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Chemical composition and tannin content in leaves of *Ficus* spp. as top feed for ruminants from the Dang forest of South Gujarat Province, India

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Abstract
An experiment was conducted to estimate proximate composition, fibre fraction and tannin content of leaves amongst 10 spp. of genus *Ficus* L. belonging to family Moraceae from the Dangs Forest in South Gujarat. Results revealed that all parameters varied significantly among different species leaves. Leaves of *F. racemosa* was observed with high (p<0.05) dry matter (DM %) content while *F. arnottiana* leaves was high in organic matter (OM %) amongst. Per cent of crude protein (CP) and ether extract (EE) was significantly high in leaves of *F. benjamina* (11.64%) and *F. virens* (4.23%), respectively. The species *F. asperrima*, *F. arnottiana*, *F. religiosa* and *F. benjamina* were shown to be superior for the parameters like neutral detergent fibre (NDF %), acid detergent fibre (ADF %), acid detergent lignin (ADL %), and cell content. Tannin content was low in *F. benghalensis* and *F. benjamina* while highest in *F. arnottiana* followed by *F. amplissima.* Among different studied species *F. benghalensis* and *F. benjamina* found most suitable top feed for ruminant feeding.

Keywords: Proximate parameters, fibre fraction, tannins, ficus, moraceae, ruminant

Introduction
For livestock animals, fodder serves as their main and basic source of nutrition and is essential to their growth, development, and general well-being. Species, age, gender, and production goals all affect the nutritional needs of livestock animals [10]. To meet the nutritional requirement of increasing livestock population, it is necessary both to increase the productivity and to use available resources more efficiently. The leaves of tree considered nutritious feed due to their high proteins, vitamins and minerals [17]. Tree leaves play an important role in the nutrition of grazing animals in area where few or no alternatives are available [20].
For instance, in order to support milk production, dairy cows need a diet high in calories and protein, whereas beef cattle need a diet high in fibre to support healthy rumen function [9]. Because of the secondary plant chemicals (tannins) found in tree leaves, which allow ruminants to acquire larger quantities of dietary protein at post rumen for digestion and absorption, trees are employed as forages as sources of protein and energy for small ruminants [5]. For livestock animals to obtain enough nutrients from their food, it is essential to understand and determine the nutritional makeup of various types of fodder. For this, it is crucial to comprehend the basic nutrient composition of fodder, including its fiber fraction and tannin content.
The Moraceae family includes a wide range of trees and shrubs collectively known as *Ficus* spp., or simply figs. These plants are widespread in tropical and subtropical areas and are valued for their decorative qualities, edible fruits, and ecological significance [3,4]. But one of the less well-known advantages of *Ficus* species is their potential as a source of cattle fodder. *Ficus* spp. leaves and fruits are extremely nutrient-dense, loaded with protein and minerals, and have long been utilised as animal feed in many cultures [28]. Exploring the potential of *Ficus* spp. as a sustainable and cost-effective fodder source can help to promote livestock farming and conservation initiatives in a variety of areas. We can increase animal health, productivity, and welfare while lowering the environmental impact of animal husbandry by optimizing the nutritional content of livestock feeds.

Materials and Methodology

Tree leaves have traditionally been used as sources of fodder since they are a natural component of ruminant diets. For tiny ruminants, tree fodders constitute a significant source of nutrition. Tree fodders can supplement low-quality grasses since they provide more protein and minerals than grasses [5]. To ascertain the nutritional content of leaves from locally accessible fodder tree species, a field survey experiment was carried out in Dang district of South Gujarat. The Dangs comes under the AES-III, South Gujarat Heavy Rainfall Zone with a hilly terrain, is governed by dryness except during the rainy season. It consists of mixed tree growth among which teak is the predominant species in most parts of the area. The forest is continuous in all parts except at the places where the slopes are too steep to retain the soil and where biotic interference has cleared or opened it out.

Leaf fodder of ten different *Ficus* species *viz*., (*Ficus asperrima* Roxb., *F. racemosa* L., *F. virens* Ait., *F. benghalensis* L., *F. religiosa* L., *F. hispida* Vahl., *F. amplissima* Sm., *F. rumphii*, *F. benjamina* L., *F. arnottiana* Miq.) was collected from Dangs Forest, Gujarat in the Summer season (April-may) of year 2022-23. Proximate parameters such as moisture content (MC), dry matter (DM), organic matter (OM), crude protein (CP), crude fiber (CF), ether extract (EE), total ash (TA) and nitrogen free extract (NFE) along with fibre fraction such as neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin (ADL), cell content, cellulose and hemi-cellulose content of collected leaves were analyzed as per Van soest *et al*., (1991) [33] and AOAC (2016) [1] in three replication and the further data were analysed using CRD analysis ([26, 14]. The tannin content of leaves was estimated though by using Folin Ciocalteu assay method [21].

Result and Discussion

The proximate composition and fiber fractions of different *Ficus* tree leaves were revealed significant variations (P≤0.05) among different species (Table 1). The maximum, OM% (92.95) and CF% (27.91) were significantly higher in leaves of *F. arnottiana* however, DM % was found higher in *F. racemosa* (47.27%). CP (%) content was high (p<0.05) in *F. benjamina* (11.64%), which was comparable with *F. benghalensis* (11.41%) and *F. racemosa* (11.29%). EE (%) was found in the range of 1.23 to 4.23, which is better to that of conventional fodder like maize (1.79%) and sorghum (1.94%) [18, 29].

Generally, CP content typically provides a reliable indicator of their nutritional status, however it varies widely and similar research was conducted by Osagie and Aguebor-Ogie (2020) [24] on the three *Ficus* species (*F. thonningii*, *F. carica*, and *F. exasperata*) and reported the CP range (7.63-15.76%), which validates and illustrates the range (8.51-11.64%) of our results.

Similarly, in our study we reported significant variations (p>0.05) in proximate composition like OM, CF, CP, EE and the ash, NFE and crude fibre concentration among the ten *Ficus* species studied in our study which validates our finding and there are also comparable to values previously reported for Osowe *et al*., 2021 [25] in different species of *Ficus; F. racemosa* [11, 30, 2, 7] and *F. benghalensis* [19, 30, 27, 12]. Chitra and Balasubramanian 2016 [6] also reported the different proximate composition and fiber fraction in the five Albizia species which is also supports our results.

Table 1: Proximate content in the different *Ficus* spp. from the Dang Forest of South Gujarat Province, India

#	MC (%)	DM (%)	OM (%)	N (%)	CP (%)	EE (%)	CF (%)	AC (%)	NFE (%)
1	61.15^{d}	38.85^{d}	81.73^{e}	1.62^{c}	10.12^{c}	1.35^{f}	26.39^{a}	18.27^{a}	43.86^{d}
2	71.19^{a}	28.81^{g}	92.95^{a}	1.37^{e}	8.58^{e}	1.74^{e}	27.91^{a}	7.05^{e}	54.72^{ab}
3	67.70^{b}	32.30^{f}	87.37^{b}	1.77^{b}	11.07^{b}	2.34^{d}	17.99^{cd}	12.63^{d}	55.97^{ab}
4	59.15^{e}	40.85^{c}	85.14^{bc}	1.83^{ab}	11.41^{ab}	2.23^{d}	20.78^{b}	14.86^{cd}	50.72^{c}
5	65.03^{c}	34.97^{e}	83.25^{cde}	1.86^{a}	11.64^{a}	1.23^{f}	16.72^{cde}	16.75^{abc}	53.67^{bc}
6	67.71^{b}	32.28^{f}	84.00^{cd}	1.62^{c}	10.10^{c}	1.36^{f}	15.15^{e}	16.00^{bc}	57.40^{a}
7	52.73^{g}	47.27^{a}	86.66^{b}	1.80^{ab}	11.29^{ab}	3.86^{b}	15.79^{de}	13.34^{d}	55.72^{ab}
8	63.78^{c}	36.22^{e}	91.77^{a}	1.52^{d}	9.51^{d}	3.58^{c}	25.68^{a}	8.23^{e}	53.00^{bc}
9	57.53^{f}	42.47^{b}	82.28^{de}	1.36^{e}	8.51^{e}	3.71^{bc}	12.10^{f}	17.72^{ab}	57.95^{a}
10	56.52^{f}	43.48^{b}	85.42^{bc}	1.40^{e}	$8.^{78e}$	4.23^{a}	19.17^{bc}	14.58^{cd}	53.25^{bc}
S.Em	0.53	0.53	0.77	0.03	0.18	0.07	0.92	0.77	1.21
CV%	1.46	2.41	1.55	3.20	3.14	4.19	8.06	9.56	3.91

[MC: Moisture content (%), OM: Organic Matter (%), N: Nitrogen (%), CP: Crude Protein (%), EE: Ether extract (%), CF: Crude fibre (%), AC: Ash Content (%), NFE: (Nitrogen free extract. %), 1: *F. amplissima*, 2: *F. arnottiana*, 3: *F. asperrima*, 4: *F. benghalensis*, 5: *F. benjamina*, 6: *F. hispida*, 7: *F. racemosa*, 8: *F. religiosa*, 9: *F. rumphii*, 10: *F. virens*. {means with same and different superscript letter in the same column indicate significant and insignificant difference (p <0.05).}]

In ruminant system, nutrient digestibility is affected by content of fiber and its fractions which is shown in Table 2. Highest CF (%) was observed in *F. arnottiana* (27.91%), which is also found high in ADF (52.40%). Leaves of *F. asperrima* was found significantly high for NDF (72.42%) and ADL (36.43%) content. Cellulose and Hemi cellulose being considered as major polysaccharides available from fibrous portion of roughages. In the present study, highest cellulose and hemicellulose was found in *F. arnottiana* (17.64%) and *F. asperrima* (21.55%), respectively. The ADL portion contributed by lignin and total ash, which are indigestible and reduce the digestibility of fodder. Here, highest (p<0.05) ADL was observed in *F. religiosa* (38.09%) followed by *F. asperrima* (36.43%).

Results of fiber fraction are supported by the Niranjan, 2007 [23], Dhungana *et al*., 2012 [7], Nayak and Basak, 2015 [22] for the *F. benghalensis. However, values for* NDF (42.43-72.72%) was found higher than Ramachandran *et al*., 2015 [27] and Gaikwad *et al*., 2017 [12] for *F. religiosa*. Similarly, proximate parameter of *F. virens* reported in the study was in corroboration with of Khan 2011 [16] and Niranjan 2007 [23].

Table 2: Fiber fraction and Tannins content in the different *Ficus* spp. from the Dang Forest of South Gujarat Province, India

#	NDF (%)	ADF (%)	ADL (%)	Cellulose (%)	Hemi-cellulose (%)	CC (%)	Tannins (%)
1	46.94^{f}	29.45^{e}	12.79^{f}	16.66^{a}	17.49^{c}	53.06^{b}	27.37^{b}
2	64.59^{b}	52.40^{a}	34.76^{b}	17.64^{a}	12.20^{f}	35.41^{f}	38.56a
3	72.42^{a}	50.87^{a}	36.43^{a}	14.43^{b}	21.55^{a}	27.58^{g}	11.81^{cd}
4	52.96^{d}	40.29^{b}	34.06^{bc}	6.23^{c}	12.66^{ef}	47.04^{d}	8.10^{g}
5	42.43^{g}	29.34^{e}	24.53^{e}	4.80^{cd}	13.09^{ef}	57.57^{a}	9.46^{fg}
6	46.83^{f}	33.39^{d}	30.01^{d}	3.38^{de}	13.44^{e}	53.17^{b}	11.00^{de}
7	49.24^{e}	36.67^{c}	32.46^{c}	4.21^{de}	12.58^{ef}	50.76^{c}	11.85^{cd}
8	55.49^{c}	40.84^{b}	38.09^{a}	2.76^{e}	14.65^{d}	44.51^{e}	12.61^{c}
9	51.46^{d}	32.42^{d}	29.56^{d}	2.86^{e}	19.05^{b}	48.54^{d}	10.19^{ef}
10	57.33^{c}	40.18^{b}	33.96^{bc}	6.22^{c}	17.15^{c}	42.67^{e}	12.31^{cd}
S.Em	0.73	0.80	0.57	0.65	0.31	0.73	0.47
CV%	2.34	3.60	3.19	14.22	3.53	2.75	5.27

[NDF: (Neutral detergent fiber %), ADF: (Acid detergent fiber %), ADL: (Acid Detergent Lignin %), C: Cellulose (%), HC: Hemi-Cellulose (%), CC: Cell content (%), DM: Dry Matter (%), 1: *F. amplissima*, 2: *F. arnottiana*, 3: *F. asperrima*, 4: *F. benghalensis*, 5: *F. benjamina*, 6: *F. hispida*, 7: *F. racemosa*, 8: *F. religiosa*, 9: *F. rumphii*, 10: *F. virens*.{means with same and different superscript letter in the same column indicate significant and insignificant difference (p <0.05).}]

The common *Ficus* trees fodder is quite usual among the cattle and small ruminants. However, no information is available on the nutritive value for few of the selected species. It might be the first attempt to analysed *Ficus asperrima*, *F. amplissima*, *F. rumphii*, *F. benjamina* and *F. arnottiana* for their proximate and fiber fraction composition.

The tannin content of fodder plants, which has a substantial impact on digestibility and nutrient availability, is one element that affects the nutritional value of the plants [15]. The majority of tree leaves include different types of tannins as an antinutritional substance that necessitates appropriate measures while choosing the species of tree leaves [5].

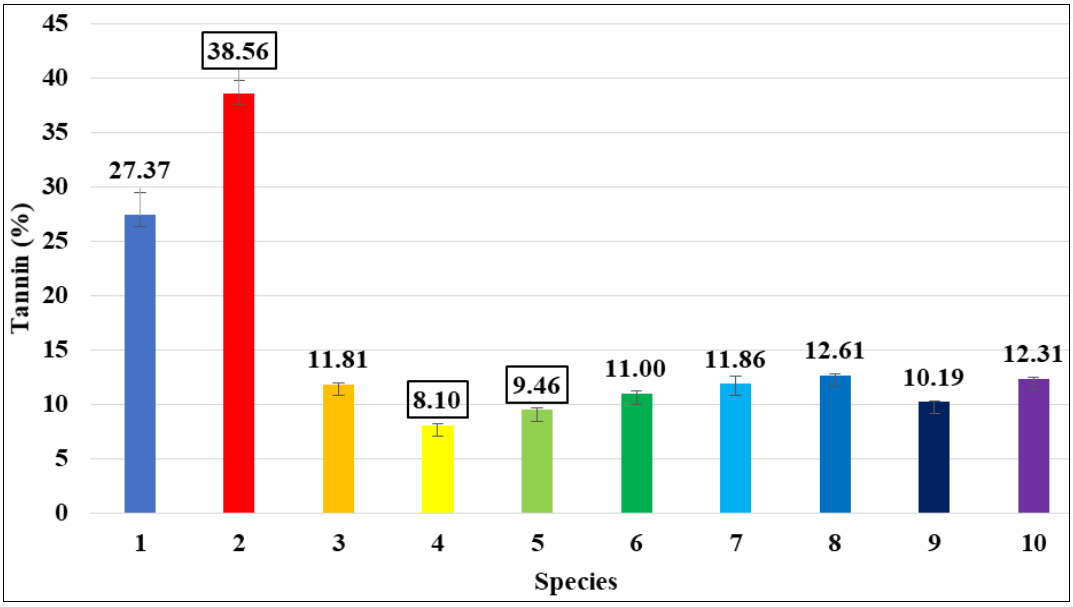

Fig 1: Tannin (%) content in the different *Ficus* spp. from the Dang Forest of South Gujarat Province, India. (1: *F. amplissima*, 2: *F. arnottiana*, 3: *F. asperrima*, 4: *F. benghalensis*, 5: *F. benjamina*, 6: *F. hispida*, 7: *F. racemosa*, 8: *F. religiosa*, 9: *F. rumphii*, 10: *F. virens*.)

In present investigation of *Ficus* spp., the tannin was found in the range of 8.10-38.56%. Maximum mean tannin content was observed in the FAR (*Ficus arrnottiana)* leaves 38.56% followed by FAM (*F. amplissima*) leaves 27.37%. However, the minimum mean tannin content was observed in FB (*Ficus benghalensis*) 8.10% and shown in the Table 2 and Fig. 1. Similar findings were reported by Fernandes *et al*., (2007) [11] and Sumi *et al*., (2021) [32], they reported that the tannin levels in *Ficus racemosa* was 2.9% and 19.72 mg GAE/g of dry extract, respectively by Folin Ciocalteu method. Numerous reports that have shown the reduction of enteric methane from ruminants due to inclusion of tannin rich browses because the tannins have anti-methanogenic activity [13] and ranged the total tannin concentration between 32.4 to 209.1 g/kg DM. Similarly, Saxena *et al*., 2013 [31] reported 99.55 mg/gm, 9.95mg/gm, 54.96 mg/gm, and 57.4869 mg/gm of tannin for Harde, Arjuna, Baheda and Ashoka respectively.

Conclusion

The present study on nutrional evaluation of leaves from different *Ficus* species have been revealed that leaves are good source of nutrients with tolerable amount of ADL as well as tannin content and can be used as a supplemental feed in livestock.

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