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Research article

Floral diversity and nutritional value of forages in Pulikulam cattle breeding tract

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Abstract

Documenting the floral diversity in the Pulikulam cattle breeding tract (Sivaganga, Madurai and Virudhunagar districts in Tamil Nadu) and the nutrient content of predominant forages were important for maintaining Pulikulam cattle under zero input grazing system of management. Hence, a study was carried out to document the forage biomass, botanical composition, and nutritional profile of the forages present in the Pulikulam cattle breeding tract. The number of edible forage species other than shrubs and trees documented in the grazing tract at Sivaganga, Madurai and Virudhunagar districts was 10, 8 and 9, respectively. *Pennisetum clandestinum* recorded significantly (p <0.05) highest biomass (133.25, 148.25 and 115 g/m^2) and botanical composition (31.32, 34.99, and 26.31%) in all the districts. Variability was observed in proximate principles, fiber fractions and mineral contents between forages. Zinc was not detectable in *Aristida setacea* and both zinc and copper were not in detectable levels in *Echinochloa colona.*

Keywords: Botanical composition, Breeding tract, Forage biomass, Nutritive value, Pulikulam cattle

Introduction

Pulikulam is a registered breed of indigenous cattle native to southern Tamil Nadu, India. This breed is reared between 9°30′ and 10°30′ N latitude and between 77°47′ and78°49′ E longitude, covering Sivaganga, Madurai and Virudhunagar districts of Tamil Nadu, which falls in the southern agro-climatic zone of Tamil Nadu. The region has a semi-arid tropical climate, with a mean temperature during summer between 42 to 43°C and a relative humidity of 40 to 45% (Srinivasan *et al*., 2021). The annual rainfall in the area is generally more than 800 mm. The soil of the area is red or black cotton (Singh *et al*., 2012).

Pulikulam cattle are comparatively smaller in size, very active, and capable of high endurance activity. They have a moderately long face, and a well-developed hump, which is short in females and large in males, the horns are long, curved inside with pointed edges and the ears are moderately long (Srinivasan and Sathiamoorthy, 2020). The cattle are maintained in a zero-input management system as migratory herds. The herd size is about 100 to 500 animals; multiple herds are pooled to form big herds of 250 to 1000 animals, which are maintained on community land. The herds are grazed in forests or harvested agricultural fields from the morning till evening for which the herds cover around 5 to 6 km. For the past decade, the herd size of this breed has been decreasing due to the ban on grazing in forests and the shrinkage of existing grazing lands that are being diverted for other farming activities and real-estate development. Shinde and Mahanta (2020) also reported that grazing lands in the dry zones of the country are the main source of fodder for livestock is declining rapidly with urbanization. To reverse this trend, steps must be taken to restore grazing land and watering grounds. As a first step towards this, the capacity of existing grazing tracts needs to be ascertained so that grazing of this breed can be planned on a rotational basis.

Generally, the vegetation in any grazing tract is a mixture of different plant varieties that are unique to the locality and their nutritional values differ from the monoculture forage plants (Vazquez de Aldana *et al*., 2000). Moreover, the feeding values of grassland forages depend upon flora, climatic conditions, altitude, irrigation, fertilization, soil structure and the influence of the plant's vegetative period (Buxbaum and Vanderbilt, 2007). For grazing

livestock, the composition of the pasture, variations in the species and the nutritive value of the grass type are important (Jing *et al*., 2017). Grassland and rangeland ecosystems play a major role in livestock productivity, livelihood and rural economics in India. Grasslands in India are under heavy grazing pressures and require rejuvenation (Roy *et al*., 2019; Kumar *et al*., 2023).

Diverse grasses in grazing tracts result in higher dry matter yield, greater resistance of grass species to environmental stress and weed invasion, and offer livestock a balanced diet. Hence, knowledge of different types of species that constitute the biomass in grazing tracts is important, especially in shrinking grazing tracts, as it may influence policymakers in restoring accessibility of these tracts to pastoralists herding indigenous herds of cattle.

Materials and Methods

Study area and sampling*:* The study area was the grazing tract of Pulikulam cattle spread across Sivaganga, Madurai and Virudhunagar districts in Tamil Nadu, India. In each of the districts, three different grazing locations, frequently visited by the Pulikulam cattle herds for grazing, were chosen for sampling. In each site, sampling was carried out during post north-east monsoon with three replications. The locations in which the animals grazed were observed for a few days, the grazing spots were identified and edible forages in these spots were documented and sampled.

Herbage biomass, botanical composition and predominant species: The forage biomass (g/m^2) was determined as per Dabadghao and Shankarnarayanan (1973). To assess the floral diversity, forage was collected through quadrant throws from various locations in the grazing tract. The proportion of different forage species in the total material collected was determined and was expressed as a percentage of botanical composition on a dry matter basis (Holechek *et al.,* 1982). The predominant forages present in the grazing tracts in each of the districts *viz.,* Sivaganga, Madurai and Virudhunagar, were selected based on the results of botanical composition. The forage species up to the third order, predominantly present in the grazing tract of each district, were designated as predominant forages.

Nutritional value of predominant forages*:* Samples of the predominant forage species collected were brought to the laboratory and estimated for moisture, crude protein, crude fiber, ether extract, total ash, acid insoluble ash, and NFE (calculated) as per AOAC (2019). The fiber fractions *viz*., neutral detergent fiber (NDF), acid detergent fiber (ADF), hemicelluloses, and lignin present in the samples were estimated as per the method described by Goering and Van Soest (1970). The major minerals (calcium, phosphorus, magnesium, sodium, and potassium), trace minerals (zinc, copper and iron), and heavy metal (chromium, lead, and aluminum) contents were estimated using ICP-OES (Szymczycha et *al.,* 2014).

Statistical analysis: Data were analyzed using IBM® SPSS® Statistics version 20.0 for Windows® software as per Snedecor and Cochran (1989) for analysis of variance (ANOVA). Duncan's multiple range tests analyzed the critical difference between the groups.

Results and Discussion

***Herbage biomass and botanical composition*:** The forage biomass (g/m^2) was recorded in the grazing tract of Pulikulam cattle (Table 1). The number of edible plant species other than shrubs and trees documented in the grazing tract at Sivaganga, Madurai and Virudhunagar districts were 10, 8, and 9, respectively. In Sivaganga district, amongst the ten plant species documented, *Pennisetum clandestinum* had significantly (p <0.05) highest (133.25 g/m^2) biomass, all the other nine plant species had statistically similar biomass. In Madurai district, again *P. clandestinum* documented significantly (p <0.05) highest (148.25 g/m^2) biomass. All the other seven plant species had statistically similar biomass. In the Virudhunagar district also *P. clandestinum* documented the significantly (p <0.05) highest (115.00 g/m^2) biomass and biomass of other plant species significantly exhibited variations. *P. clandestinum* favors moist areas and frequently becomes naturalized from introduction as a cultivated alien (Clayton *et al.,* 2008). This was probably the reason for the Pulikulam grazing tract documenting significantly highest biomass of this grass during the post-monsoon season. *Aristida setacea* (93.33 g/m^2) documented comparable biomass to *P. clandestinum* in the Virudhunagar district. *A. setacea* grows throughout the year in scrub jungles and dry lands of Tamil Nadu (Sekar and Murugesan, 2017).

In all three districts, Sivaganga (31.32%), Madurai (34.99%) and Virudhunagar (26.31%), *P. clandestinum* documented significant (p <0.05) highest botanical composition. Other plant species in Sivaganga and Madurai districts had a statistically similar botanical composition, but in Virudhunagar district *A. setacea* (20.74%) recorded the next highest and comparable botanical composition. There exists no record on the documentation of the botanical composition of forages in the Pulikulam cattle grazing tract. However, the characterization of vegetation in terms of its botanical composition is one of the most important aspects and it reflects both the site conditions and management factors, which in turn has an impact on yield and forage quality (Peratoner and Potsch, 2019). The present study established the predominance of *P. clandestinum* in the Pulikulam cattle grazing tract. *P. clandestinum* is generally used to prevent soil erosion, but

Table 1. Forage biomass (g/m^2) documented in a grazing tract of Pulikulam cattle

Botanical name	Forage biomass (g/m^2)		
	Sivaganga	Madurai	Virudhunagar
Abutilon indicum	-	$33.50^{b} \pm 15.64$	-
Achyranthes aspera	-	$35.25^{b} \pm 9.82$	-
Aerva lanata	$28.75^{b} \pm 16.63$	-	$23.33^{b} \pm 13.02$
A. setacea	-	-	$93.33^{ab} \pm 8.82$
Brachiaria ramose	$16.25^{b} \pm 13.12$	-	-
Bulbostylis barbata	$18.25^{b} \pm 10.63$	-	-
Corchorus olitorius	$65.50^{b} \pm 32.05$	-	-
Cyanotis axillaris	-	-	$55.00^{ab} \pm 55.00$
Cynodon dactylon	$24.50^{b} \pm 3.86$	$26.25^{b} \pm 17.11$	$19.00^{b} \pm 10.69$
Cyperus sp	-	-	$19.00^{b} \pm 9.71$
Dactyloctenium aegyptium	$58.25^{b} \pm 8.50$	-	-
Echinochloa colona	-	-	$55.67^{ab} \pm 6.36$
Malvastrum coromandelianum	-	$24.25^{b} \pm 14.33$	-
Melothria maderaspatana	$46.25^{b} \pm 26.72$	-	-
Ocimum basilicum	-	$53.50^{b} \pm 20.48$	-
Ocimum sp	-	$38.75^{b} \pm 13.91$	-
Panicum repens	-	-	$42.67^{ab} \pm 21.61$
Perotis indica	$30.25^{b} \pm 12.59$	$56.60^{b} \pm 15.60$	-
P. clandestinum	$133.25^{a} \pm 13.12$	$148.25^{a} \pm 32.42$	$115.00^{a} \pm 33.86$
Stevia sp	-	-	$51.67^{ab} \pm 26.82$
Tribulus terrestris	$17.50^{b} \pm 14.36$	-	-

Mean values bearing alphabetical superscripts within a column differed significantly ($P<0.05$)

in many places, it has become a weed that is difficult to control. This grass thrives along irrigation canals, roads, railway lines and industrial areas, causing considerable problems (FAO, 2021). This study confirmed that the migratory herds of Pulikulam cattle are dependent on this grass for their survival.

The botanical composition of forages in the Pulikulam cattle grazing tract *viz.,* Sivaganga, Madurai and Virudhunagar districts of Tamil Nadu was also recorded (Table 2). The predominant edible forages in the Pulikulam cattle grazing tracts were *Corchorus olitorius, D. aegyptium* and *P. clandestinum* for Sivaganga district, *Ocimum basilicum, P. clandestinum* and *Perotis indica* for Madurai district and *A. setacea, Echinochloa colona* and *P. clandestinum* for Virudhunagar district. Variations in the predominant forage species between Sivaganga, Madurai and Virudhunagar districts were observed. However, *P. clandestinum* was the forage that was commonly found to be predominant in all three districts. Rainfall variability could play a strong effect on range land production and species composition (Fynn and O'Connor, 2000). Similarly, multilayer interaction between species and the environment could lead to their differential spatial distribution.

***Proximate composition*:** The proximate composition of predominant forages in the Pulikulam cattle breeding tract was recorded (Table 3). In Sivaganga district, no significant variations were observed in crude protein, ether extract, and NFE contents between the predominant forages. *P. clandestinum* had significantly highest crude fibre (35.69%) and lowest total ash (7.75%). In the Madurai district, no significant variations were observed in crude protein, crude fiber, and NFE contents between the predominant forages. *Ocimum basilicum* had significantly highest (5.19%) ether extract and *P. clandestinum* had significantly lowest total ash (8.33%). In Virudhunagar district *Echinochloa colona* had significantly lowest crude fibre (20.89%) and significantly highest NFE (55.14 %) contents.

The crude protein content of *P. clandestinum,* the predominant forage species of the Pulikulam breeding tract showed minor variations when compared with that reported by Sahoo *et al.* (2014). With respect to other

Table 2. Botanical composition of forages in Pulikulam cattle grazing tract

Botanical name	Botanical composition (%DMB)		
	Sivaganga	Madurai	Virudhunagar
A. indicum	-	$7.03^{b} \pm 2.83$	-
A. aspera	-	$9.44^{b} \pm 2.20$	-
A. lanata	$6.58^{b} \pm 9.77$	-	$5.23^{b} \pm 3.40$
A. setacea	-	-	$20.74^{ab} \pm 3.91$
B. ramose	$3.92^{b} \pm 8.72$	-	-
B. barbata	$4.87^{b} \pm 8.49$	-	-
C. olitorius	$13.23^{b} \pm 13.69$	-	-
C. axillaris	-	-	$8.99^{ab} \pm 8.99$
C. dactylon	$6.25^{b} \pm 5.87$	$9.75^{b} \pm 6.79$	$3.58^{b} \pm 1.83$
Cyperus sp	-	-	$4.67^{b} \pm 2.35$
D. aegyptium	$14.50^{b} \pm 8.89$	-	-
E. colona	-	-	$12.13^{ab} \pm 1.99$
M. coromandelianum	-	$5.99^{b} \pm 4.08$	-
M. maderaspatana	$8.69^{b} \pm 12.05$	-	-
O. basilicum	-	$11.45^{b} \pm 4.14$	-
Ocimum sp	-	$8.39^{b} \pm 2.87$	-
P. repens	-	-	$8.34^{ab} \pm 4.22$
P. indica	$6.42^{b} \pm 6.46$	$13.71^{b} \pm 3.03$	-
P. clandestinum	$31.32^{a} \pm 7.78$	$34.99^{a} \pm 1.66$	$26.31^{a} \pm 10.38$
Stevia sp	-	-	$10.00^{ab} \pm 5.00$
T. terrestris	$6.12^{b} \pm 9.35$	-	-

Mean values bearing alphabetical superscripts within the column differed significantly (p <0.05); DMB: Dry matter basis

predominant herbage of the Sivaganga district, crude protein observed in *C. olitorius* was lower than the value reported by Ndlovu and Afolayan (2008). However, in *D. aegyptium*, the crude protein observed in the present study was higher than that reported by Ranjhan (1998). In the Madurai district *O. basilicum*, had crude protein content higher than that reported by Afolabi *et al.* (2012). *Perotis indica* also had a crude protein content higher than that reported by Ranjhan (1998). In Virudhunagar district, the crude protein content of *E. colona* was well within the range reported by Singh *et al.* (2018).

Fibre fractions: The fiber fractions of predominant forages in the Pulikulam cattle breeding tract were also recorded (Table 4). In all three districts, there existed significant (p <0.05) variation in neutral detergent fiber (NDF), Acid detergent fiber (ADF), cellulose, hemicellulose and lignin contents between the forages analyzed. Among all the forages in Sivaganga, Madurai and Virudhunagar districts *Dactyloctenium aegyptium* (18.82%), *P. clandestinum* (16.85%) and *A. setacea* (17.21%) had significantly highest lignin content. Singh *et al.* (2015) also observed high lignin contents (12.75–21.76%) in eight underutilized forage shrubs (*Grewia asiatica, G. hirsute, G. flavescence, Bauhinia racemosa, Helicteres isora, Ehretia aspera*, and *Vitex negundo*).

Mineral contents: The major minerals assayed, like Ca, P, Mg, Na, and K, showed significant (p <0.05) variations between herbs in all the districts (Table 5). Across districts, *Perotis indica* had the highest calcium (2.63%), *O. basilicum* had the highest phosphorus (0.08%) and magnesium (0.48%), *C. olitotius* had the highest potassium (1.44%) and *D. aegyptium* had highest sodium (0.40%) contents. The trace minerals assayed zinc, copper

Table 3. Proximate principles (%DMB) of predominant herbage in Pulikulam cattle breeding tract

District/Botanical name	Proximate principles				
	Crude protein	Ether extract	Crude fibre	Total ash	Nitrogen free extract
Sivaganga					
C. olitorius	12.87 ± 0.18	1.85 ± 0.15	$25.43^{a} \pm 0.42$	$11.85^{b} \pm 0.32$	48.00 ± 4.76
D. aegyptium	12.86 ± 0.13	1.44 ± 0.03	$27.27^{a} \pm 0.12$	$17.12^{b} \pm 0.02$	41.31 ± 2.22
P. clandestinum	12.50 ± 0.23	2.03 ± 0.12	$35.69^{b} \pm 0.43$	$7.75^{a} \pm 0.88$	42.03 ± 3.31
Madurai					
O. basilicum	12.63 ± 0.32	$5.19^{b} \pm 0.07$	31.33 ± 4.80	$9.52^{b} \pm 0.13$	41.33 ± 2.33
P. clandestinum	11.01 ± 1.12	$1.33^{a} \pm 0.01$	29.97 ± 5.21	$8.33^{a} \pm 0.11$	49.36 ± 2.65
Perotis indica	12.08 ± 0.98	$1.76^{a} \pm 0.01$	34.45 ± 0.03	$12.74^{b} \pm 0.12$	38.97 ± 2.90
Virudhunagar					
A. setacea	$10.21^{a} \pm 0.18$	1.48 ± 0.02	$31.95^{b} \pm 1.43$	$8.53^{a} \pm 1.11$	47.83 ± 2.22
E. colona	$9.88^{a} \pm 0.90$	2.06 ± 0.10	$20.89^{a} \pm 4.32$	$12.03^{ab} \pm 1.13$	55.14 ± 3.23
P. clandestinum	$10.01^{a} \pm 0.76$	1.68 ± 0.09	$30.43^{b} \pm 3.212$	$9.28^{a} \pm 0.10$	48.60 ± 4.12

Mean values bearing alphabetical superscripts within a column differed significantly (p <0.05); DMB: Dry matter basis

Table 4. Fibre fractions of predominant herbage in Pulikulam cattle breeding tract

District/Botanical name	Fibre fractions (%)				
	NDF	ADF	Hemicellulose	Cellulose	Lignin
Sivaganga					
C. olitorius	$55.40^{a} \pm 0.17$	$41.80^{a} \pm 0.43$	$13.60^{a} \pm 0.28$	$26.93^{a} \pm 0.32$	$14.87^{a} \pm 0.12$
D. aegyptium	$72.60^{b} \pm 0.01$	$47.14^{b} \pm 0.04$	$25.45^{b} \pm 0.03$	$28.32^{a} \pm 0.29$	$18.82^{c} \pm 0.24$
P. clandestinum	$84.32^{c} \pm 0.72$	$60.76^{c} \pm 1.75$	$23.56^{b} \pm 2.47$	$44.60^{b} \pm 2.81$	$16.16^{b} \pm 0.13$
Madurai					
O. basilicum	$74.48^{a} \pm 2.85$	$59.81^{c} \pm 3.68$	$14.67^{a} \pm 5.69$	$45.22^{b} \pm 4.10$	$14.58^{b} \pm 0.50$
P. clandestinum	$77.10^{a} \pm 0.31$	$51.31^{b} \pm 0.32$	$25.78^{a} \pm 0.01$	$34.46^{a} \pm 0.34$	$16.85^{c} \pm 0.02$
P. indica	$83.94^{b} \pm 0.28$	$40.71^{a} \pm 0.98$	$43.23^{b} \pm 1.26$	$29.82^{a} \pm 0.94$	$10.89^{a} \pm 0.03$
Virudhunagar					
A. setacea	$85.64^{c} \pm 0.02$	$61.99^{c} \pm 0.12$	$23.65^{ab} \pm 0.14$	$44.78^{b} \pm 0.08$	$17.21^{b} \pm 0.20$
E. colona	$74.45^{a} \pm 0.33$	$49.79^{a} \pm 0.41$	$24.66^{b} \pm 0.74$	$37.35^{a} \pm 0.35$	$12.44^{a} \pm 0.05$
P. clandestinum	$82.42^{b} \pm 0.21$	$60.42^{b} \pm 0.71$	$22.00^{a} \pm 0.3$	$44.08^{b} \pm 0.73$	$16.34^{b} \pm 0.56$

Mean values bearing alphabetical superscripts within a column differed significantly ($p < 0.05$)

Table 5. Major minerals contents of predominant forages in Pulikulam cattle breeding tract (Mean ± SE)*

Botanical name	Major minerals (%)				
	Ca	P	Mg	Na	K
Sivaganga					
Corchorus olitorius	$0.20^{a} \pm 0.13$	$0.06^{b} \pm 0.01$	$0.34^{b} \pm 0.07$	$0.09^{a} \pm 0.04$	$1.44^{b} \pm 0.03$
Dactyloctenium aegyptium	$0.70^{b} \pm 0.01$	$0.03^{a} \pm 0.01$	$0.28^{b} \pm 0.02$	$0.40^{b} \pm 0.03$	$0.46^{a} \pm 0.07$
Pennisetum clandestinum	$0.48^{a} \pm 0.21$	$0.04^{a} \pm 0.00$	$0.18^{a} \pm 0.01$	$0.10^{a} \pm 0.04$	$0.37^{a} \pm 0.01$
Madurai					
Ocimum basilicum	$0.06^{a} \pm 0.01$	$0.08^{c} \pm 0.00$	$0.48^{b} \pm 0.03$	0.02 ± 0.09	$1.09^{b} \pm 0.11$
Pennisetum clandestinum	$0.58^{a} \pm 0.03$	$0.03^{a} \pm 0.01$	$0.13^{a} \pm 0.00$	0.01 ± 0.00	$0.35^{a} \pm 0.01$
Perotis indica	$2.63^{b} \pm 0.32$	$0.05^{b} \pm 0.01$	$0.23^{a} \pm 0.01$	0.02 ± 0.01	$1.04^{b} \pm 0.03$
Virudhunagar					
Aristida setacea	0.67 ± 0.06	$0.03^{a} \pm 0.00$	$0.10^{a} \pm 0.00$	0.02 ± 0.00	$0.23^{a} \pm 0.02$
Echinochloa colona	0.53 ± 0.08	$0.05^{b} \pm 0.00$	$0.17^{b} \pm 0.01$	0.03 ± 0.00	$0.92^{b} \pm 0.03$
Pennisetum clandestinum	0.62 ± 0.04	$0.03^{a} \pm 0.01$	$0.09^{a} \pm 0.00$	0.06 ± 0.02	$0.17^{a} \pm 0.01$

*Mean of three replications; Mean values bearing alphabetical superscripts within a column within the district differed significantly ($p < 0.05$)

and iron also showed significant ($p < 0.05$) variations between forages in all the districts (Table 6). *C. olitorius* had the highest zinc (46.47 mg/kg), *Ocimum basilicum* had the highest copper (30.81 mg/kg), *D. aegyptium* had the highest iron (0.22%) contents. In the Virudhunagar district, zinc was not detectable in *A. setacea* and both zinc and copper were not in detectable levels in *E. colona.* Chromium was not in detectable levels in all the forages assayed across districts. Similarly, lead was not in detectable limits in all the forages except in *C. olitorius* and *D. aegyptium* In the Sivaganga district. Variations were observed in the aluminum content between forages. *C. olitorius and D. aegyptium* in Sivaganga district had very high concentrations of aluminum 1955 and 4331 ppm, respectively.

This study revealed variability in mineral content between forages. Forage species in grazing lands cannot individually supply adequate minerals required by grazing livestock but they can complement each other to meet the mineral requirements (Msiza *et al.,* 2022). An interesting finding was that in the Virudhunagar district, two predominant herbages *viz., A. setacea and E. colona,* had no detectable levels of either zinc or zinc and copper. Similar to the finding of this study while

Table 6. Trace minerals of forage in Pulikulam cattle breeding tract (Mean ± SE)*

Botanical name	Trace minerals		
	Zn (mg/kg)	Cu (mg/kg)	Fe (%)
Sivaganga			
Corchorus olitorius	46.47^{b}±2.65	20.62^{b}±1.26	0.12^{b}±0.01
Dactyloctenium aegyptium	37.70^{ab}±3.45	8.73^{a}±1.23	0.22^{b}±0.00
Pennisetum clandestinum	22.24^{a}±2.56	7.80^{a}±1.12	0.04^{a}±0.00
Madurai			
Ocimum basilicum	22.25±1.23	30.81^{b}±1.28	0.02±0.01
Pennisetum clandestinum	28.34±2.56	6.92^{a}±0.76	0.03±0.00
Perotis indica	21.73±2.87	7.35^{a}±0.87	0.05±0.01
Virudhunagar			
Aristida setacea	ND	5.37±0.98	0.04±0.02
Echinochloa colona	ND	ND	ND
Pennisetum clandestinum	22.84±3.23	6.58±1.54	0.03±0.00

*Mean of three replications; Mean values bearing alphabetical superscripts within a column within the district differed significantly ($p < 0.05$); ND: Not detectable

Table 7. Heavy metals of forage in Pulikulam cattle breeding tract (Mean ± SE)*

Botanical name	Heavy metals (ppm)		
	Cr	Pb	Al
Sivaganga			
Corchorus olitorius	ND	1.33±0.12	1955^{b}±233.80
Dactyloctenium aegyptium	ND	2.08±0.03	4331^{c}±344.87
Pennisetum clandestinum	ND	ND	233.30^{a}±11.65
Madurai			
Ocimum basilicum	ND	ND	121.80^{a}±18.10
Pennisetum clandestinum	ND	ND	524.10^{b}±16.32
Perotis indica	ND	ND	441.30^{ab}±16.12
Virudhunagar			
Aristida setacea	ND	ND	151.00^{a}±19.20
Echinochloa colona	ND	ND	883.80^{b}±86.76
Pennisetum clandestinum	ND	ND	237.80^{a}±56.80

*Mean of three replications; Mean values bearing alphabetical superscripts within a column within the district differed significantly ($p < 0.05$); ND: Not detectable

arriving at a mineral map for Tamil Nadu, Sudhaharan (2009) also reported the deficit of zinc and copper in this district, which emphasizes the deficit of zinc and copper in the soil. Hence, zinc and copper are included in the area-specific mineral mixture formulated for this district. The variations between forages in their nutritive value as evident in this study, were dependent upon the interaction of a number of factors, which include plant species, soil type, plant age, pasture management and climate (McDowell *et al*., 1983).

Conclusion

Study indicated that a total number of 27 edible forage species were identified, of which *P. clandestinum* was predominant in all three districts of the Pulikulam cattle breeding tract. Variations between forages in their nutritive value were also evident. In the Virudhunagar district *A. setacea and E. colona* had no detectable levels of either zinc or zinc and copper, which reflects the importance of supplementation of these minerals to herds grazing in this tract for better productive and reproductive performances.

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