



Taxonomical, Phytochemical, Traditional Explanation, Nutritional Values, and Biological Activities of Certain Edible Medicinal Plants of Tripura, India

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Abstract

Edible plants are used as valuable sources of food and medicine to prevent nutritional imbalance, illness, and maintenance of human health. This review covers botanical descriptions, phytochemicals studies, traditional comprehensions, dietary values, and biological activities of ten vegetable plants and eight fruit plants of Tripura, India. The book “The Flora of Tripura State” helps to choose the plant species of Tripura, India and PubMed, NCBI, Google scholar databases have been used to describe the plant species briefly. Literature reveals that all the selected edible plants contain bio-active constituents (alkaloids, phenols, flavonoids, tannins, terpenoids, glycosides, etc.) and give dynamic biological activities. All the plants have a high nutritional value. This review believes it will provide significant advances in the prevention of malnutrition and chronic diseases.

Keywords: Biological Activities, Edible Medicinal Plants, Nutritional Values, Phytochemicals, Tripura

1. Introduction

Edible plants are essential in our diet and have ethnomedicinal values without any toxicity. They are the primary sources of food and highly beneficial for the nourishment of health and the prevention of diseases¹. Terpenoids, limonoids, phytoestrogens, carotenoids, polyphenols, glucosinolates, flavonoids, isoflavonoids, and anthocyanidins are active phytochemicals present in fruits, seeds, herbs, and vegetables. In different stages of life cycles, these phytochemicals provide various health beneficial activities^{2,3}. Edible plants provide energy, proteins, necessary fats, vitamins, and minerals, to develop and for proper functions of life. A large variety of nutrients is essential for our daily diet for well-being. The pleasure of a healthy diet can also be one of the unique ethnic preferences of life. Concerns protein malnutrition is a paramount general health issue in emerging countries. Essential nutrients being roots and tubers are mostly stiff.

Nutritive fiber shows a dynamic role in diminishing the hazards of various illnesses⁴.

The Himalayas extends over eight Northeast states (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura) of India. It comprises over 16% of the country's geographical area. Tripura lies between 22°56' – 24°32' N latitudes and 90°09' – 92° 20' E longitudes. The average temperature of Tripura is 27°C during summer and 8°C during winter. The average rainfall is about 2400 mm. Although the biodynamic geographical diversity of Tripura, many bioactive plants are grown naturally. Some of these plant parts consumed directly by local peoples for their dietary benefits because these edible plants cannot produce toxic effects on human body^{5,6}. This review covers general descriptions of plant, phytochemicals study, traditional comprehension, nutritional values, and biological activities of eighteen edible plants of Tripura, Northeast India.

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2. Method for Plant Choosing and Elaboration

The plant species of Tripura, India have been chosen from the book "The Flora of Tripura State"⁷. The selected is based on two categories i) vegetable plants and ii) fruit plants. PubMed, NCBI, Google scholar databases have been used to describe the chosen plant species.

3. Vegetable Group's Plants

3.1 Elephant Foot Yam (*Amorphophallus paeoniifolius*)

Amorphophallus paeoniifolius (Figure 1A) is a stout herbaceous plant well known as elephant foot yam. It is a potential humid tuber crop of the Araceae family that widely grows in a shady region or swampy areas of northeast India during June-August. A darkbrown corn is an edible part⁸. The taxonomical classification of *Amorphophallus paeoniifolius* is represented in Table 1.

Table 1. Taxonomical classification of *Amorphophallus paeoniifolius*

Kingdom	Plantae
Phylum	Tracheophyta
Class	Liliopsida
Order	Arales
Family	Araceae
Genus	<i>Amorphophallus</i>
Species	<i>A. Paeoniifolius</i>

Qualitative analysis of the methanolic extract and 70% of hydro-alcoholic extract of corm of *Amorphophallus paeoniifolius* have shown the presence of alkaloids, steroids, flavonoids, and phenols. Traditionally corms are used as an astringent, liver tonic, thermogenic, irritation, painkiller, anti-inflammatory, anti-haemorrhoidal, hemostatic, linctus, relieve flatulence, stimulate appetite, anthelmintic, aphrodisiac, emmenagogue, rejuvenating tonic⁸. The corm of *Amorphophallus paeoniifolius* is highly nutritional food. Nutritional values per 100 g of corm consists 11.53 g protein, 3.52 g fat, 70.75 g carbohydrate, 14.32 g crude fiber, 359.08 Kcal energy, 3.81 mg potassium, 11.92 mg magnesium, 2.31 mg Zinc, and 34.02 mg iron respectively⁹. Different solvents extract (petroleum ether, methanolic extract, chloroform extract, pet-ether extract)

of *Amorphophallus paeoniifolius* have shown analgesic, anti-inflammatory, CNS depressant, antimicrobial, anthelmintic, hepatoprotective, antioxidant, and anti-tumor activities⁸.

3.2 Taro (*Colocasia esculenta*)

Colocasia esculenta (Figure 1B) is a tropical herbaceous perennial plant belonging to Araceae. It is cultivated primarily during the rainy season for its edible corms, most commonly known as taro, and other consumable parts are leaf and stem. It is believed to be one of the earliest cultivated plants. This plant is found in entire northeastern India. Taxonomical classification of *Colocasia esculenta* is represented in Table 2¹⁰.

Table 2. Taxonomical classification of *Colocasia esculenta*

Kingdom	Plantae
Phylum	Tracheophyta
Class	Liliopsida
Order	Arales
Family	Araceae
Genus	<i>Colocasia</i>
Species	<i>C. esculenta</i>

Phytochemicals estimate different edible parts (leaf, stem, and taro) of *Colocasia esculenta* have shown the presence of phenols, flavonoids, terpenoids, and steroids¹¹⁻¹³. The documented record of ethnobotanists, various edible parts of *Colocasia esculenta*, is used to diminish the menace of obesity, heart attack, diabetes, and iron level maintenance¹⁴. Nutritional values per 100 g of corm consist of 2.5 g protein, 0.2 g fat, 19 g carbohydrate, 3.4 g crude fiber, 85 Kcal energy, 32 mg calcium, 64mg phosphorus, 514 mg, potassium, 7 mg sodium, and 0.8 mg iron, and 10 mg Vit. C respectively. Nutritional values per 100 g of the leaf consist of 4.4 g protein, 1.8 g fat, 12.2 g carbohydrate, 0.6 g crude fiber, 69 Kcal energy, 268 mg calcium, 78mg phosphorus, 1237 mg, potassium, 11 mg sodium, and 4.3 mg iron, 20385 IU Vit. A and 142 mg Vit. C respectively¹⁵. Corm and leaf of *Colocasia esculenta* possess anti-microbial, anti-oxidant, and anti-diabetic activities¹⁶⁻¹⁸.

3.3 Bengal Arum (*Typhonium trilobatum*)

Typhonium trilobatum (Figure 1C) is a leafy vegetable evergreen perennial herb of height 0.85m tall. This herb mainly grows between May to July on plain grassland. Taxonomical classification of *Typhonium trilobatum* is represented in Table 3¹.

Table 3. Taxonomical classification of *Typhonium trilobatum*

Kingdom	Plantae
Phylum	Tracheophyta
Class	Liliopsida
Order	Alismatales
Family	Araceae
Genus	Typhonium
Species	<i>T. trilobatum</i>

Typhonium trilobatum contains alkaloids, phenols, flavonoids, and steroids. Beta-sitosterol is one of the essential sterols isolated from *Typhonium trilobatum*^{1,19}. In India, China, Bangladesh, leaves and tubers are consumed as food and frequently prescribed to the patient suffering from piles, rheumatism, constipation, hemorrhoids, trauma, and injury¹. Nutritional values per 100 g of the leaf consist of 2.81 g protein, 0.66 g fat, 2.94 g carbohydrate, 2.44 g crude fiber, 28.94 Kcal energy, 22.59 mg calcium, 0.03 mg sodium, and 58.40 mg iron, and 108.08 mg Vit. C respectively²⁰. *Typhonium trilobatum* has multiple pharmacological activities, including anti-inflammatory, analgesic, wound healing, anti-bacterial, anti-fungal, anti-diarrheal, larvicidal, anti-oxidant, anti-diabetic and anti-depressant¹.

3.4 Dolichos Bean (*Lablab purpureus*)

Lablab purpureus (Figure 1D) is generally known as Dolichos bean, Hyacinth bean, or Field bean. It exists only as a whole antique food amongst cultivated plants. It is a bushy, semi-erect, perennial herb, having no affinity to ascend. This plant grows during the winter season. Taxonomical classification of *Lablab purpureus* is represented in Table 4²¹.

Table 4. Taxonomical classification of *Lablab purpureus*

Kingdom	Plantae
Phylum	Tracheophyta
Class	Magnoliopsida
Order	Fabales
Family	Fabaceae
Genus	Lablab
Species	<i>L. purpureus</i>

The mature seeds of *Lablab purpureus* contained cyanogenic glycosides, oxalates, phytates, tannins and saponins. Seeds were used to stimulate stomach, treatment of cholera, diarrhea, colic, rheumatism, and sunstroke²². Seeds of *Lablab purpureus* contain high nutritional values. In 100 g of fresh seeds gives 23.90 g of protein, 1.69 g of fat, 60.74 g of carbohydrate, and 344 Kcal of total energy. Grains also contain the right amount of minerals such as 1235 mg potassium, 21 mg sodium, 1.335 mg copper, 130 mg calcium, 283 mg Magnesium, and 5.10 mg iron in 100 g of sample. Niacin (1.610 mg/100 g) and thiamin (1.130 mg/100 g) are two essential vitamins present in seeds²³. Seeds of *Lablab purpureus* possess anti-inflammatory, antioxidant, antibacterial and cytotoxicity activities. Seeds of *Lablab purpureus* shows anti-inflammatory, antioxidant, antibacterial and cytotoxicity activities²⁴.

3.5 Clumping Bamboo (*Melocanna baccifera*)

Melocanna baccifera (Figure 1E), an evergreen arborescent, non-clump forming, is a single bamboo species naturally distributed in a hilly area of northeast India like Tripura, Assam, and Meghalaya. Its local Bengali name is "Muli", and its English name is "Clumping bamboo". Edible parts are young shoots and are harvested during the rainy season. Culms are considered mature when it is two years old. Taxonomical classification of *Melocanna baccifera* is represented in Table 5²⁵.

Table 5. Taxonomical classification of *Melocanna baccifera*

Kingdom	Plantae
Phylum	Tracheophyta
Class	Liliopsida
Order	Poales
Family	Poaceae
Genus	Melocanna
Species	<i>M. baccifera</i>

4-Oxabicyclo[3.2.2]nona-1(7), 5, 8-triene, and verbacine are the two important phytochemicals present in the leaves and fruits of *Melocanna baccifera*. Fruit also contains ferulic acid as a phenolic compound²⁶. The record of ethnobotanist, peoples of northeast India consumes the young shoots of *Melocanna baccifera*²⁷. Per 100 gram of young shoot of *Melocanna baccifera* contained 43.35 g carbohydrate, 3.9 g protein, 1.77 g fat, and 204.93 kcal energy. Shoot of *Melocanna baccifera* possess anti-oxidant activities²⁸.

3.6 Miracle Tree (*Moringa oleifera*)

Moringa oleifera (Figure 1F) native to northeast India grows in the tropical and subtropical part of lower Himalayan regions. It is a small, elegant, broadleaf tree with sparse foliage. The flowering period starts in January and lasts over March. The leaves, flowers, and immature pods (called long green pods), are eatable portions. *Moringa oleifera*, is also known as 'the miracle tree' due to its remarkable curing abilities for many chronic diseases. The taxonomical classification of *Moringa oleifera* is described in Table 629.

Table 6. Taxonomical classification of *Moringa oleifera*

Kingdom	Plantae
Phylum	Tracheophyta
Class	Magnoliopsida
Order	Capparales
Family	Moringaceae
Genus	Moringa
Species	<i>M. oleifera</i>

Different edible parts of *Moringa oleifera* contained alkaloids, phenols, flavonoids, and saponines. *Moringa oleifera* leaves are used to reduce cholesterol and body weight, infertility in women, lower blood pressure, reduce jaundice, menstrual relief, cure diabetes, and constipation. Flowers were used to curing thyroid problems; roots were used to minimize spinal cord pain; seeds powder was used to kill intestinal worms, and pods were used to lower blood sugar levels³⁰. The three common edible parts (leaves, flowers, and long green pods) of *Moringa oleifera* contained the right amounts of nutritional compositions. Nutritional values per 100 g of leaves consist of 6.7 g protein, 1.7 g fat, 12.5 g carbohydrate, 0.9 g crude fiber, 92 Kcal energy, 259 mg potassium, 70mg phosphorus, 440 mg calcium, 0.85 mg iron, 220 mg of Vit. C and 300 IU Vit. A. Nutritional values per 100 g of flowers consists 0.42 g protein, 0.88 g fat, 0.67 g carbohydrate, 0.14 g crude fiber, 17.95 Kcal energy, 671 mg potassium, 19.66 mg phosphorus, 32.34 mg calcium, 48.11 mg iron, 7.6 mg of Vit. C and 333 IU Vit. A. Nutritional contents per 100 g of long green pods consists 2.5 g protein, 0.1 g fat, 3.7 g carbohydrate, 4.8 g crude fiber, 26 Kcal energy, 259 mg potassium, 110 mg phosphorus, 30 mg calcium, 5.3 mg iron, 120 mg of Vit. C and 184 IU Vit. A³¹. Different edible parts of *Moringa oleifera* possess hypolipidemic, anti-peroxidative, cardioprotective, anti-oxidant, anti-inflammatory, anti-nociceptive, anti-microbial,

hepatoprotective, anti-hyperglycemic, down-regulation of nuclear factor-kappa B and anti-atherosclerotic activities²⁹.

3.7 Turkey Berry (*Solanum torvum*)

Solanum torvum (Figure 1G) commonly known as Turkey berry. It is a bushy, erect, and spiny perennial plant. The fruit is the edible part of this plant. The flowering season of this plant is from May to July. The taxonomical classification of *Solanum torvum* is described in Table 7³².

Table 7. Taxonomical classification of *Solanum torvum*

Kingdom	Plantae
Phylum	Tracheophyta
Class	Magnoliopsida
Order	Solanales
Family	Solanaceae
Genus	Solanum
Species	<i>S. torvum</i>

Sun-dried *S. torvum* fruits contain alkaloids, flavonoids, saponins, tannins, glycosides, and fixed oils. Others phytochemicals present in *S.torvum* is neochlorogenin 6-O- β -D-quinovo-pyranoside, neochlorogenin 6-O- β -D-xylopyranosyl-(1 \rightarrow 3)- β -D-quinovopyranoside, neochlorogenin 6-O α -L-rhamnopyranosyl-(1 \rightarrow 3)- β -Dquinovopyranoside, solagenin 6-O- α -L-rhamnopyranosyl-(1 \rightarrow 3)- β -D-quinovopyranoside, isoquercetin, rutin, kaempferol and quercetin. Traditionally it is used to control bacterial and fungal diseases³². Nutritional values per 100 g fruits of *Solanum torvum* consists 2.32 g protein, 0.28 g fat, 7.04 g carbohydrate, 3.99 g crude fiber, 39.96 Kcal energy, 21.5 mg zinc, 2.6 mg copper, 19.5 mg magnesium, 211.6 mg calcium, and 76.9 mg iron, and 2.68 mg Vit. C³³. Biological activities of the fruit of *S. torvum* are anti-oxidant, anti-fungal, anti-bacterial, anti-ulcer, antihypertensive and metabolic correction, nephron-protective, cardio-protective, and anti-diabetic³².

3.8 Sesame (*Sesamum indicum*)

Sesame (*Sesamum indicum*) (Figure 1H) is an herbaceous annual plant. The primary flowering season is in July month. Oilseeds of sesame are traditional healthy food, generally used to improve nutritional status. The taxonomical classification of *Sesamum indicum* is represented in Table 8³⁴.

Table 8. Taxonomical classification of *Sesamum indicum*

Kingdom	Plantae
Phylum	Tracheophyta
Class	Dicotyledonae
Order	Scrophulariales
Family	Padaliaceae
Genus	Sesamum
Species	<i>S. Indicum</i>

Sesamum indicum seed contains alkaloids, phenols, flavonoids, saponins, anthraquinones, terpenoids, and steroids. Traditionally the seed oil is used in cookery, as a stimulant, nutrient, aphrodisiac, diuretic, and in the remedy of dry cough, asthma, lung diseases, inflammation, ulcers, urinary diseases, and migraine³⁴. Nutritional values per 100 g of seeds consists 17.73 g protein, 49.67 g fat, 23.45 g carbohydrate, 11.8 g crude fiber, 573 Kcal energy, 7.75 mg zinc, 468 mg potassium, 4.08 mg copper, 11 mg sodium, 975 mg calcium, 2.46 mg magnesium, and 14.55 mg iron, 4.51 mg niacin, 0.79 mg thiamine, 9 IU Vit. A and 0.25 mg Vit.E³⁵. Biological activities of *Sesamum indicum* seed oil regulate cholesterol, neurological role, and blood pressure. It also possesses antioxidant properties, and it is used for the protection from ultraviolet light³⁶.

3.9 Vegetable Hummingbird (*Sesbania grandiflora*)

Sesbania grandiflora (Figure 1I) is a fast-growing perennial, deciduous, or evergreen legume tree that raises to 8-15 m high and 25-30 cm in diameter. The roots of the tree are usually heavily nodulated with large nodules. Leaves and white-yellowish color flowers are the edible portions. This plant is widespread in most humid tropical regions of Northeast India. The taxonomical classification of *Sesbania grandiflora* is represented in Table 9³⁷.

Table 9. Taxonomical classification of *Sesbania grandiflora*

Kingdom	Plantae
Phylum	Tracheophyta
Class	Monoliopsida
Order	Fabales
Family	Fabaceae
Genus	Sesbania
Species	<i>S. grandiflora</i>

Leaves of *Sesbania grandiflora* contain alkaloids, flavonoids, glycosides, tannin, anthraquinone, steroid, and terpenoid³⁸. Traditionally the mixture of fresh leaves juices and coconut milk is used topically for skin diseases³⁹. 100 g of fresh leaves contain 8 g protein, 1 g fat, 12 g carbohydrate, 2 g crude fiber, and 93 kcal energy. The same quantity of leaves contains 1130 mg calcium, 80 mg phosphorus, and 4 mg iron. 100 g of the fresh flower contains a size of 1.28 g protein, a size of 0.04 g fat, 6.73 g carbohydrate, and 27 kcal energy. 100 g of flowers contains 18 mg calcium, 84 g iron, 12 mg magnesium, 30 mg phosphorus, 184 mg potassium, 15 mg sodium, 73 mg Vitamin C, 0.083 mg thiamine, and 0.081 mg riboflavin⁴⁰. Leaves and flower of *Sesbania grandiflora* give anti-microbial activity, decreased serum cholesterol levels, wound healing activity, and anti-ulcer activity⁴¹.

3.10 Stink Bean (*Parkia speciosa*)

Parkia speciosa (Figure 1J) or stink bean is a plant that is abundantly found in the tropical regions of lower parts of the Himalaya. Up to 15-40 m tall and 50-100 cm in diameter. Leaves are bipinnate, 2-6 cm elongated stems with the gland of 7-15 mm aloft stalk base. Pods are bulky, 35-55 cm in length and 3-5 cm broad. Seeds are the edible parts of this plant. Taxonomical classification of *Parkia speciosa* is described in Table 10⁴².

Table 10. Taxonomical classification of *Parkia speciosa*

Kingdom	Plantae
Phylum	Tracheophyta
Class	Magnoliopsida
Order	Fabales
Family	Fabaceae
Genus	Parkia
Species	<i>P. speciosa</i>

Seeds of *Parkia speciosa* consist of alkaloid, terpenoid, phenolic, flavonoid, and tannin. In the seeds, identified terpenoid was β -sitosterol, stigmasterol, lupeol, campesterol, and squalene. Seeds of *Parkia speciosa* are used traditionally to treat diabetes, high blood pressure, and kidney complications. Per 100 g of fresh seeds, contains 6.0 g protein, 1.6 g fat, 13.2 g carbohydrate, 1.7g crude fiber, and 91.0 kcal energy. A same amount of seeds contains 108.0 mg calcium, 2.2 mg iron, 115.0 mg phosphorus, 341.0 mg potassium, 29.0 mg magnesium, 19.3 mg vitamin c, 4.15 mg α -Tocopherol, and 0.28 mg thiamin. *Parkia speciosa* gives anti-oxidant, hypoglycemic, anti-tumor, and anti-mutagenicity, anti-microbial activities⁴².



Figure 1. (A) *Amorphophallus paeoniifolius*, (B) *Colocasia esculenta*, (C) *Typhonium trilobatu*, (D) *Lablab purpureus*, (E) *Melocanna baccifera*, (F) *Moringa oleifera*, (G) *Solanum torvum*, (H) *Sesamum indicum*, (I) *Sesbenia grandiflora*, (J) *Parkia speciosa*.

4. Fruit Group's Plants

4.1 Banana (*Musa paradisiaca*)

Musa paradisiaca (Banana) (Figure 2A) is one of the well-known herbaceous flowering plants. Banana is one of the majors and economically important fruit crop in India. The entire lower parts of Himalaya are rich in banana plantation because of the suitable range of temperature (15-35°C), humidity (75-85%), and loamy soil type. The primary harvesting season of banana is from September to April. Fruit, stem, and flower are edible parts of banana. The taxonomical classification of *Musa paradisiaca* is described in Table 11⁴³.

Table 11. Taxonomical classification of *Musa paradisiaca*

Kingdom	Plantae
Phylum	Tracheophyta
Class	Liliopsida
Order	Zingiberales
Family	Musaceae
Genus	<i>Musa</i>
Species	<i>M. paradisiaca</i>

Banana fruits, stem, and flowers contain alkaloids, phenols, flavonoids (quercetin), tannins, glycosides (a phenylpropanoid glycoside analogs), saponins, and volatile oils, respectively^{44,45}. Flowers are used in dysentery, diabetes, and menorrhagia. Stems juice is

used for treating diarrhea, dysentery, cholera, otalgia, and hemoptysis. Fruit (unripe) is used for diarrhea, dysentery, intestinal lesions in ulcerative colitis, diabetes, in sprue, uremia, nephritis, gout, hypertension, and cardiac diseases⁴⁵. Nutritional values per 100 g of flowers consist of 1.6 g protein, 0.6 g fat, 9.9 g carbohydrate, 5.7 g crude fiber, 51 Kcal energy, 553.3 mg potassium, 73.3 mg phosphorus, 56 mg calcium, 56.4 mg iron, and 1.07 mg of Vit. E. Nutritional values per 100 g of raw stem consist of 1 g protein, 0 g fat, 2 g carbohydrate, 2 g crude fiber, 13 Kcal energy, 137 mg phosphorus, 1335 mg calcium, and 3.31 mg iron. Dietary contents per 100 g of ripe fruit consist of 1.09 g protein, 0.33 g fat, 2.842 g carbohydrate, 260 g crude fiber, 89 Kcal energy, 358 mg potassium, 22 mg phosphorus, 5 mg calcium, and 0.26 mg iron, 64 mg Vit. A, 9.7 mg Vit. C and 0.10 mg Vit. E⁴⁶⁻⁴⁸. Banana is a low cost, highly economical fruit in India. Biological activities of edible parts of banana are minimizing diabetes and anemia, boost lactation, decrease free radical activity, curing menses complications, and reduce anxiety⁴⁵.

4.2 Pineapple (*Ananas comosus*)

Ananas comosus (Figure 2B) is the accepted name for the commonly known pineapple fruit. It is an herbaceous perennial plant. The adult plant will grow 1 m - 1.5 m tall and inscribed in the general shape of a spinning top. This plant mostly grows in tropical forests, and the primary fruiting season is from April to May. In northeast India, pineapple is favorite for the fruit lovers in its fresh as well as processed forms like jam, jelly, and squashes. The taxonomical classification of *Ananas comosus* is described in Table 12⁴⁹.

Table 12. Taxonomical classification of *Ananas comosus*

Kingdom	Plantae
Phylum	Tracheophyta
Class	Lilopsida
Order	Bromeliales
Family	Bromeliaceae
Genus	Ananas
Species	<i>A. comosus</i>

Phytochemical analysis for pineapple fruit juice shows the existence of phenols, flavonoids, steroids, tannins, saponins, alkaloids, and volatile and non-volatile compounds⁵⁰. The valuable phenols were gallic acid, catechin, epicatechin, ferulic acid, caffeic acid, sinapic acid, ellagic acid, and vanillin⁵¹. Identified major flavonoid and isoflavone compounds of pineapple fruit were rutin, isoquercetin, and genistin⁵². Identified primary non-volatile organic acids were malic acid, quinic acid, and citric acid. Major volatile compounds were methyl-3-(methylthio) propionate, ethyl-3-(methylthio) propionate, 3-hydroxy-2-butanone, furaneol, ethyl-2-methyl butanoate, hexanoic acid, nonanoic acid, decanoic acid, β -guaiene⁵³. Khamptis tribe of Arunachal Pradesh, India, used burnt fruit for the treatment of urinary tract ailments (Khongsai et al. 2011). Bamileke, communities in the Douala region of Cameroon, used *Ananas comosus* fruit to relieve yellow fever, obesity, prevention against cancer, Vit. C maintenance and leaves were used to relieve cough and jaundice⁵⁴. Fresh juices of pineapple are rich sources of minerals, vitamins, and energy. Nutritional values per 100 g of fruit juice consist 0.54 g protein, 0.12 g fat, 13.52 g carbohydrate, 1.40 g crude fiber, 50 Kcal energy, 109 mg potassium, 1 mg sodium, 0.110 mg copper, 13 mg calcium, and 0.29 mg iron, 0.500 mg niacin, 0.079 mg thiamine, 58 IU Vit. A and 47.8 mg Vit. E⁵⁵. Biological activities of pineapple fruit extracts possess anti-bacterial, anti-viral, anti-fungal, anti-parasitic, anti-inflammatory, anti-oxidant, anti-rheumatic, and anti-diarrheal⁵⁶.

4.3 Jackfruit (*Artocarpus heterophyllus*)

Jackfruit or *Artocarpus heterophyllus* (Figure 2C) is a tropical evergreen perennial plant of height up to 20 m. Fruits bear from June to August. Fruit and seed are the main edible parts of jackfruit. The Taxonomical classification of *Artocarpus heterophyllus* is represented in Table 13⁵⁷.

Table 13. Taxonomical classification of *Artocarpus heterophyllus*

Kingdom	Plantae
Phylum	Tracheophyta
Class	Magnoliopsida
Order	Urticales
Family	Moraceae
Genus	Artocarpus
Species	<i>A. heterophyllus</i>

Artocarpus heterophyllus contains morin, dihydromorin, cynomacurin, artocarpin, isoartocarpin, cyloartocarpin, artocarpesin, oxydihydroartocarpesin, artocarpetin A, artocarpetin B, norartocarpetin, cycloartinol and artocarpanone. The plant also comprises fatty acids, ellagic acid, and some essential amino acids like arginine, cystine, histidine, leucine, lysine, methionine, threonine, tryptophan, etc. heteroflavanones A and B were isolated from the root bark. The fresh fruits are worthwhile in astringent and carminative. The mature fruits are syrupy, cooling, purgative, aphrodisiac, and available as a brain tonic. The seeds are diuretic and obstipation. The wood is nervine, anti-diabetic, tranquilizing, and is helpful in seizures⁵⁷. Nutritional values per 100 g of jackfruit juice consist of 1.72 g protein, 0.64 g fat, 23.5 g carbohydrate, 1.5 g crude fiber, 95 Kcal energy, 303 mg potassium, 3 mg sodium, 34 mg calcium, and 0.60 mg iron, 0.920 mg niacin, 110 IU Vit. A, 13.7 mg Vit.C and 0.34 mg it. E. Nutritional values per 100 g of jackfruit seeds consist of 7 g protein, 1 g fat, 38 g carbohydrate, 1.5 g crude fiber, 184 Kcal energy, 1.30mg potassium, 30mg sodium, 0.02 mg calcium, and 1.5mg iron, 10 IU Vit. A and 11 mg Vit. C^{58,59}. The principle biological properties of jackfruit are anti-ulcer and cardiovascular, improving digestion, anti-oxidant, skin diseases, anti-cancer, and anti-aging activities. A jackfruit seeds starch is used to reduce stomach sickness. Roasted seeds possess aphrodisiac properties⁶⁰.

4.4 Gaub Tree (*Diospiros malabarica*)

Diospyros malabarica (Figure 2D) is a perennial, blossoming bush that is inherent in the Indian subcontinent. It is slow developing, well-branched, and has an extended crown and a long, cylindrical trunk that raises about 70 cm in diameter. It extends a height of about 37 m. The leaves are sparkly olive, and the flowers are white or green. This plant is grown in the lowland rainforests zone of lower Himalayan region. A flowering

season is from January to February. Ripe fruits are the edible part of this plant. The taxonomical classification of *Diospiros malabarica* is represented in Table 14⁶¹.

Table 14. Taxonomical classification of *Diospiros malabarica*

Kingdom	Plantae
Phylum	Tracheophyta
Class	Magnoliopsida
Order	Ericales
Family	Ebenaceae
Genus	Diospyros
Species	<i>D. malabarica</i>

Leaves contain β -sitosterol, betulin, oleanolic acid and myricyl alcohol. Fruits contain new lupine-type triterpenes- peregrinol and bark consist of saponin, betulinic acid. Traditionally the fruits are used as bitter, acrid, cooling, digestive, carminative⁶². Per 100 g of eatable part of fruits contains 1.36 g protein, 0.17 g fat, 20.34 g carbohydrate, 1.59 g crude fiber, and 88.36 kcal energy. Per 100 g of fruits contains 0.07 mg copper, 0.46 mg manganese, and 0.08 mg zinc⁶³. The fruits showed anthelmintic activity in a dose-dependent manner, anti-bacterial activity, anti-fungal activity, hepatoprotective activity, and anti-oxidant activity⁶².

4.5 Custard Apple (*Annona reticulata*)

Annona reticulata (Figure 2E) is a small deciduous or semi-evergreen tree. It has well known for its fruit, called custard apple. The plant needs a tropical climate for proper growth, but it can survive in subtropical conditions—this plant mostly located in northeast India, such as Tripura, Assam, and Manipur. The taxonomical classification of *Annona reticulata* is represented in Table 15⁶⁴.

Table 15. Taxonomical classification of *Annona reticulata*

Kingdom	Plantae
Phylum	Tracheophyta
Class	Magnoliosida
Order	Magnoliales
Family	Annonaceae
Genus	Annona
Species	<i>A. reticulata</i>

Ethyl acetate extract of seeds of *Annona reticulata* consists of cis-/trans-isomurisolenin, annoreticuin, annoreticuin-9-one, cis-/trans-bullatacinone, bullatacin, cis-trans-murisolinone, and squamocin. Annonaretin A, a new triterpenoid, was chemically investigated from the leaves (Chavan et al. 2014). Raw fruit peel extracts contain alkaloids, cholesterol, coumarins, flavonoids, phenols, and saponins. Traditionally the unripe fruit is used for dysentery and diarrhea. Leaves are used to prepare tea for relieving colic. A decoction of the leaves is used mostly in reducing malaria and syphilis. The roots used to reduce epilepsy⁶⁴. Per 100 g of eatable part of fruits contains 1.98 g protein, 0.10 g fat, 27.49 g carbohydrate, 1.59 g crude fiber, and 118.84 kcal energy. Per 100 g of fruits contains 0.15 mg copper, 0.02 mg iron, 0.01 mg manganese, and 0.21 mg zinc. The fruits also contained a good amount of vitamin C (37.40 mg/100 g)⁶³. Custard apple seed extract is potent for the remedy of the liver, prostate, pancreatic, cervical cancers, and leukemia. Fruit pulp possesses anti-oxidant activity, anti-diabetic, and anti-cancer properties⁶⁵.

4.6 Sugar Apple (*Annona squamosa*)

Annona squamosa (Figure 2F) is a pint-sized, semi-evergreen tree that is 3-7 m tall and widely unfold crown or unevenly distribute branches. Leaves are single, 6-17 x 3-6 cm, lanceolate or oblong-lanceolate. Flowers are greenish-yellow, fragrant, on slender hairy stalks. The accumulated fruit is formed together by various pistils of a flower, which are lightly joined together. The taxonomical classification of *Annona squamosa* is described in Table 16⁶⁶.

Table 16. Taxonomical classification of *Annona squamosa*

Kingdom	Plantae
Phylum	Tracheophyta
Class	Magnoliosida
Order	Magnoliales
Family	Annonaceae
Genus	Annona
Species	<i>A. squamosa</i>

The fruit pulp of *Annona squamosa* contains alkaloids, tannins, flavonoids, saponins, terpenoids, glycosides, and steroids. The fruit also contains Annonaceous acetogenins, cyclopeptides⁶⁷. Traditionally the leaf, bark, and unripe fruit were used for diarrhea and dysentery⁶⁸.

Per 100 g of eatable part of fruits contains 5.44 g protein, 0.067 g fat, 20.41 g carbohydrate, 2.78 g crude fiber, and 92.90 kcal energy. Per 100 g of fruits pulp contains 602.5 mg calcium, 9.500 mg copper, 48.08 mg iron, 5.569 mg manganese, and 28.68 mg zinc, 52.5 mg magnesium, 80.0 mg phosphorus, 618 mg potassium, 22.5 mg sodium. The fruits were also content a good amount of vitamin C (90.7 mg/100 g) and vitamin A (150 IU/100 g)^{69,70}. *Annona squamosa* possesses anti-diabetic and hypolipidemic, anti-oxidant, anti-inflammatory, analgesic, anti-hypertensive, hepatoprotective, anti-parasitic, anti-malarial, insecticidal, and anti-microbial activities⁶⁸.

4.7 Indian Jujube (*Ziziphus jujuba*)

It is a tiny deciduous tree or shrub of 5–12 meters (16–39 ft) height, generally with much thorny brushwood. The leaves are glossy-green, ovate-acute, 2–7 centimeters. February to March is the flowering reason of *Ziziphus jujuba* (Figure 2G). The fruits were mature between 2 and 3 months after flowering. The taxonomical classification of *Ziziphus jujuba* is described in Table 17⁷¹.

Table 17. Taxonomical classification of *Ziziphus jujuba*

Kingdom	Plantae
Phylum	Tracheophyta
Class	Magnoliopsida
Order	Rosales
Family	Rhamnaceae
Genus	Ziziphus
Species	<i>Z. jujuba</i>

Fruit of *Z. jujuba* contains phenolic acids, flavonoids, anthocyanins, and proanthocyanidin. Identified phenolic acids were p-coumaric acid, cinnamic acid, caffeic acid, chlorogenic acid, ferulic acid, gallic acid, and vanillic acid. Determined flavonoids were quercetin, rutin, quercetin-3-galactoside, quercetin-3-rutinoside, kaempferol-glucosyl-rhamnoside, quercetin-3-robinobioside, epicatechin, catechin, and procyanidin B2⁷². Fruits are used traditionally as cooling, digestible, tonic, aphrodisiac, and laxative and remove biliousness, burning sensations, thirst, and vomiting. The leaves are antipyretic and reduce obesity. The folk practitioners avail the fresh leaves with cumin to cure the urinary disorder. The bark of the tree is used for the remedy of dysentery and diarrhea. New roots are used to treat throat hoarseness⁷³. Per 100 g of fresh fruits, contain 1.20 g

protein, 0.20 g lipid, 20.23 g carbohydrate, 1.7 g crude fiber, and 79 kcal energy. A similar amount of fruits contains 21 mg calcium, 0.48 mg iron, 23 mg phosphorus, 250 mg potassium, 3 mg sodium, 10 mg magnesium, 69.0 mg vitamin C, and 40 IU vitamin A. *Ziziphus jujuba* possesses anti-cancer, anti-inflammatory, anti-obesity, immunostimulating, anti-oxidant, and hepatoprotective properties⁷².

4.8 Pummelo (*Citrus maxima*)

Citrus maxima (Figure 2H) is a tree of 5-15 m height, with a somewhat crooked trunk 10–30 cm thick, low branches, asymmetrical, and extending. Leaves are compound, appearing dull, having one leaflet. Flowers are fragrant, borne singly, and fruit ranges tightly curved to oblate or pear-form. Early April is the flowering season of this plant. The taxonomical classification of *Citrus maxima* is described in Table 18⁷⁴.

Table 18. Taxonomical classification of *Citrus maxima*

Kingdom	Plantae
Phylum	Tracheophyta
Class	Magnoliopsida
Order	Sapindales
Family	Rutaceae
Genus	Citrus
Species	<i>C. maxima</i>

Citrus maxima contain alkaloids, phenols, flavonoids, monoterpenes, and sesquiterpenes. 5-hydroxyacronycine, acgrinine A, atalafoline, baiyumine A and B, buntanine, buntanmine, grandisine I and II, pumiline, honyumine, natsucrin, prenilycitpressine, citropone A & B, and glycocitrine I identified alkaloids were existing in the roots and the bark of the plant. Acacetin, rutin, tangeretin, cosmosiin, diosmetin, diosmin, eriocitrin, hespeidin, and naringin were identified flavonoids. Identified steroids: were β -Sitosterol, campesterol, daucosterol, stigmasterol. Leaves are used for the treatment of epilepsy, chorea, and convulsive cough and given for hemorrhage disease. Flowers are used for the treatment of tranquilizer in nervous affection, and fruits are used to treat leprosy, hiccough, mental aberration, and cardiotoxic⁷⁴. Per 100 g of fresh fruits, contain 0.76 g protein, 0.04 g fat, 9.62 g carbohydrate, 1 g crude fiber, and 38 kcal energy. A

similar amount of fruits contains 0.11 mg iron, 17 mg phosphorus, 216 mg potassium, 1 mg sodium, 10 mg magnesium, 61 mg vitamin C, 0.034 mg thiamine, 0.027 mg riboflavin, and 0.22 mg niacin⁷⁵. *Citrus maxima* give anti-oxidant, anti-inflammatory, anti-diabetic, anti-tumor, hepatoprotective, anti-bacterial, and CNS stimulant activities⁷⁴.

5. Results from Literature Survey

5.1 Plants of Vegetable Group

The literature survey observed that ten vegetable plants have medicinal values and nutritional importance (Table 19). These ten vegetable plants have contained alkaloids, phenols, flavonoids, tannins, terpenoids, glycosides, etc.



Figure 2. (A) *Musa paradisiac*, (B) *Ananas comosus*, (C) *Artocarpus heterophyllus*, (D) *Diospiros malabarica*, (E) *Annona reticulata*, (F) *Annona squamosa*, (G) *Ziziphus jujube*, (H) *Citrus maxima*.

Table 19. Summary of vegetable group plants

Botanical name and family	Edible parts	Energy content per 100 g	Biological activities	Citations
<i>Amorphophallus paeoniifolius</i> (Araceae)	Corm	359.08 Kcal	Anti-inflammatory, CNS depressant, anti-microbial, anthelmintic, hepatoprotective, anti-oxidant,	[8,9]
<i>Colocasia esculenta</i> (Araceae)	Corm	85 Kcal	Anti-microbial, anti-oxidant, and anti-diabetic activities	[10-18]
	Leaf	69 Kcal		
<i>Typhonium trilobatum</i> (Araceae)	Leaf	28.94 Kcal	Anti-inflammatory, analgesic, wound healing, anti-bacterial, anti-fungal, anti-diarrheal, and anti-diarrheal.	[1,19,20]
<i>Lablab purpureus</i> (Fabaceae)	Seed	344 Kcal	Anti-inflammatory, anti-oxidant, anti-bacterial and cytotoxicity activities	[21-24]
<i>Melocanna baccifera</i> (Poaceae)	Shoot	204.93 kcal	Anti-oxidant activity	[25,28]
<i>Moringa oleifera</i> (Moringaceae)	Leaf	92 Kcal	Hypolipidemic, anti-peroxidative, cardioprotective, anti-oxidant, anti-inflammatory, anti-nociceptive, anti-microbial, hepatoprotective, anti-hyperglycemic and anti-atherosclerotic activities	[29-31]
	Flower	17.95 Kcal		
	Green pod	26 Kcal		
<i>Solanum torvum</i> (Solanaceae)	Fruit	39.96 Kcal	Anti-oxidant, anti-fungal, anti-bacterial, anti-ulcer, anti-hypertensive and metabolic correction	[32-33]
<i>Sesamum indicum</i> (Pedaliaceae)	Seed	573 Kcal	Regulates cholesterol, neurological role, and blood pressure	[34-36]

<i>Sesbania grandiflora</i> (Fabaceae)	Leaf	93 kcal	Anti-microbial activity, decreased serum cholesterol levels, wound healing activity, and anti-ulcer activity	[37–41]
	Flower	27 kcal		
<i>Parkia speciosa</i> (Fabaceae)	Seed	91.0 kcal	Anti-oxidant, hypoglycemic, anti-tumor, and anti-mutagenicity, anti-microbial activities	[42]

5.2 Plants of Fruit Group

The literature survey observed that eight fruit plants have medicinal values and nutritional importance (Table 20). These eight fruit plants have also contained bioactive

compounds. The important bioactive compounds are alkaloids, phenols, flavonoids, tannins, terpenoids, glycosides, etc.

Table 20. Summary of fruit group plants

Botanical name and family	Edible parts	Energy content per 100 g	Biological activities	Citations
<i>Musa paradisiaca</i> (Musaceae)	Flower	51 Kcal	Anti-diabetic, anti-oxidant, anti-hypertension activities	[43–48]
	Stem	13 Kcal		
	Fruit	89 Kcal		
<i>Ananas comosus</i> (Bromeliaceae)	Fruit	50 Kcal	Anti-bacterial, anti-viral, antifungal, antiparasitic, anti-inflammatory, anti-oxidant, anti-rheumatic, and anti-diarrheal	[49–56]
<i>Artocarpus heterophyllus</i> (Moraceae)	Fruit	95 Kcal	Anti-ulcer and cardiovascular, improving digestion, anti-oxidant, skin diseases	[57–60]
<i>Diospiros malabarica</i> (Ebenaceae)	Fruit	88.36 kcal	Anti-bacterial, anti-fungal, hepatoprotective, and anti-oxidant activities	[61–63]
<i>Annona reticulate</i> (Annonaceae)	Fruit	118.84 kcal	Anti-oxidant activity, anti-diabetic, and anti-cancer properties	[64, 65]
<i>Annona squamosa</i> (Annonaceae)	Fruit	92.90 kcal	Anti-diabetic and hypolipidemic, anti-oxidant, anti-inflammatory, analgesic, anti-hypertensive activities	[66–70]
<i>Ziziphus jujuba</i>	Fruit	79 kcal	Anti-cancer, anti-inflammatory, anti-obesity, immunostimulating, anti-oxidant, and hepatoprotective properties	[71–73]
<i>Citrus maxima</i> (Rutaceae)	Fruit	38 kcal	Anti-oxidant, anti-inflammatory, anti-diabetic, anti-tumor, hepatoprotective, anti-bacterial, and CNS stimulant activities	[74,75]

5. Discussion

Edible medicinal plants are food-based plants those fulfill the dietary supplement and minimize chronic diseases⁷⁶. The acute toxicity studies observed that edible medicinal plant parts do not shown any toxic effects at a maximum doses^{77–79}. Phytochemicals are biologically active, naturally occurring secondary plant metabolites. The traditional medicinal knowledge and biological activity of the plant species depended on the presence of different phytochemicals^{80,81}. The literature

revealed that eighteen edible medicinal plants have contained common phytochemicals like alkaloids, phenolic, flavonoids, terpenoids, tannin, glycosides and gave various traditional medicinal values and biological activities represented in the Tables 19 and 20. Nutritional assessment refers to the contents of micronutrients and macronutrients of the food samples and the impact on the body. Most of the Indian peoples have suffering malnutrition (especially scurvy, rickets, beriberi, etc.) for deficiency of nutrients⁸². If Indian peoples take periodically various seasonal vegetables and food in their

diet, then it can be easily minimizing the malnutrition deficiencies⁸³. Energy content on food is a vital property. The energy level (Table 19 & 20) depends on the total amount of carbohydrate, protein, and fat present in the food samples⁸⁴. Traditional medicinal knowledge of plant species is essential for herbal drug development. It is a way to save the cultural therapeutic wisdom from the different ethnic communities of India⁸⁵. In this review it was noticed that all the edible plant parts have traditional values.

6. Conclusion

In this review, we have focused on eighteen edible plants in Tripura, India for their nutraceutical values. Consumable parts of selected plants showed the right amount of proximate composition, minerals, and vitamins. These edible plant parts also diminish the possible causes like high blood pressure, diabetes, cardiovascular diseases, and may help to prevent cancer. This review helps natural product researchers to find out the new floras of Tripura with their biological and nutritional importance.

7. Conflict of Interest

The authors declare no conflict of interest.

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