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REVIEW ARTICLE

Sustainable prospective of some selected species from Moraceae and Araceae family of Northeast India: A Review

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Abstract

The north-eastern region of India is a rich hub of floristic diversity. The intricate relationship between forest resources and indigenous people is a key to sustainability and rural livelihood. The objective is to review on some plants that has possible function for sustainable source of food. The regional people have been utilizing various species of the two commonly available angiosperm plant families viz. Araceae (*Alocasia macrorrhizos, Colocasia esculenta*) and Moraceae (*Ficus carica, F. semicordata, F. auriculata*) as a source of food, herbal medicine, and fodder plants. A variety of natural compounds found among various members of these two families are alkaloids viz., Alocasin B, α-monopalmitin in *A. macrorrhizos*; flavonoids viz., orientin, isovitexin, in *C. esculenta*; betulinic acid, lupeol in *F. auriculata*; quercetin, leucine, tryptophan in *F. carica*; terpenoids like α-thuzene, α-pinene in *F. semicordata*; besides the presence of phenols, tannins, saponins, fats, carbohydrates, amino acids and proteins, minerals like Ca, Mg, K, Mn, Cu. The rich tradition of indigenous herbal healthcare practices for curing various ailments are widespread among the rural communities. The review entails the indigenous practices with pharmacological efficacy, phytochemistry and sustainable prospects of Moraceae and Araceae which are widely used in food, nutraceutical and medicinal aspects. These lesser-known plant species may attribute to ecological restoration, bioremediation of toxic compounds, discovery of novel therapeutics, sources of carbon sink in near future as well.

Keywords

Indigenous, Araceae, Moraceae, Pharmacological, Sustainable prospects.

Introduction

Sustainability is a crucial step towards the survival of every organism in harmony with nature. According to Food and Agriculture Organization (FAO), sustainable food and agriculture must support four important criteria for food sustainability i.e., availability, access, utilization and stability. Due to the increase in meat consumption, the animal food industry has become one of the causative agents for maximum global carbon production globally, food scarcity and nutrition lacking diseases are at front to solve. Therefore, finding solution of food varieties that are nutritious and medicinal property rich in the wild and edible practises from traditional communities are quite urgent to battle the climate change. India recently held the rank of 120th in SDG (sustainable development report index & dashboard), 2021 toward the progress for SDG goals (1). We need to organize production system and cost speculation for local community's upliftment and economic growth (2). The Northeast (NE) region of India, the cradle of early angiosperms lies in the Himalaya and Indo-Burma biodiversity hotspot with occupancy of about 50% of total Indian biodiversity (3). NE region of India is rich in its unique biogeography and it treasures diversified plant resources that are highly valued and having high potentiality as far as medicinal value is concerned. The NE ethnic groups with more than 200 known tribes indulge with traditional knowledge systems for their food, fodder, fibre and herbal drugs giving a new dimension to ethnobotanical research. The age-old tradition of inherited medicinal practices can be a key for novel drug discovery for researchers with potential phytochemical markers.

The two angiosperm plant families Moraceae and Araceae are predominant dwellers in Northeast India with widespread distribution throughout. The dicot family Moraceae or 'Fig family' with worldwide distribution is represented by about 40 genera and over 1000 species. Whereas, the monocot family Araceae or 'Arum family' with 115 genera and over 2000 species are distributed mostly in the tropical and temperate world (4, 5). Distribution around the world of these species is given in (Table 1). The genus

Table 1. Life form and distribution pattern of studied taxa

Family	Plant species	Habit and habitat	Native range and Distribution	Reference
Araceae	*A. macrorrhizos* (L.) G. Don	Evergreen herb of marshlands	Native to India and Malesia; distributed around tropical Africa, Asia, North, South-Central America, West Indies, Indo Pacific islands	(9–13)
	C. esculenta (L.) Schott	A perennial herb of swamp-lands	Native to Asia; wide-spread in India and Sri Lanka, distributed around the world, introduced or cultivated in Africa, Oceania, Europe, North and South America, Southeast Asia	(17, 18, 24, 29, 33)
Moraceae	*F. carica* L.	Gigantic deciduous tree, terrestrial	Native to the Mediterranean and the middle east; Distributed globally, cultivated in Asia including India	(46, 47, 54, 59, 71)
	F. semicordata Buch Ham. ex Sm.	Small medium-sized tree, terrestrial	Distributed in Bhutan, China, India, Malaysia, Myanmar, Nepal, Pakistan, Thailand, Vietnam	(72, 73)
	F. auriculata Lour.	Moderately tall deciduous tree, terrestrial	Native to Asia; distributed widely in the Himalayas from Nepal to NE India, Burma, Southern China, Indo- China and Malaya, South America, Brazil	(74–76)

Ficus L. is amongst the most significant genera in angiosperms represented by about 750 species and commonly regarded as 'keystone species' for its potential role in ecosystem maintenance providing habitat and food for a wide variety of animals (6) and its importance in rituals like ceremonies and festivals are seen in communities (7). The genus *Colocasia*, an edible aroid represented by 16 species of Southeast Asian origin is represented predominately by *Colocasia esculenta, C. affinis*, *C. fallax*, *C. gigantea* and *C. lihengiae* from Northeast India. The genus *Alocasia* (L.) G. Don with about 2500 species worldwide is a major inhabitant of tropical and sub-tropical regions. *Alocasia macrorrhizos*, *A. fornicata* and *A. longiloba* are predominant in Northeastern marshlands (8). The ethnobotanical practices with these three genera are quite fascinating among Northeastern people in their livelihood as food in close association with nature (Table 2).

Table 2. Ethnobotanical validation of the species in terms of use among rural communities of NE India

Plant species	Tribe/ Region	Plant Parts	Indigenous medicinal practices/ commonly available food sources	Reference
A. macrorrhizos	Arunachal Pradesh	Leaves, corm	Rhizome as a food source used to treat liver disorders and abscesses	(77)
	Zeliang tribe (Nagaland)	Rhizome, leaves	Used as a food plant	(78)
	Manipur	Petioles	Cure of dizziness and headache	(79)
	Jamatia tribe (Tripura)	Rootstock	Used as vegetables	(80)
	Assam	Leaf, Rhizome	To treat knee joint pain and headache	(80, 81, 83)
C. esculenta	Assam	Whole plant	Leaves used for blood coagulation in injuries, roots against pharyngitis	
	Tai-Khamyangs	Leaves	To treat jaundice	(82)
	Ethnic groups (Assam)	Tuber, petioles	Tuber juice used against blisters and skin sores; petiole juice for remedy of cuts and wounds	(84)
	Assam	Rhizome, petiole	Rhizome as food sources, petiole to cure haemostatic	(77)
	Mizo ethnic	Stem	Used against insect	(86)
	Mizoram	Stalk, rhizome	Stalk sap used to cure bee-sting, wound and cuts; rhizome used against diabetes	(86)
	Tribes of Assam	Corms, runner	Used to remedy tonsillitis and piles	(87)
	Nath people (Assam)	Leaves, roots	Leaves used for blood coagulation, roots for pharyngitis	(88)
	Bodo tribe (Assam)	Petiole	Used for minor cuts	(89)

	Mishing tribe	Tender leaves	Eaten as vegetables, used against malaria and blood coagulation	(89, 90)
F. carica	Zeliang tribe (Nagaland)	Fruit	Eaten as raw	(78)
F. semicordata	Manipur	Bark	To cure dysentery and liver disorders	(91)
	Zeliangrong ethnic group	Fruit	Used to cure diabetes	(92, 93)
	Mizoram	Bark and leaves	To cure liver ailments	(93)
	Mizo ethnic group	Stem bark	Used to heal boils	(85)
F. auriculata	Manipur	Fruit and	To cure dysentery, lung diseases and	(94, 95)
	Arunachal Pradesh	Whole plant	Fruits used as pig feed	(95)

This review paper emphasized these two commonly available plant families i.e., Moraceae and Araceae (3 genera and 5 species) of the NE region of India that holds potential properties to be introduced for extensive production as a sustainable food.

Materials and Methods

A literature review on the species belonging to the family Araceae and Moraceae viz., *Alocasia macrorrhizos* (Fig. 1), *Colocasia esculenta* (Fig. 2), *Ficus auriculata* (Fig. 3), *Ficus carica* (Fig. 4A-F), *Ficus semicordata* (Fig. 5) was searched

Fig. 1. *Alocasia macrorrhizos* (L.) G. Don

Fig. 2. *Colocasia esculenta* (L.) Schott

Fig. 3. *Ficus auriculata* Lour.

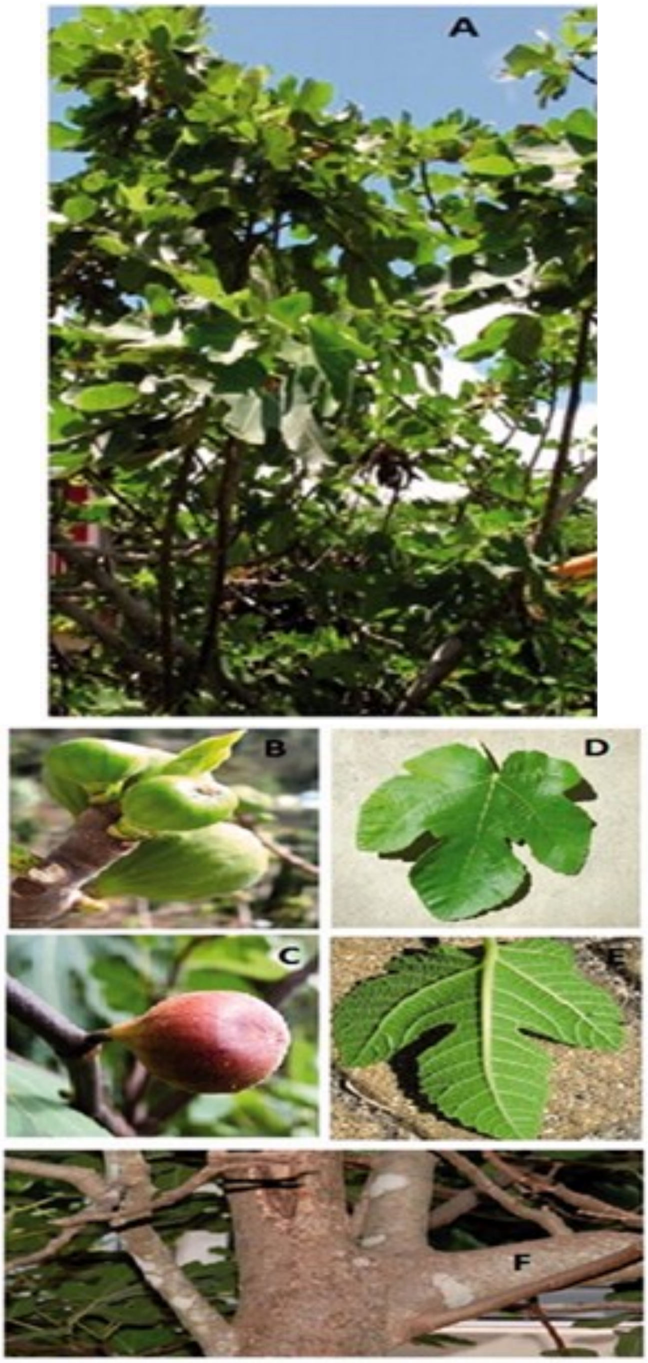

Fig. 4. A-F. *Ficus carica* L. A. Habit, B. Unripe fruit, C. Ripe fruit, D. Dorsal side of leaf, E. Ventral side of leaf, F: Stem Bark.
(Source: Pharm.Bio.52:11,1487-1503)

Fig. 5. *Ficus semicordata* Buch-Ham. ex.Sm.
(Source: IJMFM&AP Vol.2 No.1,2016
http://www.ijmfap.in/pdf_vol2_1/vol_8.pdf)

with keywords like pharmacological efficacy, phytochemistry and sustainable prospects by using scientific databases including PubMed, SciFinder, Research Gate, Science Direct, Google Scholar etc. The searched information was compiled to arrange the manuscripts with distinct sections.

Results

Based on the wide ethnobotanical use of *A. macrorrhizos*, *C. esculenta*, *F. auriculata*, *F. carica* and *F. semicordata* among the communities of NE India the plant species are definitely significant for phytochemical analysis and efficacy studies on various model organisms to decipher the potential role against various ailments including prolonged and lifestyle diseases. The various plant parts or whole plant extracts of the species have elegantly shown the curative properties adding new dimensions to ethnobotanical research (Table 2).

Phytochemistry and pharmacological properties of A. macrorrhizos

A. macrorrhizos leaves extract in different solvents (chloroform, petroleum ether, ethanol, ethyl acetate, aqueous) have reported the presence of alkaloids, phenols, tannins, flavonoids, saponins, fats, carbohydrates, amino acids, proteins and minerals whereas terpenoids and steroids were absent. Further, ethanolic extract contains comparatively much more phenolic and flavonoid content than any other extract (9). Alkaloids such as β-sitosterol, hyrtiosin B, α-monopalmitin, alocasin B, 2-(5-hydroxy-1*H*-indole-3-yl)-2-oxo-acetic acid, 5-hydroxy-1*H*-indole-3-carboxylic acid methyl ester,1-O-β-D-glucopyranosyl-(2S,3R,4E,8Z)-2-[(2(R)-hydroctadecanoyl) amido]-4,8-octadecadiene-1,3-diol, 3-epi-betulinic acid, β-sitosterol-3-O- β-D-glucoside, 3-epi-ursolic acid were isolated from the rhizomes. The anticancer activity of *A. macrorrhizos* was investigated and the results demonstrated the inhibition of hepatic cancer growth in different cell lines. Anticancer activity is because they act as tumour suppressor lipids and also tubulin polymerization inhibitor (10).

Studies have revealed the antioxidant potency of *A. macrorrhizos*. The crude methanolic extract of *A. macrorrhizos* has shown the highest antioxidant activity with IC_{50} value 47.11μg/ml amongst all the other extracts which were subjected to (2,2-diphenyl-1-picryl-hydrazl-hydrate radical scavenging assay or DPPH Assay. *A. macrorrhizos* showed promising effect against a few gram-positive and gram-negative bacteria and some selected fungi. The methanolic and Carbon tetrachloride (CCl_4) extracts well demonstrated antimicrobial activities against gram positive and gram-negative bacteria. However, the petroleum ether extract, aqueous extract as well as methanolic extract depicted the presence of chemical compounds which are responsible for antifungal activities (11). It was also reported that methanolic extract possesses a significant anthelminthic potential where the study revealed that *A. macrorrhizos* took an average of 45 and 51 min for paralyzing and killing the worms viz., *Ascaris lumbricoides*, *Ascaridia galli, Pheretima posthuma* respectively (11). In another study, the methanolic extract of rhizome of *A. macrorrhizos* administered in diabetic mice lowered the blood sugar level (12, 13). The leaves extract of this plant showed to be promising anti-diarrheal activity by elevating the reabsorbance of minerals in the intestine hence showing antimobility activity (14).

Phytochemistry and pharmacological properties of C. esculenta

Phytochemical analysis on the leaves and petiole extracts of *C. esculenta* revealed habitation of the anthocyanin namely pelargonidin-3-glucoside, cyanidin-3-glucoside and cyanidin-3-rhamnoside that possess antioxidant activities (15, 16). The leaf extract of *C. esculenta* has shown the presence of flavonoids and triterpenoids, starch, vitamins (A, B, C), fibres, minerals (calcium, phosphorous etc.), calcium oxalate (17-19). The corms of *C. esculenta* contain important nutritive components like protein, niacin, riboflavin, thiamine, carbohydrates, minerals, lipids, calcium oxalate, unsaturated fatty acids, oxalic acid and anthocyanin. The flavonoids reported in *Colocasia* leaf extracts are orientin-7-O-glucoside, orientin, iso-vitexin-3'-O-glucoside, iso-orientin, vitexin X"-O-glucoside, iso-vitexin, luteolin-7-O-glucoside, vicenin-2. The propagative part of *Colocasia* is rich in stored starch, amino acids, nitrogen content, lipids, phosphate monoester derivatives, sterols, aliphatic compounds, enzymes (20–22).

The aqueous extract of *C. esculenta* has demonstrated strong antimicrobial against *Salmonella mutans* amongst different species of microbe selected for the study (18). *C. esculenta* ethanolic extract have showed a strong potency in reducing blood glucose level in alloxan induced diabetic rats (18). Also, the juice of leaf of *C. esculenta* has reported antioxidant activity by preventing reduction in tissue glutathione level in rat liver tissue (18). The leaf juice of *C. esculenta* have shown hepatoprotective activity against paracetamol and CCl_4 in rats. The study reported that *Colocasia* extract surprising decreases the toxic marker enzyme alanine transaminease (ALT), Aspartate transaminase (AST), Alkaline phosphate (ALP) and protects the hepatocyte integrity (18). It has been also shown that compounds present in the roots of *C. esculenta* have inhibitory potential against tumour metastasis (18). In another study, it was found that cystatin present in *C. esculenta* has a deleterious effect on growth of fungi (26). Further, the leaf extract of *C. esculenta* showed a promising anti-inflammatory effect in carrageenan induced paw oedema in Wistar rats (18). The aqueous and ethanolic extract of *C. esculenta* have shown significant antihelminthic activity against earthworm (25). A compound present in tuber of *C. esculenta* reported antimelanogenic activity (27). Another investigation on the crude extract of *C. esculenta* has revealed the presence of immunostimulatory proteins in it. The crude extract exaggerated *in vitro* proliferation of spleen and bone marrow cells in mice in a dose-dependent manner (37).

Phytochemistry and pharmacological properties of F. carica

Phytochemical investigation on *F. carica* reported the presence of phytosterols, flavonoids, anthocyanin, phenols, amino acids, fatty acids, organic acids, hydrocarbons, aliphatic alcohols and other volatile compounds. The phytochemicals are mostly found in latex, leaves, fruits and roots. *F. carica* contains different essential minerals for human nutrition like copper, manganese, magnesium, potassium and calcium (38–43).

Ethanolic extract of *F. carica* when administered at dose of 100, 200, 300 mg/kg body weight could lower the body temperature and the effect is persistent upto 5 hrs than paracetamol (44). Further, leaf extracts prepared in different solvents (Chloroform, petroleum ether and ethanol) demonstrated antiflammatory activiy in rats against carageenan induced oedema (44). In another study conducted, it was found that the ripe fruit of *F. carica* showed remarkable antispasmodic activity in by producing instant relaxations in jejunum of rabbit. The same study described the inhibitory role of fruit extract against human platelet aggregation (48). Leaves of *F. carica* also possess antihelminthic activity and is supported by a research on its potential against *Pheretima posthuma* infections (44). Leaves of *F. carica* have showed protective activity against liver damage in rats. A concentration of 500 mg/kg body weight was administered orally which lowered the serum concentrations of liver enzymes along with other biochemical indicators (54). Fig paste of *F. carica* when fed to rats improved the lopamide induced constipation (49). In a similar study it was reported that the consumption of fig paste led to improvement in conditions in patients suffering from constipation (27). Also, the chloroform leaf extract of *F. carica* showed signcificant reduction in cholesterol levels (51). The leaf extract also regulates the secretion of cholesterol and triglyceride from the liver (52). In a study, a strong inhibitory effect against different cancer cell lines was demonstrated by latex of *F. carica* in a study (56). In another study, latex, fruit and leaf extracts of *F. carica* have lowered the feasibility of HeLa cell lines at a lower concentration (45). Extract of *F. carica* possess the capability of decreasing the hazardous effect of mu tagens present in the environment. Leaves and latex of *F. carica* have also strong inhibitory potential against growth of different species of bacteria and fungi (46, 47). The hexane and hexane ethyl acetate extract of *F. carica* have shown promising activity against viral infections (47). Furthermore, the total flavonoid from the leaves of *F. carica* have showed potent scavenging effects against the hydroxyl and superoxide ions in a concentration dependent manner (58). Ethanolic leaf extract of *F. carica* have significantly ameriolated both cellular and antibody mediated response in mice (44).

Phytochemistry and pharmacological properties of F. semicordata

Phytochemical analysis on *F. semicordata* indicated the presence of flavonoids, steroids, terpenoids, tannins, saponins, carbohydrates, glycosides (60, 61). Tannins, catechin, quercetin, mono and sesquiterpenoids, fatty acid derivatives, shikimic acids were found to be present in the dried leaves of *F. semicordata* (62). The fruits of *F. semicordata* emit a floral scent which contains compounds like terpenes (Monoterpenoids: Sabinene, Limonene-1,8-Cineole, beta-Myrcene, γ-Terpinene, Terpinolene, beta-Pinene, (E)- beta -ocimene, alpha-Thujene, (Z)- beta-Ocimene, alpha-Pinene; Sesquiterpene:α-Cubebene, β- Cubebene, α -Selinene, β-Selinene, α -Ylangene, α- Copaene, α-Gurjunene, α-Humulene, β-Caryophyllene, β-Elemene, Panasinsene, γ-Muurolene, Germaacrene A, Germacrenene D, Alloaromadendrene, (E, E) α-Farnesene, o-Cadinene; Shikimic compounds (4-Methylanisole,1,4-Methoxybenzene, Indole) (63).

The leaves of *F. semicordata* have shown antibacterial efficacy in high concentration against gram-negative bacteria as compared to the gram-positive bacteria. The leaves and fruits of *F. semicordata* possess antioxidant properties (64).

Phytochemistry and pharmacological properties of F. auriculata

The hexane, chloroform and methanol soluble extracts of bark of *F. auriculata* were tested for the presence of different secondary metabolites. Carbohydrates, alkaloids, saponins, resins, phenols, proteins, amino acids were present in all three extracts. The presence of phytosterols and flavonoids was indicated in methanol and chloroform extracts but was absent in hexane extracts. The presence of glycosides was only found in the methanolic extract. Fats and fixed oils were not present in any of the three extracts being screened (65). Phytochemical investigation on the methanolic and chloroform leaf extract of *F. auriculata* indicated the presence of alkaloids, phenols, tannins, flavonoids, terpenoids, carbohydrates. Glycosides were found to be present only in methanolic extract whereas saponins were absent in both the extracts (50). Myricetin, betulinic acid, beta -sitosterol-3-O- beta- D-glucopyranoside, lupeol, quercetin-3-O- beta- D-glucopyranoside, stigmasterol, scopoletin, bergapten (66).

The leaf extracts of *F. auriculata* exhibited antibacterial activity against *Escherichia coli* and *Salmonella typhimurim*. The antioxidant analysis of leaves of *F. auriculata* had revealed strong DPPH scavenging potential. However, the anti-cancerous activity was not found to be effective at a low concentration of 100 µg/ml (50).

Discussion

Sustainability not only advocate the safeguard for the environment but also emphasizes eco-friendly food production, distribution and consumption keeping harmful impact away from the environment. Choosing green clean organic plant-based food is a crucial step for food sustainability. Modern techniques of sustainable agriculture focus on more increase in the product without hazardous impact on the ecosystem. Sustainable farming of these plant species belonging to the two families i.e., Araceae and Moraceae will support low carbon food production and could encourage biodiversity restoration. Arum plants being easily propagated and Fig plants for their modest contribution in providing food and shelter for numerous flora and fauna, have a role to restore the outer ecosystem. The plant species belong to the family Araceae are widespread in the vicinity of swamplands whereas the species belong to Moraceae are dominant in terrestrial habitat. A variety of nutritive compounds reported among the members of these extensively studied genera viz., *Alocasia*, *Colocasia* and *Ficus*. Only few species are mentioned in this study among these genera to reduce the haphazard content of multiple species.

Family Moraceae and Araceae are quite abundant in their distribution as discussed (Table 1). Apart from mentioned members, other species of NE region like *Abelmoscus manihot, Abrus precatorius, Desmodium, Peperomia pellucida, Polygonum hydropiper* etc (81, 87) also are full of potential compound for medicinal purposes as well as good nutritive food. As the mentioned species also holds the same purposes, hence, are good alternatives for sustainable way of living. Some of their particular beneficial roles discussed are like bioprospecting of effective phytochemical makers from Moraceae and Araceae has provided an added advantage. Some of those maker phytoconstituents viz. Hyrtiosin B, hyrtiosulawesin, Alocasin, Alomacrorrhizos A, Campesterol, fucosterol, beta-sitosterol, 1-O-β-D-glucopyranosyl-(2S,3R,4E,8Z)-2-[(2(R)-hydroctadecanoyl) amido]-4,8-octadecadiene-1,3-diol having role in anti-inflammatory, anti-oxidant, antiproliferative activity, hepatoprotective activity (11) may be a potent candidate in more effective new drug development.

Antioxidant properties of orientin 7-O- glucoside kaempferol , vicenin-2, Iso- vitexin-3'-O-glucoside, Iso- orientin, vitexin X"-O-glucoside , orientin, quercetin, myricetin, quercetin-3-o-beta-D-glucopyranoside, scopoletin, bergapten (67); antifungal properties of cystatin, Cyanoglucoside (66, 68, 69) bacterial growth inhibition of compound like coumarin Betulinic acid, lupeol, stigmasterol, beta-sitosterol-3-O-beta-D- glucopyranoside; hepatoprotective activity due to quercetin and catechin (42); Anti-diabetic activity shown by quercetin and Gallic acid respectively (70) are the boon to phytochemical profiling.

The high content of alkaloids viz., Alocasin B, α-monopalmitin in *A. macrorrhizos*; flavonoids viz., orientin, isovitexin, in *C. esculenta*; Betulinic acid, lupeol in *F. auriculata*; quercetin, leucine, tryptophan in *F. carica*; terpenoids like α-thuzene, α-pinene in *F. semicordata*; besides the presence of phenols, tannins, saponins, fats, carbohydrates, amino acids and proteins, minerals like Ca, Mg, K, Mn and Cu. Significant pharmacological activities established are antioxidant, antimicrobial, antidiabetic, hepatoprotective, immunostimulant, anticancer. From the present literature review, the traditional use of plants belonging to these three genera checks out for having effective therapeutic roles (Table 2) as per their various pharmacological activities discussed (Table 3). They are widely distributed, easily propagated and cultivated popularly as an edible food source for their nutritional value. Therefore, these plants can be acknowledged for commercial large-scale cultivation for sustainable agricultural practices and low-cost production of processed food.

Reviewing in *Ficus spp.* indigenous knowledge found popular use of its species in liver diseases and from previous studies it has been found that many other commonly occurring species in this geographic region known to have similar properties (96). There is scope of further extensive research in antifertility study for the *Ficus* sp. viz., *F. auriculata*, *F. Carica* and *F. semicordata* considered in this present paper which is seem to be present in other *Ficus* genera (97, 98). Sustainable food production has emerged as a challenge for the resilience of the environment. Therefore, the addition of these plants in sustainable farming practices could balance out the harmful impacts of the environment suffered from massive poultry and dairy food production. Procurement of these wild plant species is very essential for future use as wholesome food which will be a step to remove the world hunger problems around the globe. On the other hand, the production of such native wild forest resources will bring the knowledge and practices of ethnic people to the world for the socio-economic development of the communities.

Conclusion

Switching to alternate food items that are nutritious and easily grown for the betterment of the health of people is always a positive emphasis. All these plants contain important bioactive compounds that impart characteristic biological properties to them. Various research works are being conducted to report pharmacological activities like antidiabetic, antihypertensive, antimicrobial, anthelminthic, anticancer, antiproliferative, anti-inflammatory, hepatoprotective, immunomodulatory properties of various species of *Alocasia, Colocasia,* and *Ficus*. However, there are some few species for which scientific evaluation and deeper understanding of compounds mechanism of action is still to be done. Since food system is the locus of all environmental impacts. This review focused on the plants have a reliable lead towards sustainability in the sense of distribution, nutrition, traditional values as well as cost-effectiveness.

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Authors contributions

Both JMD and BS shaped and wrote the manuscript and NN and MKB conceive and analysed the data.

Compliance with ethical standards

Conflict of interest: The authors declare that no conflict of interest exists.

Ethical issues: None.

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