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Characterization of underutilized shrubs for forage potential in rainfed and dry areas

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Abstract
Shrubs are considered as important genetic resources for fodder supplements in dry areas. Accordingly eight underutilized forage shrubs (*Grewia asiatica, G. hirsute, G. flavescence, Bauhinia racemosa, Helicteres isora, Ehretia aspera,* and *Vitex negundo*) were evaluated for their morphology, growth, forage production potential and nutritional quality under rainfed conditions. *Securinega virosa* had maximum plant height (275.3 cm) and high number of primary branches was observed in *Grewia hirsuta* (12.7). *Securinega virosa* gave maximum (15.7) response to secondary branches but tertiary branches were found maximum in *Bauhinia racemosa* (18.0). High number of leaves was observed in *Bauhinia racemosa* (249.3), however maximum leaf size was observed in *Grewia asiatica* (14.2 cm × 10.7 cm). *Securinega virosa* had maximum total biomass yield (8.87 kg/plant) with maximum leaves (6.60 kg/plant) as green fodder yield (GFY) and leaf to stem (wood) ratio (3.0). Average crude protein (CP) content of the green foliage ranged between 12.45 to 17.74% being found maximum in *Ehretia aspera.* While maximum NDF (63.42%) and ADF (48.68%) contents were observed in *Grewia asiatica* foliages. Similarly, cellulose and lignin contents were ranged from 7.97-26.40% and 12.75-21.76%, respectively and found maximum in *Helicteres isora* and *Vitex negundo*, respectively. The values in ash content were ranged from 7.84-12.89%, being maximum in *Ehretia aspera*. Shrubs like *Vitex nigundo* and *Securinega virosa* were found promising in terms of high protein contents and biomass yields.

Keywords: Forage yield potentials, Livestock, Nutritional quality, Underutilized shrubs

Abbreviations: ADF: Acid detergent fibre; **ADL**: Acid detergent lignin; **CP:** Crude protein; **DM:** Dry matter; **GFY:** Green fodder yield; and **NDF:** Neutral detergent fibre

Introduction

Herbaceous or woody shrubs are recognized as rich sources of supplementary feed/browse, mulch and green manure to develop sustainable and low-input production systems (Brewbaker *et al*., 1982: Sumberg, 1984: Kang and Duquma, 1985). Traditionally farmers retain certain trees and shrubs in their crop production systems to restore soil fertility, for top feeds, fuel wood etc. (Moorman and Greenland, 1980; Getahun *et al*., 1982). In India, evergreen shrubs and trees have not yet fully exploited in traditional farming systems (Wong, 1990). The use of fodder shrubs has been a recent phenomenon and much awareness is to be created encouraging small farmers to exploit these valuable feed resources. Shrubs and tree fodders are good option for protein supplementation and can be easily planted on bunds, riversides, way sides and homesteads (Chema *et al*., 2011; Saadullah, 1990). Forage legumes can also reduce the need for N fertilizer in the production system and assist in nutrient recycling. Species of genera *Leuceanae*, *Zizyphus*, *Acacia*, *Crassa* etc. were already used as feed resources or browse species, but many of such species are still underutilized. Keeping this in view, eight underutilized shrub species were studied for their forage yield potentials and nutritional quality.

Materials and Methods

Morpho-agronomic evaluation: Species diversity is the basis for ecological balance. Eight species of underutilized shrubs comprised of *Grewia asiatica, G. hirsute, G. flavescence, Bauhinia racemosa, Helicteres isora, Ehretia aspera,* and *Vitex negundo* were collected and grown in Central Research Farm of Indian Grassland and Fodder Research Institute (IGFRI), Jhansi at 2.5 x 3 m spacing and maintained at 1.10 m height. These shrubs species were evaluated for quantitative traits (before first cut) namely, plant height, number of multiple branches per plant, number of leaves per plant, leaf

length and breadth, green fodder yield, total biomass, wood and leaves and fresh weight. Observation was taken from five randomly selected plants of each species during 2012 -14 under rainfed condition after monsoon season. Herbarium of shrubs species were preserved and housed at IGFRI herbarium.

Quality analysis: The foliage of different shrubs (about 200 g) was collected in middle of rainy season every year. Samples were air dried followed by dried to constant mass in an oven at 60ºC for 72 hours. The oven dried samples were ground in a Willey Mill to pass through 1mm sieve for the determination of chemical composition. Feed samples were analyzed for DM and ash contents using the method of AOAC (2000). Nitrogen was determined using the micro- kjeldahl method (AOAC, 2000). Crude protein (CP) was calculated as N x 6.25. The neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were analyzed according to Van Soest *et al*. (1991).

***Data analysis*:** The data were organized, summarized and analyzed using the SAS statistical package (SAS, 2001).

Results and Discussion

***Morpho-agronomic evaluation*:** Amongst the eight shrub species studied (Table 1), *Securinega virosa* exhibited maximum plant height (275.3 cm) followed by *Helicteres isora* (255.0 cm) *and Vitex nigundo* (251.7 cm). However, minimum plant height was observed in *Grewia flavescence* (160.0 cm) followed by *Grewia asiatica* (165.0 cm). Further, maximum number of primary branches was observed in *Grewia hirsute* (12.7) followed by *Helicteres isora* (9.3) and *G. flavescence* (9.0) while minimum number of primary branches was observed in *B.racemosa* (1.0) and *E.aspera* (1.7). In case of secondary branches, *Securinega virosa* gave maximum (15.7) response followed by *Vitex nigundo* (14.0), *Grewia flavescence* (10.7) and *Ehretia aspera* (10.3), whereas minimum secondary branches were noticed in *G.asiatica* (5.0) and *Helicteres isora* (6.3). However, maximum number of tertiary branches was recorded in *Bauhinia racemosa* (18.0) followed by *Securinega virosa* (17.3), while *Helicteres isora* showed minimum number (2.0) of tertiary branches. Number of leaves per plant also varied significantly and ranged from 18.0 to 249.3. Maximum number of leaves per plant was noted in *Bauhinia racemosa* (249.3) followed by *Vitex nigundo* (224.7) and others. While minimum number of leaves was found in *Grewia asiatica* (18.0). Further, leaf size, leaf length and leaf width were also varied significantly in the studied species. Maximum leaf size (length × width) was observed in *Grewia asiatica* (14.2 cm × 10.7 cm) followed by *Helicteres isora* (11.8 cm × 7.9 cm) and others. While minimum leaf size was observed in *Grewia flavescence* (3.8 cm × 1.6 cm).

Shrubs are good browse species that can yield a considerable amount of forage for livestock particularly for small ruminants during drought and lean periods. In the present study, shrubs species showed significant variation for green fodder yields (Table 2). *Securengia virosa* had maximum biomass yield (8.87 kg/plant) followed by *Vitex nigundo* (7.00 kg/plant). Whereas minimum biomass yield was noted in *Grewia flavescence* (1.08 kg), which was closely followed by *Bauhinia racemosa (*1.83 kg). Similarly leaves as green fodder yield (GFY) was also found maximum in *Securinega virosa* (6.60 kg/plant) followed by *Vitex nigundo* (4.50 kg/plant) and others. Minimum GFY (leaves) was found in *Grewia flavescence* (0.67 kg/ plant). Further leaf and stem (wood) ratio was found maximum in *Securinega virosa* (3.0) followed by *Helicteres isora* (2.0). Moderate L/S ratio was

Table 1. Morphological characterization of different species of shrubs

Shrub species	Plant height** (cm)	Primary branch* (number)	Secondary branch (number)	Tertiary branch** (number)	Leaves/ plant** (number)	Leaf length** (cm)	Leaf width** (cm)
Grewia asiatia	165.0±2.89	6.0±1.00	5.0±0.58	3.3±0.88	18.0±1.53	14.2±0.99	10.7±0.61
Vitex nigundo	251.7±4.41	6.7±1.67	14.0±4.58	7.7±1.86	224.7±68.9	14.3±0.37	2.0±0.03
Grewia hirsute	206.7±14.2	12.7±3.84	6.3±1.45	8.3±1.20	66.0±10.1	6.6±0.10	1.8±0.09
Grewia flavescence	160.0±2.89	9.0±1.73	10.7±1.33	8.3±0.88	43.0±9.02	3.8±0.21	1.6±0.06
Helicteres isora	255.0±2.89	9.3±1.76	6.7±2.19	2.0±0.58	24.7±5.55	11.8±0.84	7.9±0.46
Securinega virosa	275.3±2.91	4.0±0.58	15.7±3.18	17.3±0.88	163.0±6.43	4.9±0.21	3.1±0.29
Ehretia aspera	231.7±30.0	1.7±0.33	10.3±1.20	9.0±0.58	83.3±18.55	8.1±0.30	4.6±0.59
Bauhinia racemosa	241.7±6.01	1.0±0.00	9.3±1.76	18.0±1.15	249.3±56.2	3.3±0.20	4.3±0.33
CD (P<0.05)	36.64	5.31	7.08	3.22	97.85	1.52	1.13

Means within a column differed significantly (*P<0.05; **P<0.01)

Table 2. Fodder yield potential of different species of shrubs

Shrub species	Biomass yield /plant** (kg)	Stem (wood)**(kg)	Leaves** (kg)	Leaf/Stem ratio	Leaves/ total biomass (%)
Grewia asiatia	1.47 ± 0.26	0.70 ± 0.15	0.77 ± 0.13	1.1	52.4
Vitex nigundo	7.00 ± 1.32	2.50 ± 0.58	4.50 ± 0.76	1.8	64.3
Grewia hirsute	2.00 ± 0.29	1.07 ± 0.22	0.93 ± 0.12	0.9	48.3
Grewia flavescence	1.08 ± 0.22	0.42 ± 0.04	0.67 ± 0.18	1.6	62.0
Helicteres isora	3.00 ± 0.87	1.00 ± 0.29	2.00 ± 0.58	2.0	66.6
Securinega virosa	8.87 ± 0.68	2.27 ± 0.38	6.60 ± 0.30	3.0	74.4
Ehretia aspera	2.03 ± 0.26	1.03 ± 0.09	1.00 ± 0.17	1.0	49.2
Bauhinia racemosa	1.83 ± 0.17	0.62 ± 0.07	1.22 ± 0.12	1.9	66.6
CD (P<0.05)	1.91	0.85	1.12	-	-

Means within a column differed significantly (**P<0.01)

observed in *Bauhinia racemosa* (1.9) followed by *Vitex nigundo* (1.8), *Grewia flavescence* (1.6), *Grewia asiatica* (1.1), *Ehretia aspera* (1.0) whereas minimum L/S ratio was recorded in *Grewia hirsute* (0.86).

Similar kinds of studies were conducted in Ethiopia for identification of potential fodder shrubs in the mid rift valley of Ethiopia (Shenkute *et al.,* 2012). In India, Shanker and Singh (1997) evaluated and characterized the different fodder shrubs from hilly regions. Studies conducted in north-east Morocco showed that average production was 374 g DM/plant in *Atriplex nummularia* shrub and it varied from 36 to 1100 g DM/plant depending on the site and age of the plant (Chriyaa, 2015).

Quality analysis: The chemical composition of leaves of different browse species were studied (Table 3). Average crude protein (CP) content of the green leaves/ foliage ranged between 12.45 to 17.74%. The highest CP content was recorded in *Ehretia aspera* (17.74%) followed by *Vitex nigundo* (17.69%) while the lowest CP was recorded in *Helicteres isora* (12.45%). Further the highest NDF value was observed in *Grewia asiatica* (63.42%) and the lowest value was found in *Securinega virosa* (39.02%). Similarly *Grewia asiatia* leaves contained maximum (48.68%) ADF while the lowest ADF value was recorded in *Securinega virosa* (21.06%).The ash content was found maximum (12.89%) in *Ehretia aspera* and minimum in *Vitex nigundo* (7.84%). The highest value (21.76%) for lignin was found in *Vitex nigundo* whereas highest value (26.4%) for cellulose was noticed in *Helicteres isora*. Results obtained from the present investigation indicated that CP values found in few shrubs were optimum for livestock production. Similar protein and other nutrient contents were recorded earlier in browse species of Bundelkhand which included *Helicteres isora, Ehretia aspera, Securinega virosa, Grewia flavescence* etc. *(*Negi *et al.,* 2003). Chemical composition and nutritive value of different browse species were studied in tropical West Africa (Le Houérou, 1980). Thus it was suggested that browse species are richer in CP, minerals and digestible nutrients than grasses, and they can be exploited for better nutrition of livestock leading to improvement in productivity (Norton, 1982; Devendra, 1990; Topps, 1992; Shenkute *et al*., 2012; Chema *et al*., 2011).

Conclusion

It was concluded that promising shrubs like *Vitex nigundo* and *Securinega virosa* can be exploited for livestock production keeping in view high protein contents and biomass yields in rainfed and dry areas of the country.

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Table 3. Chemical composition of leaves (%DM basis) in different species of shrubs

Shrub species	CP%	NDF%	ADF %	Cellulose	Lignin	Ash %
Grewia asiatica	12.50	63.42	48.68	24.09	20.86	8.95
Vitex nigundo	17.69	55.93	44.85	20.41	21.76	7.84
Grewia hirsute	15.94	60.16	43.73	25.13	16.68	8.89
Grewia flavescence	13.32	61.25	38.48	19.75	18.42	9.44
Helicteres isora	12.45	59.55	41.24	26.4	13.07	10.36
Securinega virosa	13.29	39.02	21.06	7.97	12.75	10.27
Ehretia aspera	17.74	53.96	33.55	16.3	15.96	12.89
Bauhinia racemosa	13.41	63.84	41.71	21.61	16.30	8.08

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