the livestock in such regions are dependent on forest grasses and tree leaves. Out of 20 species of forest tree leaves and 10 species of wild grasses, leaves of *Morus alba, Ehretia leavis, Grewea optiva, Anogeissus latifolia,* Kango*, Melia azedarach* and *Leucaena leucocephala* (Bakshi and Wadhwa 2004, Bakshi *et al.* 2011) and grasses like *Taraxacum purpureum* and *Sancharum spontaneum* (Bakshi *et al.* 2005) were found highly nutritious and showed great potential as alternate feed resources. Based on tannin profile, it was concluded that leaves of *A. nilotica, A. latilfolia* and *L. leucocephala* could serve as an excellent alternate feed stuffs for ruminants, and that feeding of leaves of *Phoenix, Carrisa, Bauhinia* and *Dodonea* should be avoided (Rana *et al*. 2006). Leaves of *M. azedarach, M. alba* and *L. leucocephala* along with supplements proved to be excellent alternate feedstuffs for small ruminants (Bakshi and Wadhwa 2007). However, till date no report is available on the comparative nutritive value of tree leaves and wild grasses. Therefore, an attempt was made to assess the comparative potential of tree leaves and wild grasses as livestock feed.

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MATERIALS AND METHODS

Procurement of tree leaves and wild grasses: Samples of 26 species of forest tree leaves [*kikar* (*Acacia nilotica*)*, tun* (*Toona ciliate*)*, tut* (*Morus alba*), *garuna* (*Carrisa spinarum*)*, chamroar* (*Ehretia leavis*), *tahli* (*Dalbergea sisso*), *chanjhan* (*Ougenia oojeiuealis*)*,* subabul (*Leucaena leucocephala*), *beri* (*Zizyphus mauritiana*)*,* neem (*Azadirachta indica*)*, malha* (not available), *mahender* (*Dodonea viscose*)*, biul* (*Grewea optiva*), *phulahi* (*Acacia modesta*), *kachnar* (*Bauhina variegate*), *khajur* (*Phoenix acaulis*), *dhak* (*Butea monosperma*), *kango* (Not available), *bans* (*Bambusa arundinacea*)*, chall* (*Anogeissus latifolia*), *dhrake* (*Melia azedarach*), *pilkan* (*Ficus glomerata* var. *sublanceolata*), *gular* (*Ficus glomerata*), *sreen* (*Albizzia lebbock*), *pipal* (*Ficus religoosa*), *subabul* (*Leucaena leucocephala*)] and 10 species of wild grasses [*barua* (*Taraxacum purpureum*), Sancharus (*Sancharum spontaneum*), *bansari* (not available), *kahi* (not available), *khahu* (*Olea ferruginea*), *kana* (*Saccarum munja*), *baghar* (*Eulaliopsis binata*), *sarla* (*Chrysopogon aciculatus*), *tholu* (not available) and *badewan* (not available)] commonly fed to livestock in the semi-hilly arid zone of Punjab State were collected at 30 day interval for 12 months and dried in a forced air oven at 60°C for 48 h.

In sacco *studies*: Three male rumen fistulated buffaloes (live weight 387 ± 25 kg) were used for *in sacco* degradability studies. Animals were maintained on 1.5 kg concentrate mixture (maize 15, wheat 15, mustard cake 20, groundnut cake 10, rice bran 10, deoiled rice polish 27, mineral mixture 2, salt 1 part each) supplemented with 5 kg wheat straw and 2 kg green fodder so as to meet their nutrient requirements (NRC 2001). Animals were adapted for 20 days on this diet before starting the *in sacco* evaluation. The *in sacco* degradability was assessed by parachute nylon bag (8 cm ×15 cm; 50±10 µ pore size) technique (Mehrez and Orskov 1977). The bags containing 3 g ground test sample in triplicate were incubated in the rumen of 3 rumen fistulated male buffaloes. The bags were taken out at 0, 3, 6, 9, 12, 24, 36, 48, 60 and 72 h after incubation in the rumen. The bags were washed under running tap water till the rinsing water became colourless. The bags after squeezing gently were dried at 55°C for 48 h. The disappearance of DM was calculated from the amount incubated and left in the bag at each incubation period. The residue was also analysed for N and NDF for determining their rate and extent of digestion in the rumen. The different parameters, characterizing extent and rate of ruminal degradation i.e. 'a' rapidly soluble fraction, 'b' insoluble but degradable fraction, and 'c' degradation rate of potentially degradable fraction were calculated according to Orskov *et al.* (1988). The effective degradability was estimated according to McDonald (1981) at an outflow rate of 5% / h. The rumen fill values were calculated by using the equation of Van Eys (1982).

Chemical and statistical analysis: The finely ground samples of tree leaves were analyzed for proximate components (AOAC 1995), cellulose (Crampton and Maynard 1938) and other cell wall constituents (Robertson and Van Soest 1981). Tannins were extracted, from fat free samples, using 70% aqueous acetone. The contents were centrifuged at 3000g at 4°C for 10 min and the supernatant was taken for determination of tannins by Folin-Ciocalteu reagent using tannic acid as a standard (Makkar *et al.* 1993). Condensed tannins were determined by using butanol-HCl (Porter *et al.* 1986). The hydrolysable tannins were calculated by subtracting the condensed tannins from total tannins. Water soluble oxalates were estimated as per Abaza *et al.* (1968). The extractable aliquots were used for the estimation of Zn, Fe, Cu, Mn and Co by atomic absorption spectrophotometer, while calcium by AOAC (1995) and phosphorus was determined by colorimetric method (Jackson 1987). The data of all the parameters were pooled separately for leaves and grasses and analysed statistically by following simple ANOVA (Snedecor and Cochran 1994) by using SPSS (2007) version 16.0. The means were compared for statistical significance by using Tukey's b.

RESULTS AND DISCUSSION

The chemical composition of tree leaves and wild grasses revealed that the OM content was comparable, but CP and EE contents were higher ($P<0.01$) in tree leaves as compared to grasses (Table 1) by 46.4 and 36.0%, respectively. With regards to cell wall constituents; NDF, ADF, cellulose and hemicelluloses content were higher ($P<0.01$) in grasses as compared to tree leaves by 34.5, 15.5, 52.2 and 71.5%, respectively. But, acid detergent lignin content was higher ($P<0.01$) in tree leaves as compared to grasses by 35.3%.

The mineral profile of tree leaves and grasses revealed that calcium and magnesium content was higher ($P<0.01$) in tree leaves as compared to grasses (Table 2) by 52.89 and 43.34%, respectively. But the phosphorus content was observed to be comparable. The tree leaves contained higher ($P<0.05$) copper, but lower ($P<0.01$) zinc as compared to wild grasses by 36.4 and 47.4%, respectively. The iron, manganese and cobalt content were comparable in tree leaves and grasses. In comparison to NRC (2001) recommendations for complete feed for dairy cattle, the Ca and Mg content in tree leaves and wild grasses was much higher than the requirements (Table 2), which could be useful for high yielding animals during early stages of lactation. However, the average concentration of calcium in tree leaves was found beyond tolerance limits. But, both the tree leaves and wild grasses were highly deficient in phosphorus and most of the trace elements. It is therefore recommended that animals in semi hilly arid zone must be provided area specific, quality mineral mixture, to avoid the mineral deficiencies in the live stock.

Table 1. Chemical composition of tree leaves and wild grasses of semi hilly arid zone

Parameters	Tree leaves	Grasses	PSE
Total ash	8.09	8.56	0.22
Organic matter	91.91	91.44	0.22
Crude protein	12.18^{b}	6.53^{a}	0.34
Ether extract	2.64^{b}	1.69^{a}	0.10
Neutral detergent fiber	60.10^{a}	80.83^{b}	1.19
Acid detergent fiber	44.87^{a}	51.83^{b}	0.70
Hemicellulose	16.91^{a}	29.00^{b}	0.99
Cellulose	24.45^{a}	37.22^{b}	0.68
Lignin	13.79^{b}	8.92^{a}	0.41

Figures with different superscript in a row differ significantly **$P<0.01$; PSE, pooled standard error.

Table 2. Mineral profile of tree leaves and wild grasses of semi hilly arid zone

Parameters	Tree leaves	Grasses	PSE	Requirement[1]	Tolerance level[1]
Macro elements (%)					
Calcium**	2.42^b	1.14^a	0.17	0.4–0.7	2.0
Phosphorus	0.08	0.10	0.006	0.35	1.0
Magnesium**	40.75^b	23.09^a	2.75	0.22	0.5
Micro elements (ppm)					
Iron	0.057	0.058	0.001	50	1000
Copper*	0.11^b	0.07^a	0.007	10	100
Zinc**	0.19^a	0.28^b	0.01	40	500
Manganese	0.136	0.138	0.01	40	1000
Cobalt	0.097	0.051	0.02	0.1	10

[1]In complete feeds for dairy cattle as recommended by NRC (2001); figures with different superscript in a row differ significantly, *P<0.05, **P<0.01, PSE, pooled standard error.

Table 3. Anti nutritional factors (%) in tree leaves and wild grasses of semi hilly arid zone

Parameters	Tree leaves	Grasses	PSE
Total tannins** (TT)	5.11^b	0.86^a	0.68
Condensed tannins** (CT)	1.65^b	0.02^a	0.29
Hydrolyzable tannins* (HT)	3.46^b	0.84^a	0.65
CT as % of TT**	32.29^b	2.32^a	5.28
HT as % of TT**	67.71^a	97.67^b	5.28
Water soluble oxalates	0.69	0.82	0.04

Figures with different superscript in a row differ significantly, *P<0.05, **P<0.01; PSE, pooled standard error.

The antimetabolites like total tannins, condensed tannins and hydrolysable tannins were higher (P<0.01) in tree leaves as compared to grasses (Table 3) by 83.2, 98.8 and 75.7%, respectively. The condensed tannins as per cent of total tannins were higher (P<0.01), while hydrolysable tannins as per cent of total tannins were lower (P<0.01) in tree leaves as compared to grasses by 92.8 and 44.3%, respectively. The grasses had negligible concentration of condensed tannins. The low tannins content present in grasses may be beneficial in preventing frothy bloat (Li *et al.* 1996). Bakshi and Wadhwa (2004) reported the presence of various types of tannins and adverse effects of condensed tannins on the digestibility of nutrients (correlation coefficient for DM, NDF and CP was –0.71, –0.79 and –0.64, respectively), whereas hydrolysable tannins showed no such adverse effect (correlation coefficient for DM, NDF and CP were, 0.56, 0.46 and 0.4, respectively). Similar trend on toxicity of condensed tannins was observed by Kumar and Vaithiyanathan (1990) and Rittner and Reed (1992). The high concentration of oxalates reduced the availability of calcium by forming precipitates of calcium oxalates. The water soluble oxalate content was comparable in tree leaves and grasses, but the concentration was much lower than the toxic level of 4% in ruminants (Lal *et al.* 1966).

The digestion kinetic parameters, for DM revealed that

Table 4. Digestion kinetic parameters for DM and NDF (%) of tree leaves and wild grasses of semi hilly arid zone

Parameters	Tree leaves	Grasses	PSE
Dry matter			
Rapidly soluble fraction (a)**	27.49^b	13.64^a	0.95
Potential degradable fraction (b)*	37.89^a	42.74^b	1.05
Degradation rate (c)**	0.057^b	0.045^a	0.002
48h DM degradability**	62.09^b	50.63^a	1.18
Effective degradability (ED)**	53.17^b	41.29^a	1.13
True digestibility (TD)**	68.52^b	63.14^a	0.67
Potential extent of digestion (PED)**	66.71^b	61.58^a	0.64
Apparent extent of digestion (AED)**	46.31^b	36.59^a	1.04
Rumen fill (RF)**	22.27^a	27.26^b	0.62
Neutral detergent fiber			
'a'	9.18	5.86	0.87
'b'	44.33	49.69	1.31
'c'	0.061	0.046	0.004
48h NDF degradability	49.38	48.96	1.00
ED	39.59	38.07	0.80
TD**	67.51^b	63.57^a	0.67
PED**	65.85^b	62.00^a	0.65
AED	37.40	36.44	0.86

Figures with different superscript in a row differ significantly, *P<0.05, **P<0.01; PSE, pooled standard error.

the rapidly soluble fraction was higher (P<0.01) in tree leaves whereas the insoluble but potentially degradable fraction was higher (P<0.05) in wild grasses (Table 4). The total degradable fractions were higher in tree leaves as compared to grasses (65.38 vs. 56.38%) by 16%. The undegradable fraction of DM was lower (P<0.01) in tree leaves as compared to grasses by 22.5%. The degradation rate of DM and its effective degradability were higher (P<0.01) in tree leaves as compared to grasses by 26.7 and 28.8%, respectively. The higher (P<0.01) true digestibility, potential and apparent extent of digestion resulted in lower (P<0.01) rumen fill values in tree leaves as compared to grasses, thereby predicting higher voluntary DM intake in tree leaves as compared to grasses. The 48h degradability of dry matter in wild grasses was found negatively correlated with the ADF (–0.78), NDF (–0.77) and lignin (–0.71) content (Bakshi *et al.* 2005).

The digestion kinetic parameters for NDF degradability revealed that the rapidly soluble fraction was considerably higher in tree leaves as compared to grasses. Reverse trend was observed in case of insoluble but potentially degradable fraction (Table 4), but the differences were statistically nonsignificant. The total degradable fractions were comparable (53.3 vs 55.6%). In spite of the fact that the degradation rate of NDF was considerably higher in tree leaves as compared to grasses, the 48h degradability as well as effective degradability was comparable. The true degradability and potential extent of digestion of NDF were higher ($P<0.01$) in tree leaves as compared to grasses. The 48h degradability of NDF in wild grasses was found to be negatively correlated with cell wall constituents (–0.83 ADF, –0.70 NDF and –0.72 lignin) content (Bakshi *et al.* 2005). On the basis of chemical composition, mineral profile, antimetabolites concentration and *in-sacco* degradability it was concluded that the tree leaves had greater potential as alternate feed resources as compared to wild grasses.

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