

Original Research Article

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Tree Foliages Fed to Dairy Animals in Mizoram: Traditional Medicinal Uses, Screening and Quantification of Phytochemicals

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ABSTRACT

The study was to identify tree foliages fed to dairy animals in Mizoram, to screen and quantify the phytochemicals and to survey traditional medicinal uses. Surveys conducted on 45 dairy farmers of 15 randomly selected villages of RDBs of Aizawl district, Mizoram (namely, Tlangnuam, Thingsulthiah and Aibawk). Aqueous extracts of representative leaf samples were made for phytochemical screening and quantification by following different procedures. The study revealed usages of 41 different tree foliages out of which 21 were evergreen. Qualitative screening revealed 33 and 25 species positive for polyphenols and flavonoids, all for terpenoids; 22, 13 and 5 species for saponins, alkaloids and reducing sugar, respectively and 4, 10 and 13 tree species positive for glycosides, quinone and phlobatanins, respectively. DM% of the tree leaves varied from 16.04 – 22.95%. Total phenolics ranged from 4.3048±0.79% to 61.5564±3.91% and CT levels from 0.1165±0.04% to 7.0692±2.53% on DM basis. The flavonoids ranged from 0.0500±0.00 to 178.4833±0.83 mg RE/g dry sample and saponins varied from 10.0667±0.33 to 112.5033±2.15 mg DE/g dry sample. The alkaloids content was 0.18±0.01 mg/g in *Cordia dichotoma* G. Forst (Muk-fang) to 7.28±0.01 mg/g in *Anogeissus acuminata* (Roxb. Ex DC) Gull. (Zai-rum). Some tree species were found to utilize by the Mizo communities for treating various ailments. Baseline data about concentration of phytochemicals of tree foliages fed to dairy animal in Mizoram will help in exploiting them as herbs and potential feeds in TMR of dairy animals in Mizoram.

Keywords

Tree foliage,
Phytochemical,
Dairy animal,
Mizoram.

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Introduction

The beneficial effects of tree leaves to livestock in addition to their nutritional values are attributed by their phytochemical constituents (Dinda *et al.*, 2007; Podsedek, 2007). Phytochemicals of plants are responsible for numerous beneficial biological effects including antioxidant, anti-inflammatory, antimicrobial and anti-cancer activities. Tree leaves provide strong protective effects against diseases associated with oxidative damage (Kaur and Kapoor,

2002) for antioxidant property (Uusiku *et al.*, 2010). Flavonoids act as free radical scavengers and saponins present in tree leaves are known to have hypolipidemic and anticancer activity. Antioxidants of tree leaves also play pivotal role in prevention of chronic and degenerative diseases of animals. Mizoram, one of the 8th North Eastern states of India, is situated between 21°58' N to 24°35' N latitude and 92°15'E to 93°29'E longitude spreading over 21,087 sq.km

geographical area with 10, 91, 014 human population. The dairy farming plays important role on economic sustainability of the rural farming communities in Mizoram. Amongst livestock, dairy farming is the most popular economic activity next to piggery among the 'Mizo people' and constitutes 9.62% of total livestock population in the state (Economic Survey of Mizoram, 2013-14).

Balanced feeding is one of the biggest constraints for the dairy farmers of the state due to shortage of nutritional feeds for deficit production of grains in the state. More than 90% of the livestock feed ingredients come from other states of the mainland.

The nutritional demands of the dairy animals are met mainly by the crop residues, natural grasses, tree leaves and shrubs (Kumaresan *et al.*, 2010) under rural production system. The tree leaves are the main components of roughage source provided to the dairy animals. The tree leaves become the sole roughage during lean season, particularly during the winter months of the year for scarcity of jungle grasses and forages in the state. A few studies had been conducted to identify the commonly utilized tree leaves for dairy animals and their nutritional composition (Das *et al.*, 2006; Sarma *et al.*, 2007; Samanta *et al.*, 2009); however, no information is available about the phytochemical constituents and anti-oxidant property of the tree leaves. In the present study, therefore, an attempt was made for screening and quantification of phytochemicals and to survey about traditional medicinal uses of the tree foliage fed to dairy animals in Mizoram, India.

Materials and Methods

Location of the study

The study was conducted covering three Rural Development Blocks (RDB) of Aizawl

district of Mizoram, India namely, Tlangnuam, Thingsulthiah and Aibawk and were purposively selected considering proportional dairy cattle and buffalo population of the district. Five villages were selected from each RDB, and three dairy farmers from each village were randomly selected for the study (Table 1).

Sampling method and sample preparation for analysis

Information about utilization of tree leaves for feeding dairy animals was collected from the selected farmers of each RDB. All farmers were visited and questioned about the feeding practices and utilization of tree leaves for feeding to their dairy animals.

The 'Mizo' names of the tree species were collected from farmers and the botanical names were confirmed in collaboration with the Department of Forestry, Mizoram University, Aizawl, Mizoram and referring to available literatures of Botanical Survey of India, Kolkata, India.

The healthy leaves representing different developmental stages were collected from the farmers. The leaves of each species were collected separately from all the selected farmers. After collection, leaves of the same tree species of a particular RDB were pooled together and six representative samples were drawn for analysis.

The samples of leaves were air dried under the shade and made in mesh with powdery consistency for preparation of aqueous extracts. Aqueous extracts were made utilizing about 30 gm of dried leaves powder in Soxhlet extraction system. The extraction was performed for 48 hrs and then the extract was concentrated by slow evaporation process through incubation at 37⁰C. The yield was recorded and stored at -20⁰C before analytical use.

Procedures adopted for phytochemical screening

The flavonoids, polyphenols and alkaloids were analysed qualitatively following procedures outlined by Akenga *et al.*, (2005). The saponin, anthraquinones and the presence of tannins were screened according to methods described by Sofowora (1982), Trease and Evans (1989) and Edeoga *et al.*, (2005), respectively.

Methods for quantitative estimation of phytochemicals

The total phenolics of tree leaves as tannic acid equivalent (TAE) were estimated as per method of Makkar *et al.*, (1993). The condensed tannins (% as leucocyanidin equivalent) were estimated following method of Porter *et al.*, (1986). The total flavonoid and saponin content of the extracts were determined as per methods described by Nabavi *et al.*, (2008) and Makkar *et al.*, (2007), respectively.

Results and discussion

Description of the tree fodder species identified

Tree leaves of forty one (41) different species were found to be utilised for feeding dairy animals in Mizoram (Table 2). Das *et al.*, (2006) analysed leaves of twelve tree species fed to dairy cattle and found that leaves of *Trema orientalis*, *Bauhinia variegata* and *Buhinia vahlii* were rich source of protein and the leaves of *Cinnamomum tamala*, *Bauhinia vahlii* and *Macaranga peltata* were rich source of energy and the leaves of *Trema orientalis*, *Bauhinia variegata* and *Hevea brasiliensis* were rich source of calcium. Samanta *et al.*, (2009) reported about twelve tree species and Sarma *et al.*, (2007) described 14 different forage species utilised by the Mizo farmers for feeding dairy animals.

However, in the present study, the personal interview with the dairy farmers revealed that they utilised tree leaves of forty one different species throughout the year, out of which 21 tree species were evergreen and the rest were either large or small deciduous trees.

Phytochemical screening

The results of the qualitative screening for polyphenols, flavonoids and terpenoids in aqueous leaves extracts of the tree leaves revealed 33 and 25 species positive for polyphenols and flavonoids and all for terpenoids. Diwan *et al.*, (2014) also reported the presence of alkaloids, flavonoids, simple phenolics, steroids and saponins in *Ficus benghalensis* Linn. root extracts. Lalawmpui *et al.*, (2014) indicated the presence of polyphenols and flavonoids in *Helicia nilagirica* Bedd., an ethnomedicinal plant of Mizoram. For saponins, alkaloids and reducing sugar, 22, 13 and 5 species were found positive, respectively.

The results thus indicated that the tree fodders are not only good sources of polyphenols, flavonoids and terpenoids, but also rich in saponins, alkaloids and reducing sugar which ensures health benefits besides providing valuable nutrients to the animals. Diwan *et al.*, (2014) reported the presence of saponins and alkaloids in Bung (*Ficus benghalensis* Linn.). Sowjanya *et al.*, (2013) indicated the presence of alkaloids and glycosides in Hmui-pui/ Len-hmui [*Syzygium cumini* (L.) Skeels].

Out of the total 41 tree species, only 4 tree species were found positive for glycosides, 10 for quinone and 13 species for phlobatanins. Ganatra *et al.*, (2012) reported the presence of quinine and glycosides in *Ficus racemosa* Linn. Egharevba and Kunle (2010) in their study indicated the presence of glycosides but absence of phlobatannins in leaves extract of *Piliostigma thionningii* (Schumach) commonly utilised under traditionally as

remedy for fever, wounds, ulcers, gastric/heart pain and gingivitis. Similarly, the presence of glycosides, quinine and phlobatannins were also reported by Lalawmpuii *et al.*, (2014) in edible leaves of various tree species.

Table.1 Villages selected for the study

Tlanguam RDB	Thingsulthiah RDB	Aibawk RDB
Aizawl (NT)	Seling	Aibawk
Bawngkawn	Sesawng	Sateek
Muthi	Saitual	Thingdawl
Serkhan	Darlawng	Falkawn
Sihphir	Edenthar	Thiak

Table.2 Different tree leaves species identified to be utilised for feeding dairy animals

Mizo/English name	Botanical name	Description
An-ku/ An-ku-hawng-tial (Eastern Nettle Tree)	<i>Celtis tetrandra</i> Roxb.	Large deciduous, found up to 1,100 m altitude. Leaves are used as fodder, fruits are prescribed for remedy of amenorrhoea and colic.
Bel-phuar (Charcoal tree)	<i>Trema orientalis</i> (L.) Blume.	Evergreen tree, fast-growing and short lived, leaves are fodder and plant juice is believed to be a useful remedy for epilepsy.
Bung (Banyan tree)	<i>Ficus benghalensis</i> Linn.	Evergreen tree, grown up to 1,200 m above MSL, eaves are good fodders, Infusion of bark is used for diabetes, nervous disorder, leucorrhoea, diarrhoea, dysentery, and juice of stem is applied externally for rheumatism, lumbago, toothache and bruises.
Ba-ting	<i>Wendlandia budleioides</i> Wall. Ex Wight & Arn.	Small evergreen tree ascending to about 1,500 m above MSL, leaves are used as fodders.
Bil (Murtenga) – Indian Red Pear	<i>Protium serratum</i> (Wall. ex Colebr.) Engl.	Medium-sized or large evergreen tree, fruits are eaten by the wild animals and leaves are very useful for feeding to cattle and buffaloes.
Chawm-zil (Wild Privet)	<i>Ligustrum robustum</i> (Roxb.) Blume	Medium sized evergreen tree, found between altitudes 700-1800 m above MSL, leaves are lopped for fodders.
Chhawn-tual	<i>Aporosa octandra</i> (Buch.-Ham. ex D. Don) Vickery	Small to medium sized evergreen tree, found within 900 m above MSL, besides leaves as roughage, bark is boiled in water and the water is taken as remedy for stomach ulcer, diarrhoea and dysentery, tender leaves as remedy for stomach trouble.
Hnum	<i>Engelhardtia spicata</i> Lechen ex Blume	Large deciduous tree found up to 1800 m above MSL, leaves are used as cattle fodder.
Hnah-thap	<i>Colona floribunda</i> (Kurz) Craib	Medium-sized deciduous tree found below 1000 m above MSL, leaves are used for feeding cattle and buffaloes by the dairy farmers in Mizoram.
Hnahkiah	<i>Callicarpa arborea</i> Roxb.	Medium sized evergreen tree ascending to about 1300 m above MSL, leaves are lopped for fodder, decoction of bark and leaves are presented for diabetes, cholera, dysentery and diarrhoea, internal bleeding, colic and stomach ulcer, bark juice is

		applied to freshly cut wounds.
Hriang (Alder birch/betula)	<i>Betula alnoides</i> Buch.-Ham. ex D. Don.	Medium to large sized deciduous tree found in altitude 900-1500 m, leaves are lopped for feeding to cattle, buffaloes, goat, wood of the plant is good for furniture, tool making, used as snake-bite remedy.
Hmui-pui/ Len-hmui (Black plum/blackberry/Jaman)	<i>Syzygium cumini</i> (L.) Skeels	Medium to large sized evergreen tree ascending to about 1500 m, leaves are used for feeding cattle and buffaloes during scarcity/lean period, seed is very useful for diabetes, bark for fever, jaundice, dysentery, urinary problems, sore-throats, bronchitis, asthma, ulcers and chronic dysentery.
Khiang (Needle wood/Schima/Chilauni)	<i>Schima wallichii</i> Choisy	Large evergreen tree found up to 1,500 m, leaves as fodders for cattle and buffaloes, fruits in powder form is utilised as remedy for scorpion-sting, bites of centipede and large black spider etc., juice of bark is used as remedy for chronic ulcer and fresh cuts.
Khawmhma (Chinese sumac/nutgall tree)	<i>Rhus chinensis</i> Mill	Small to medium sized deciduous tree ascending up to 700-1800 m, leaves for feeding cattle and buffaloes, decoction of fruits is recommended for colic, diarrhoea and dysentery, leaves boiled in water and the water is used for bath in suffering from measles, juice of crushed leaves is applied to rash or sores caused by <i>Drimycarpus racemosus</i> and <i>Semecarpus anacardium</i> .
Leh-ngo (Duggal fibre tree)	<i>Sarcochlamys pulcherrima</i> Gaudich	Small evergreen tree, leaves used for feeding cattle, buffaloes and pig, tender leaves are recommended in diarrhoea and dysentery.
Lam-khuang/ La-ui (Jackfruit tree/ Kathal)	<i>Artocarpus heterophyllus</i> Lam.	Large evergreen tree found up to 1200 m above MSL, leaves used for feeding small ruminants, cattle and buffaloes, Decoction of the root is useful in fever, diarrhoea, asthma, leaves for fever, skin diseases, wounds, boils etc., milky juice of plant is useful in sores caused by <i>Herpes eruptions</i> .
Muk-fang (Indian cherry)	<i>Cordia dichotoma</i> G. Forst	Medium sized deciduous tree ascending to about 1500 m, leaves fed to cattle, buffaloes, small ruminants.
Ngiau (Champ)	<i>Magnolia oblonga</i> (Wall. ex Hook.f. & Thomson) Figlar	Tall tree with oblanceolate leaves and white flowers, leaves are utilised for cattle and buffaloes.
Nau-thak (Common grey mango laurel/meda)	<i>Litsea monopetala</i> (Roxb.) Pers.	Medium sized evergreen tree ascending to about 1200 m, leaves used for feeding cattle.
Phan (Eastern elm)	<i>Ulmus lanceifolia</i> Roxb. Ex Wall	Large deciduous tree ascending to about 1400 m in Mizoram, leaves used for cattle buffaloes.
Ri-hnim (Kel-hmawng/Hmawng-kir)	Indian Laurel Fig	Medium to large sized evergreen tree found below 1000 m of MSL, leaves eaten by cattle, buffaloes, goat and other ruminant species, juice of leaves is used as remedy for flatulent colic and liver disease, bark is used in rheumatism.
Si-hneh	<i>Eurya cerasifolia</i> (D.Don) Kobuski	Small evergreen tree found at 900 m above MSL, leaves are lopped for cattle and buffaloes.
Sa-zu-thei-pui (hairy fig)	<i>Ficus hirta</i> Vahl.	Deciduous tree found up 1500 m, leaves used as fodders for animals.
Thing-kha	<i>Derris robusta</i> (DC.)	Medium sized deciduous tree found below 900 m,

	Benth.	leaves are lopped for cattle; Decoction of the bark is used as effective remedy for diabetes and high blood pressure.
Thel-ret (Thial-ret)	<i>Ficus elastica</i> Roxb. Ex Hoemen.	Large evergreen tree with numerous aerial roots found below 1000 m, leaves are good fodders.
Thing-lung	<i>Homalium ceylanicum</i> (Gardner) Benth. Subsp. <i>minutiflorum</i> (Kurz.) Mitra	Evergreen tree with white flowers found up to 1500 m above MSL, leaves are utilised as fodders during lean season.
Tlai-zawng/ (Padam/wild cherry)	Pai-vun Himalayan <i>Cerasus cerasoides</i> (Buch.-Ham.exD.Don) S.Y.Sokolov	Medium sized tree found between altitudes 700-1800 m above MSL, leaves are utilised as fodders Decoction of the bark is used in fever.
Thing-hmar-cha (Hackberry/ Stinwood)	<i>Celtis timorensis</i> Span.	Medium sized evergreen tree found between 800 – 1500 m leaves as fodders for cattle.
Thei-tat (Monkey jack/Lakooch)	<i>Artocarpus lakoocha</i> Roxb.	Large deciduous tree found up to altitude 1200 m, leaves as fodders for cattle.
Thingsia (Chestnut)	<i>Castanopsis tribuloides</i> (Sm.) A.DC	Medium to large sized evergreen tree ascending up to latitude 1800 m, leaves used as fodders.
Thing-ri (Black siris)	<i>Albizia odoratissima</i> (L.f.) Benth	Medium sized deciduous tree found up to altitude 1300 m, leaves very good fodders for cattle, goat and sheep.
Thei-ria (Carallia/Corkwood)	<i>Carallia brachiata</i> (Lour.) Merr.	Medium sized evergreen tree found up to altitude 1200 m leaves are lopped for fodders, bark and leaves are used for septic poisoning and itching.
Tiar	<i>Saurauia punduana</i> Wall	Small evergreen tree, found ascending up to about 1800 m above MSL, leaves are utilised as fodders for cattle and buffaloes.
Thlan-vawng	<i>Gmelina arborea</i> Roxb	Medium to large sized deciduous tree found ascending up to 1300 m, leaves are liked by cattle and hence used as fodders.
Thing-vawk-pui	<i>Balakata baccata</i> (Roxb.) Esser	Medium to large sized evergreen tree, leaves are used as fodder for cattle and buffaloes.
Thei-tit	<i>Ficus prostrate</i> (Wall. ex Miq.) Buch.-Ham. ex Miq.	Small deciduous tree found ascending up to about 1500 m, leaves for feeding to dairy cattle and buffaloes, Juice of the root is recommended for snake-bite and the white latex is applied on snake bite.
Vau-be	<i>Bauhinia variegata</i> L.	Medium sized deciduous tree found up to 1500 m, leaves good fodders for the dairy animals, Decoction of the bark or leaves is recommended for menstrual disorders in female, intestinal worms, piles, diabetes, diarrhoea and dysentery.
Vang	<i>Albizia chinensis</i> (Osborne) Merr.	Large deciduous tree found up to altitude about 1200 m, leaves good fodder for cattle, Infusion of the bark is used as lotion for cuts, scabies and other skin diseases.
Zih-nghal	<i>Stereospermum chelonoides</i> (L.f.) DC.	Medium sized tree (9-18 m tall) found up to altitude 1500 m, leaves are very good fodder for cattle.
Zai-rum (Yon)	<i>Anogeissus acuminata</i> (Roxb. Ex DC) Gull.	Large deciduous tree found within about 1000 m altitude, leaves are very good fodder for dairy animals, decoction of the bark is recommended in stomach troubles, fever, diarrhoea and also applied on measles, chicken pox, sprains and burns, leaves after cooking in water, the water is recommended as remedy for high blood pressure.

Table.3 Total phenolics and Condensed tannins (CT) as leucocyanidin equivalent (% on DM basis) in tree foliages fed to dairy animals in Mizoram

Mizo name (Botanical Name)	Total Phenolics (% on dry matter basis) (N=6)	Condensed tannins (CT) as leucocyanidin equivalent (% on dry matter basis) (N=6)
An-ku/ An-ku-hawng-tial (<i>Celtis tetrandra</i> Roxb.)	8.8607±0.74	0.3762±0.12
Bel-phuar [<i>Trema orientalis</i> (L.) Blume]	7.4740±1.20	0.3726±0.12
Bung (<i>Ficus benghalensis</i> Linn.)	6.7541±0.54	0.1374±0.04
Ba-ting (<i>Wendlandia budleoides</i> Wall. Ex Wight & Arn.)	25.5852±0.70	3.9009±1.30
Bil [<i>Protium serratum</i> (Wall. ex Colebr.) Engl.]	23.1611±8.27	5.9558±1.98
Chawm-zil [<i>Ligustrum robustum</i> (Roxb.) Blume]	18.3452±1.10	0.3436±0.12
Chhawn-tual [<i>Aporosa octandra</i> (Buch.-Ham. ex D. Don) Vickery]	4.9477±0.78	0.5700±0.26
Hnum (<i>Engelhardtia spicata</i> Lechen ex Blume)	13.8702±2.02	0.5144±0.19
Hnah-thap [<i>Colona floribunda</i> (Kurz) Craib]	8.0950±0.98	0.4486±0.15
Hnahkiah (<i>Callicarpa arborea</i> Roxb.)	12.7062±1.04	0.3551±0.10
Hriang (<i>Betula alnoides</i> Buch.-Ham. ex D. Don.)	5.5323±0.47	0.3644±0.13
Hmui-pui/ Len-hmui [<i>Syzygium cumini</i> (L.) Skeels]	22.4580±7.25	7.0692±2.53
Khiang (<i>Schima wallichii</i> Choisy)	21.4894±5.43	0.6156±0.21
Khawmhma (<i>Rhus chinensis</i> Mill)	26.7532±9.62	1.8435±0.38
Leh-ngo (<i>Sarcochlamys pulcherrima</i> Gaudich)	4.8884±0.17	0.1165±0.04
Lam-khuang (<i>Artocarpus heterophyllus</i> Lam.)	13.3478±1.01	0.4242±0.15
Muk-fang (<i>Cordia dichotoma</i> G. Forst)	13.0928±1.45	0.2653±0.07
Ngiau [<i>Magnolia oblonga</i> (Wall. ex Hook.f. & Thomson) Figlar]	22.1938±5.89	0.4366±0.15
Nau-thak [<i>Litsea monopetala</i> (Roxb.) Pers.]	4.6493±0.74	1.1991±0.46
Phan (<i>Ulmus lanceifolia</i> Roxb. Ex Wall.)	7.2829±0.46	1.2222±0.44
Ri-hnim (<i>Ficus retusa</i> L.)	32.5933±7.48	3.4690±1.21
Si-hneh [<i>Eurya cerasifolia</i> (D.Don) Kobuski]	16.1235±1.25	3.2251±1.03
Sa-zu-thei-pui (<i>Ficus hirta</i> Vahl.)	7.7894±1.11	0.3322±0.11
Thing-kha [<i>Derris robusta</i> (DC.) Benth.]	12.1166±2.93	0.8224±0.31
Thei-ret [<i>Ficus elastica</i> Roxb. Ex Hoemen.]	4.8824±0.81	0.1139±0.04
Thing-lung [<i>Homalium ceylanicum</i> (Gardner) Benth. Subsp. <i>minutiflorum</i> (Kurz.) Mitra]	26.0483±1.37	1.9656±0.66
Tlai-zawng/ Pai-vun [<i>Cerasus cerasoides</i> (Buch.-Ham.exD.Don) S.Y.Sokolov]	4.8908±0.64	0.2114±0.07
Thing-hmar-cha [<i>Celtis timorensis</i> Span.]	9.7337±2.01	0.5530±0.21
Thei-tat (<i>Artocarpus lakoocha</i> Roxb.)	27.8499±3.96	1.0695±0.34
Thingsia [<i>Castanopsis tribuloides</i> (Sm.) A.DC.]	14.8031±2.85	0.8352±0.31
Thing-ri [<i>Albizia odoratissima</i> (L.f.) Benth.]	36.9048±3.19	0.9444±0.34
Thei-ria [<i>Carallia brachiata</i> (Lour.) Merr.]	4.3048±0.79	3.7094±1.15
Tiar (<i>Saurauia punduana</i> Wall.)	7.1805±0.63	0.5837±0.24
Thlan-vawng [<i>Gmelina arborea</i> Roxb.]	26.3336±2.42	0.5331±0.23
Thing-vawk-pui [<i>Balakata baccata</i> (Roxb.) Esser]	42.4319±5.83	1.4909±0.46
Thei-tit [<i>Ficus prostrata</i> (Wall. ex Miq.) Buch.-Ham. ex Miq.]	27.8499±3.96	5.8235±1.96
Vau-be [<i>Bauhinia variegata</i> L.]	9.0975±1.31	0.9553±0.34
Vang [<i>Albizia chinensis</i> (Osb) Merr.]	7.8747±0.81	0.1824±0.05
Zih-nghal [<i>Stereospermum chelonoides</i> (L.f.) DC.]	61.5564±3.91	3.9228±1.64
Zai-rum [<i>Anogeissus acuminata</i> (Roxb. Ex DC) Gull.]	61.1845±8.42	0.5992±0.19

Table.4 Quantitative estimation of Flavonoids, saponins and Coumarin in tree leaves fed to dairy cattle in Mizoram

Mizo name (Botanical Name)	Flavonoids (mg Rutin Equivalents/g)	Saponins (mg Diosgenin equivalent/g)	Coumarin (mg coumarin equivalent/g)
An-ku/ An-ku-hawng-tial (<i>Celtis tetrandra</i> Roxb.)	ND	30.4833±0.97	5.0867±0.05
Bel-phuar [<i>Trema orientalis</i> (L.) Blume]	1.6933±0.02	30.1100±0.64	17.4667±0.50
Bung (<i>Ficus benghalensis</i> Linn.)	106.4767±1.12	19.8600±0.45	0.2467±0.09
Ba-ting (<i>Wendlandia budleoides</i> Wall. Ex Wight & Arn.)	126.6033±2.15	112.5033±2.15	14.5400±0.32
Bil [<i>Protium serratum</i> (Wall. ex Colebr.) Engl.]	1.7300±0.09	104.5333±0.55	9.9000±0.24
Chawm-zil [<i>Ligustrum robustum</i> (Roxb.) Blume]	40.1933±1.10	36.6933±1.63	9.8433±0.39
Chhawn-tual [<i>Aporosa octandra</i> (Buch.-Ham. ex D. Don) Vickery]	74.6000±0.98	21.9767±0.31	10.2533±0.38
Hnum (<i>Engelhardtia spicata</i> Lechen ex Blume)	40.0967±0.16	24.7033±0.55	10.3267±0.33
Hnah-thap [<i>Colona floribunda</i> (Kurz) Craib]	1.0167±0.08	32.6833±0.25	2.1767±0.13
Hnahkiah [<i>Callicarpa arborea</i> Roxb.)	23.0600±0.10	34.7567±0.45	14.8967±0.31
Hriang (<i>Betula alnoides</i> Buch.-Ham. ex D. Don.)	28.0500±0.28	59.0100±0.95	13.0133±0.37
Hmui-pui/ Len-hmui [<i>Syzygium cumini</i> (L.) Skeels]	169.4167±0.63	27.7333±0.66	10.6300±0.38
Khiang (<i>Schima wallichii</i> Choisy)	66.4033±0.59	57.2267±0.33	18.9567±0.14
Khawmhma (<i>Rhus chinensis</i> Mill)	127.6100±0.62	102.1367±0.89	16.6300±0.61
Leh-ngo (<i>Sarcochlamys pulcherrima</i> Gaudich)	0.0500±0.00	102.1367±0.26	5.1400±0.13
Lam-khuang (<i>Artocarpus heterophyllus</i> Lam.)	24.8300±0.32	27.8067±0.53	4.0800±0.15
Muk-fang (<i>Cordia dichotoma</i> G. Forst)	10.9167±0.40	27.8067±0.29	1.7533±0.04
Ngiau [<i>Magnolia oblonga</i> (Wall. ex Hook.f. & Thomson) Figlar]	178.4833±0.83	75.6600±0.61	12.0033±0.40
Nau-thak [<i>Litsea monopetala</i> (Roxb.) Pers.]	88.4767±0.66	65.3633±0.55	5.9867±0.25
Phan (<i>Ulmus lanceifolia</i> Roxb. Ex Wall.)	ND	ND	10.7700±0.57
Ri-hnim (<i>Ficus retusa</i> L.)	115.3067±0.55	97.8700±0.95	6.1867±0.18
Si-hneh [<i>Eurya cerasifolia</i> (D.Don) Kobuski]	77.5467±0.56	112.0667±1.24	19.3700±0.74
Sa-zu-thei-pui (<i>Ficus hirta</i> Vahl.)	8.2300±0.22	19.7000±0.48	1.8467±0.04
Thing-kha [<i>Derris robusta</i> (DC.) Benth.]	60.0267±0.68	44.7333±0.65	19.7367±0.58
Thei-ret [<i>Ficus elastica</i> Roxb. Ex Hoemen.]	5.0767±0.10	10.0667±0.33	2.1767±0.11
Thing-lung [<i>Homalium ceylanicum</i> (Gardner) Benth. Subsp. <i>minutiflorum</i> (Kurz.) Mitra]	152.4233±1.09	98.4733±0.60	9.1667±0.19
Tlai-zawng/ Pai-vun [<i>Cerasus cerasoides</i> (Buch.-Ham.exD.Don) S.Y.Sokolov]	28.5267±0.48	99.3067±0.49	31.3833±0.71
Thing-hmar-cha [<i>Celtis timorensis</i> Span.]	27.9633±0.36	37.4800±0.62	14.5000±0.25
Thei-tat (<i>Artocarpus lakoocha</i> Roxb.)	15.1667±0.18	79.5033±0.50	3.4467±0.25
Thingsia [<i>Castanopsis tribuloides</i> (Sm.) A.DC.]	51.6833±0.54	65.2067±0.29	11.8500±0.25
Thing-ri [<i>Albizia odoratissima</i> (L.f.) Benth.]	7.0467±0.09	99.0500±0.69	5.2933±0.06
Thei-ria [<i>Carallia brachiata</i> (Lour.) Merr.]	54.2667±0.50	95.6100±0.76	7.2100±0.17
Tiar (<i>Saurauia punduana</i> Wall.)	17.1767±0.19	37.0033±0.28	5.1267±0.12
Thlan-vawng [<i>Gmelina arborea</i> Roxb.]	15.2167±0.16	85.9233±0.53	12.0967±0.48
Thing-vawk-pui [<i>Balakata baccata</i> (Roxb.) Esser]	130.1133±0.77	93.5400±0.72	28.0733±0.81
Thei-tit [<i>Ficus prostrate</i> (Wall. ex Miq.) Buch.-Ham. ex Miq.]	ND	ND	10.9533±0.51
Vau-be [<i>Bauhinia variegata</i> L.]	39.4367±0.49	33.8767±0.37	3.2367±0.08
Vang [<i>Albizia chinensis</i> (Osborne) Merr.]	12.9767±0.47	5.8200±0.18	18.2600±0.38
Zih-nghal [<i>Stereospermum chelonoides</i> (L.f.) DC.]	18.2733±0.22	102.1167±0.87	5.9433±0.05
Zai-rum [<i>Anogeissus acuminata</i> (Roxb. Ex DC) Gull.]	119.6033±0.59	30.3433±0.79	19.6467±0.74

Table.5 Quantitative estimation of alkaloids in tree leaves fed to dairy cattle in Mizoram

Name	Alkaloids (mg/g)
Hnah-thap [<i>Colona floribunda</i> (Kurz) Craib]	0.45±0.00
Hriang (<i>Betula alnoides</i> Buch.-Ham. ex D. Don.)	3.03±0.03
Lam-khuang (<i>Artocarpus heterophyllus</i> Lam.)	1.80±0.01
Muk-fang (<i>Cordia dichotoma</i> G. Forst)	0.18±0.01
Ngiau [<i>Magnolia oblonga</i> (Wall. ex Hook.f. & Thomson) Figlar]	1.47±0.01
Sa-zu-thei-pui (<i>Ficus hirta</i> Vahl.)	0.86±0.01
Thing-lung [<i>Homalium ceylanicum</i> (Gardner) Benth. Subsp. <i>minutiflorum</i> (Kurz.) Mitra]	1.49±0.01
Vau-be [<i>Bauhinia variegata</i> L.]	0.80±0.00
Zai-rum [<i>Anogeissus acuminata</i> (Roxb. Ex DC) Gull.]	7.28±0.01

Quantitative analysis of phytochemicals

The DM% of the tree leaves was varied from 16.04 – 22.95%.

The total phenolics concentration was highly variable in different tree foliages varying from 4.3048±0.79% to 61.5564±3.91% on dry matter basis. The CT levels were also variable and ranged from 0.1165±0.04% to 7.0692±2.53% on dry matter basis (Table 3). New leaves often have higher tannin content than older leaves. In the present study, since leaves of various developmental stages were collected and mixed together for preparation of representative sample, the total phenolic content might be higher than the reported earlier.

Flavonoids and saponins were not detected in aqueous extracts of *Ulmus lanceifolia* Roxb. Ex Wall.(Phan) and *Ficus prostrate* (Wall. ex Miq.) Buch.-Ham. ex Miq. (Theitit); whereas flavonoids was not detected in *Celtis tetrandra* Roxb. (Anku). Leaves of other tree species had good concentrations of both flavonoids and saponins. Coumarin was detected in all the tree species. The flavonoids ranged from 0.0500±0.00 to 178.4833±0.83 mg RE/g dry sample, whereas saponins varied from 10.0667±0.33 to 112.5033±2.15 mg DE/g dry sample (Table 4). Highest level of coumarin was estimated in *Cerasus cerasoides* (Buch.-Ham.exD.Don) S.Y.Sokolov (31.3833±0.71 mg coumarin

equivalent/g dry sample) and lowest level in *Ficus benghalensis* Linn (0.2467±0.09 mg coumarin equivalent/g dry sample). Kokila *et al.*, (2013) reported that leaves of various species of *Albizia* contained saponins, terpenes, alkaloids and flavonoids. Lalawmpui *et al.*, (2014) estimated the total phenolics and flavonoids levels as 62.75 mg GAE/g dry weight and 56 mg QE/g dry weight respectively in *Helicia nilagirica* leaves, commonly known as ‘Pasaltakaza’ in Mizoram which is used for stomach ailments like peptic ulcer and indigestion by the people in Mizoram. Brighente *et al.*, (2007) also reported the total phenolics and flavonoids level as 82.98±1.72 mg GAE/g and 13.09±0.39 mg QE/g (DM basis) in aqueous extract of *Cyathea phalerata*. Joseph and Raj (2011) also confirmed the presence of flavonoids in *Ficus benghalensis* Linn.

The alkaloids varied from 0.18±0.01 mg/g in *Cordia dichotoma* G. Forst (Muk-fang) to 7.28±0.01 mg/g in *Anogeissus acuminata* (Roxb. Ex DC) Gull. (Zai-rum) (Table 5). Devanaboyina *et al.*, (2013) reported alkaloids in methanolic extract of *Alstonia macrophylla* as 42.69 µg atropine equivalent/ml. Abidemi (2013) reported alkaloids level ranging from 80 – 533 mg/100 mg in 7 selected medicinal plants, namely *B. Vulgaris*, *E. hirta*, *L. Inarmic*, *M. Pudica*, *B. Pilosa*, *C. Zambesicus* and *P. americana* in Nigeria. Sutharsingh *et al.*, (2011) estimated total alkaloids level as 0.86±0.023% (w/w) in *Naravalia zeylanica*

DC. Variability in total alkaloids level in different tree species of the present study thus in agreement with the variable concentrations of alkaloids reported earlier in different plant species by various workers.

It was concluded that the leaves of various tree species are rich sources of phytochemicals and possess significant antioxidant properties. Farmers of Mizoram have been utilizing these tree leaves without any scientific considerations from time immemorial. The baseline data gained through this study about content and concentration of phytochemicals and antioxidant property will help in their further study about usefulness as herbs and also include in total mixed ration (TMR) of dairy animals based on these properties and nutritional contents.

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