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Traditional importance and unique properties of *Garcinia* spp. found in Assam, India

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Abstract

Garcinia spp. is a tropical fruit tree native to Southeast Asia where it has a long history of use as a traditional medicine. In Assam, *Garcinia* is known as 'thechera' and is popularly used in culinary preparation and to make refreshing juice which helps to cure symptoms like headache, fatigue, nausea, vomiting and concentration difficulties. Village people usually drink them to reduce or prevent the after-effect of alcohol consumption. Also it has been claimed to have a unique properties to help lose weight because of anti-hypolipidemic properties. Despite its medicinal values, this plant is not well known and rarely found nowadays. Research on the phytochemical constituents and biological activities of *Garcinia* spp. have demonstrated that various parts of the plant contain significant amount of bioactive compounds mainly Hydroxycitric acid (HCA), xanthenes and flavonoids, with significant pharmacological properties such as anti- atherosclerosis, anti-bacterial, anti-hypolipidemic, anti-cancer, anti-hypertension, and anti-malarial. *Garcinia cambogia* and *Garcinia gummi-gutta* are already in the market as popular weight loss supplement. In the current review, recorded knowledge of the *Garcinia* spp. found in Assam and its active constituents based on the available literature are summarized in order to explore its potential applications and prospective research works on this plant.

Keywords: *Garcinia* spp., traditional medicine, phytochemical, nutraceuticals, Assam

1. Introduction

The State of Assam, popularly known as the land of the red river and blue hills is the gateway to the North East India. Geographically the state is extending from 22°19' to 28°16' North Latitude and 89°42' to 96°30' East Longitude between the foot hills of the Eastern Himalayas and the Patkai and Naga Hill Ranges. The state is bordered in the North by Bhutan and in the East by Arunachal Pradesh. Along the south lie Nagaland, Manipur and Mizoram. Meghalaya lies to the South-West, West Bengal and Bangladesh to the West. The State is divided into 33 administrative districts (Figure 1). It has rich flora and fauna among which *Garcinia* Spp. in one of the indigenous plant. *Garcinia* spp. is a tropical fruit tree found throughout the world. The genus *Garcinia* Linnaeus (1753: 443) is pantropic and comprises of over 350 species of evergreen, lactiferous, dioecious trees and shrubs of the moist, lowland tropical forests and is found in abundance in tropical region of Southeast Asia (Sweeney 2008, Nimanthika & Kaththriachchi 2010) [26, 20]. Kanjilal *et al.*, (1934) [13] reported 9 species of *Garcinia* during undivided Assam. According to the most recent data, 41 species and 5 varieties are currently recognized in India, of which 35 species and all varieties occur in natural environments, while the rest are introduced into cultivation (Maheswari 1964, Singh 1993, Srivastava 1994, Sabu *et al.* 2013) of which 14 species and 4 varieties are endemic (Sarma *et al.*, 2016) [25]. 8 species of *Garcinia* L., viz., *G. xanthochymus* Hook.f., *G. cowa* Roxburgh, *G. sopsopia* (Buch.-Ham.) Mabblerley, *G. lanceaefolia* Roxburgh, *G. acuminata* Planchon & Triana, *G. pedunculata* Roxburgh, *G. gummi-gutta* (L.) N. Robson and *G. spicata* (Wt. & Arn.) Hook.f. are recorded from Sonitpur district of Assam in India. (Kar *et al.*, 2008) [14]. Choudhury *et al.*, (2005) has reported 15 species of *Garcinia* from Assam out of which *G. acuminata*, *G. anomala* and *G. keeniana* are reported to be endangered. Borah *et al.*, (2016) [6] also reported in his study that *Garcinia keeniana* which was earlier recorded in the region is not reported at present due to its very less distribution. Sarma *et al.*, (2016) [23] has from the semi-evergreen forests adjacent to Manas National Park, Assam, India. Begum *et al.*, (2014) [4] also reported two new varieties of *Garciniamorella* from Tinsukia district, Assam. Table 1 has summarized *Garcinia* spp. recorded in Assam. *Garcinia* spp. has been found to have many beneficial properties due to which it is used as traditional medicine to heal stomach disorders, fever, malaria and typhoid. It is also claimed by villagers to help cure symptoms like headache, fatigue, nausea, vomiting

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and concentration difficulties. Village people usually drink them to reduce or prevent the after-effect of alcohol consumption. In addition to that, scientific investigations have revealed many other therapeutic properties of it being a dietary antioxidant, having hypoglycemic, hypolipidemic, anticarcinogenic, antimutagenic activities. The fruit is used in culinary practices as spice and locals cook the raw fruit with fish. The preserved fruit is used to make refreshing drinks during hot weathers. The phytochemical analysis of *Garcinia gummi-gutta* revealed the presence of several bioactive molecules such as xanthenes, benzophenones and organic acids. The fruit contains 10% to 30% (-) hydroxycitric acid (HCA), a well-known hypo- lipidemic agent and an important constituent of food supplement for weight management. The species is a rich source of the bioactive cambogin (isogarcinol) (Anju *et al.*, 2016) [1].

Garcinia dulcis, has also shown significant pharmacological properties that include anti-oxidant, anti-microbial, anti-cancer, and cardiovascular protection (Khamthong *et al.*,

2017) [15]. Thus, *Garcinia* spp. could be an important resource for novel therapeutic agents in today's growing need of functional and nutraceutical demands to aid various lifestyle diseases and metabolic syndromelike dysglycemia, high blood pressure, elevated cholesterol, obesity, cardiovascular diseases and diabetes. *Garcinia cambogia* and *Garcinia gummi-gutta* is already in the market as a popular weight loss supplement. Besides traditional uses, few restaurants in Assam also serve refreshing drinks and dishes made of *Garcinia*. Review of literature indicates the lack of sufficient scientific data to support these nutritional and nutraceutical properties. Moreover, use of *Garcinia* spp. as commercial functional food or as food ingredients is not popular except its limited use in traditional food. Hence more research work is required to characterize its bioactive components as well as to elucidate their underlying molecular mechanisms of action. Hopefully, this literature review may highlight some useful information and gain some interest to further investigate this underutilized *Garcinia* spp.



Fig 1: Map of Assam showing 33 districts

Table 1: Different varieties of *Garcinia* spp. found in Assam according to the literature reported so far.

Sl. No	Varieties	Local name	Traditional uses	Areas of study conducted	References
1.	<i>Garcinia assamica</i>	Thekera	Pickle making	Manas National Park, Baksa	Sarma <i>et al.</i> , 2016 ^[23]
2.	<i>Garcinia pedunculata</i>	Borthekera	Pickle, making curries, used as medicine to cure dysentery, jaundice. Wood is used as timber.	Upper Brahmaputra valley Kamrup Metro (M), Kamrup Rural (R), Nalbari, Barpeta, Dhemaji and Lakhimpur	Gogoi B <i>et al.</i> , 2016 ^[11] ; Dutta <i>et al.</i> , 2017 ^[10] ; Gogoi <i>et al.</i> , 2012 ^[12] ; Sarma <i>et al.</i> , 2015 ^[24] ; Sarma <i>et al.</i> , 2016 ^[23] ; Baruah <i>et al.</i> , 2012 ^[2]
3.	<i>Garcinia xanthochymus</i>	Teportenga	Used to cure piles, dysentery, tumors and diarrhoea.	Upper Brahmaputra valley	Gogoi B <i>et al.</i> , 2016 ^[11] ; Baruah <i>et al.</i> , 2012 ^[2]
4.	<i>Garcinia morella</i>	Kujithekera	Dried pulp of the fruit is used as an antiscorbutic, astringent, cooling, cardi tonic, emollient, antidiarrhoeic, antidysentric, indyspepsia and in flatulence.	Upper Brahmaputra valley	Begum <i>et al.</i> , 2014 ^[4] , Sarma <i>et al.</i> , 2016 ^[23] ; Baruah <i>et al.</i> , 2012 ^[2]
5.	<i>Garcinia lanceaefolia</i>	Rupohithekera	Consumed as vegetable, used to cure dysentery, diarrhoea.	Upper Brahmaputra valley	Gogoi B <i>et al.</i> , 2016 ^[11] ; Dutta <i>et al.</i> , 2017 ^[10] ; Baruah <i>et al.</i> , 2012 ^[2]
6.	<i>Garcinia cowa</i>	Kujithekera	Making of jam, pickle, cure against dysentery, nausea and vomiting.	Upper Brahmaputra valley	Gogoi B <i>et al.</i> , 2016 ^[11] ; Dutta <i>et al.</i> , 2017 ^[10] ; Baruah <i>et al.</i> , 2012 ^[2]
7.	<i>Garcinia acuminata</i>	Kujithekera	Arils are used to make refreshing drinks, cure dysentery	Sonitpur district	Kar <i>et al.</i> , 2008 ^[14]
8.	<i>Garcinia gummi-gutta</i>	Kauthekera	Arils are used to make refreshing drinks, pickles and seasoning of curries	Sonitpur district	Kar <i>et al.</i> , 2008 ^[14]
9.	<i>Garcinia spicata</i>	Kauthekera	Arils are used to Make refreshing drinks and pickles	Sonitpur district	Kar <i>et al.</i> , 2008 ^[14]
10.	<i>Garcinia sopsopia</i>	Mamoithekera	Arils are used to make refreshing drinks	Sonitpur district	Kar <i>et al.</i> , 2008 ^[14]
11.	<i>Garcinia dulcis</i>	Teportenga	Preparing jams and bark latex is used in dyeing mats	Upper Brahmaputra valley, Dibrugarh district	Begum <i>et al.</i> , 2013 ^[3]
12.	<i>Garcinia nervosa</i>	Pear Mangosteen, Deofal (Bengali)	Ripe fruits are used to cure dysentery and the leaves are used as laxative for cattle.	Barak valley, Cachar and Karimganj district	Dutta <i>et al.</i> , 2014 ^[9]
13.	<i>Garcinia paniculata</i>	Sochopatenga	The aril of the fruit, like that of mangosteen, is highly flavoured and is eaten with relish. The plant has been recommended as a suitable rootstock for mangosteen.	Upper Brahmaputra valley	Maheswari 1964; Baruah <i>et al.</i> , 2012 ^[2]
14.	<i>Garcinia kydia</i>	Kujithekera	The tree yields an inferior gamboge. Acid fruit is used for treatment of dysentery, constipation, high blood pressure and headache.	Tropical forests of Assam, Upper Brahmaputra valley	Maheswari 1964
15.	<i>Garcinia atroviridis</i>	thekera	Fruit is used as a fixative with alum in the dyeing of silk. Leaves and roots are used in the treatment of earaches. The sour fruit rind is used in curries.	Upper Brahmaputra valley	Maheswari 1964
16.	<i>Garcinia anomala</i>	Thechu by Garo	-	Northeast India	Maheswari 1964
17.	<i>Garcinia keeniana</i>	-	-	Barak Valley of Assam	Choudhury <i>et al.</i> , 2005 Borah <i>et al.</i> , 2016 ^[6]

2. *Garcinia* Species found in Assam

2.1 *Garcinia assamica*

G. assamica, a new species related to *G. nigrolineate* was discovered in the semi-evergreen forests in and adjacent to Manas National Park, Assam, India. It flowers during February–May and by August it starts fruiting. It seems to be rare and is only known by very few individuals. The tree is 15 m tall, with horizontal branches with turbinate fruit shape and secretes greenish yellow latex. The fruit turns orange yellow when ripe. The fruit is edible and is used in pickle making by locals in Assam. (Sarma *et al.*, 2016) ^[23]. Some of the species of *Garcinia* is given in Table 2.

2.2 *Garcinia pedunculata*

G. pedunculata, Roxb.ex Buch.-Ham known as *Borthekera*

(Figure 2) in Assamese and *Taika* in Bodo is a large evergreen tree mostly available in North Eastern region of India. It is mostly found in forest and patch vegetations in wild conditions, also found backyards of home garden as domesticated plant. (Dutta *et al.*, 2017) ^[10] The fruit is globose of size 8-12 cm diameter with fleshy edible aril. Fruits turns yellow when ripe. The raw fruit is used in pickle making and ripe mature fruit is eaten raw or cooked traditionally with fish. It is also preserved by drying and used in making of refreshing drinks. The fruit is known to cure dysentery and jaundice. Few people use wood for making bed, chairs, tables and “*dhaki*” - the traditional rice husking implements for traditional use. Literature surveys have revealed that it is a good source of natural antioxidant. It can be attributed to its high phenolic and flavonoid, and ascorbic acid content.

(Mudoi *et al.*, 2012) [18]. Old dried fruits are good for dysentery and it is a good source of antioxidant. Pedunxanthons A-C was obtained from the bark of the tree. It is also reported to have rich source of hydroxycitric acid (HCA). (Gogoi *et al.*, 2016) [11].

2.3 *G. xanthochymus*

G. xanthochymus Hook.f. ex. T. Anderson is known as *Tepor-tenga* in Assamese and *Tempwr* in Bodo (Table 2). It is a small middle sized evergreen tree distributed in Assam. It is mostly found in forest area in wild conditions and sometimes in backyard of home gardens. (Dutta *et al.*, 2017) [10]. It starts fruiting during April to August. The ripe fruit is golden yellow colour and 4-6 cm in diameter. The ripe fruit can be eaten raw having sour taste, cooked with other vegetables or fish or made chutney with mustard oil, salt and chilli (Kar *et al.*, 2008) [14]. The latex is used as a lubricant during weaving. The yellow colour latex is also used as natural dye for dying of fabric in olden days. It is a medium sized, dioecious tree with narrow crown. Fruits are large as medium sized apple, smooth and pointed at the apex and deep yellow when ripe. The fruit is pulpy and has sweet-sour taste. It is known to be used as folk medicine for bilious conditions, diarrhoea and dysentery. The fruit juice has anti-scorbutic, anthelmintic and cardiogenic properties. Hence, it is used to cure piles, dysentery and tumors. (Gogoi *et al.*, 2016; Baruah *et al.*, 2012) [11, 2].

2.4 *Garcinia morella*

G. morella Hook.f. ex. T. Anderson is commonly known as *Kuji-thekera* in Assamese. It is a small evergreen tree that grows upto 40 ft. in height. It is mostly found in forest area under wild conditions (Dutta *et al.*, 2017) [10]. Ripe fruit is about 2-3 cm in diameter, globose and yellow colour. It starts to blossom during April and starts fruiting till September. Raw fruits are preferred for pickles and sundried fruits are used as spices in foods. It is an indigenous plant of Northeast region of India and it has been reported that it is used as an effective medicine to cure diarrhoea, dyspepsia, dysentery etc. Literature survey reveals that it has great potentiality as lipid lowering agent by the ability to lower cholesterol, triglycerides and LDLc. (Pator *et al.*, 2011; Gogoi *et al.*, 2016; Begum *et al.*, 2014; Baruah *et al.*, 2012) [21, 11, 4, 2].

2.5 *Garcinia lanceaefolia*

G. lanceaefolia Roxb. is commonly known as *Rupohi Thekera* in Assamese. It is a tropical evergreen plant having small thick-skinned fruit with juicy, acid and fragrant pulp. It is found in home gardens as domesticated plant. It has been reported that its tender leaves are consumed as vegetable by some tribes of Cachar District, Assam and sometimes people use the trunk and leaf of the fruit plants as wood and fodder respectively. The pericarps of fruits are eaten as raw and pickles. The dry sliced prepared from pericarps are used as acidifying agent for traditional curry, medicine against stomach trouble. The juice prepared from the dry sliced pericarp is taken as sherbet during warmer days to get relief from hot. It has various health benefits as treatment for headache, stomachic diabetic, dysentery and diarrhoea. A decoction of fruit with salt is swallowed for fever. The crude fruit extracts were reported to be antibacterial. (Gogoi *et al.*, 2016; Dutta *et al.*, 2017; Baruah *et al.*, 2012) [11, 10, 2].

2.6 *Garcinia cowa*

G. cowa Roxb. Ex Choisy is commonly known as *Kuji*

thekera in Assamese. It is an evergreen middle sized tree up to 12 m in height with an oval crown. It occurs in wild conditions in forest areas and sometimes found in backyards of home gardens. Mature fruits are opaquely red, ovoid-globose and usually apiculate. It is distributed across the North-East India. Its fruiting season is between March to July. (Kar *et al.*, 2008) [14]. Researchers have reported various uses of its fruits in curing dysentery, nausea and vomiting. The fruit is eaten when ripe and raw fruit is used in making curries and pickles. Fruit pulp is also used for making jam. Dry sliced pericarp of the fruits are preserved and used as medicine against dysentery, constipation, high blood pressure and stomach disorder for human as well as domestic animals. The dry sliced pericarp is used to prepare refreshing juice because of its sour taste. The stem is used in construction of house. The latex and bark of *G. cowa* revealed the presence of prenylated xanthenes (Cowaxanthone, cowanin, cowanol, 1,3,6-trihydroxy-7-methoxy-2,5-bis (3-methyl 2 butenyl). Some of these compounds have been tested for anti-malarial and antimicrobial activity. (Gogoi *et al.*, 2016; Dutta *et al.*, 2017) [11, 10].

2.7 *Garcinia acuminata*

G. acuminata is commonly known as *Kuji thekera* in Assamese. It is a small tree. Fruits are 15 cm in diameter, globose or slightly elongate, seated on persistent sepals and crowned with imperfectly 4-lobed stigma. Fruits become yellow when ripe. It flowers during December to February and starts fruiting during February to June. Locals use the aril for making juice and dry preserved fruits are used to treat blood dysentery. The gum resin is useful as a dye and medicine, but its use is not known in Assam. The seed yields fatty oil which can be used for illuminating purposes and as a substitute for ghee. (Maheswari 1964)

2.8 *Garcinia gummi-gutta*

G. gummi-gutta is locally known as *Kau thekera*. It is a small tree. Fruits are equal to the size of a plum, turns yellow when ripe with succulent aril. Fruiting season is from June to August. It was reported from Sonitpur district of Assam. Locals use the ripe fruit for making refreshing drinks. Raw fruit are used for making pickle and also used for seasoning curries. (Kar *et al.*, 2008) [14].

2.9 *Garcinia spicata*

G. spicata Hook.f. is locally known as *Kau thekera*. It is a medium tree. Fruits are globose to oval, smooth, deep green, turns yellow when ripe, 2 – 4 seeded, aril is juicy. It is used for pickle making and in preparation of traditional curries. It is found mostly in forest area under wild condition. (Dutta *et al.*, 2017) [10]. It was reported from Sonitpur district of Assam. Fruiting season is from May to July. (Kar *et al.*, 2008) [14].

2.10 *Garcinia sopsopia*

G. sopsopia (Buch.-Ham.) Mabb. is locally known as *Mamoithekera*. It is an evergreen big tree. Fruits are small, apple sized, globose or slightly elongate, red when ripe, crowned with hemispherical granular stigma; seeds 3 - 5 enclosed in pulpy aril. Fruiting season is observed between November to February. Arils has sweet taste and used for making refreshing drinks. It is found mostly in forest under wild conditions. (Dutta *et al.*, 2017) [10].

2.11 *Garcinia dulcis*

G. dulcis (Roxb.) Kurz is known as *Tepor tenga* (Assamese).

It is common in forest areas under wild condition. (Dutta *et al.*, 2017) ^[10]. The tree grow upto 20 m tall, 40 cm in diameter, trunk straight, fluted at the top with blackish brown and smooth bark. Wood is yellowish white with some red marks exuding scanty cream coloured latex which later turns yellow. Fruit is globule, smooth, green, 3.4 – 5.3 cm x 3.2 – 5.1 cm, with straight or oblique pointed apex base. It turns yellow when ripe with yellow pulp. It's flowering and fruiting takes place between April to November. The species resembles closely with *Garcinia spicata* (Wight & Arnott) Hooker f. The fruits contain citric acid and are suitable for preparing jams and preservers. The bark is used for dyeing mats. The species resembles with *G. spicata* (Wight & Arnott) Hooker f. (Begum *et al.*, 2013) ^[3].

2.12 *Garcinia nervosa*

G. nervosa is commonly known as Pear Mangosteen. It is known as *Deofal* in Bengali. It is an evergreen tree with 6 to 12m in height. Ripe fruits are ovoid or obovoid, yellow with red blotches, 5.1cm long and 3.8cm in diameter with seeds about 2, elongated ovoid. It's flowering and fruiting takes place between March to Oct. In Assam it is locally found in Barak Valley region. The pulp is edible but sour in taste. The ripe fruits are used to cure dysentery and the leaves are used as laxative for cattle. The species is closely related to *G. dulcis* and *G. xanthochymus*. (Dutta *et al.*, 2014) ^[9].

2.13 *Garcinia paniculata*

G. paniculata Roxb. Is commonly known as *Sochopa tenga* in Assamese. It is a dioecious small evergreen tree growing upto 12- 18 m high, with many ascending branches. Wood is moderately hard and brown in colour. Fruit is spherical, yellow, the size of the large cherry, succulent, usually 4-locular having 3 – 5 seeds with pulpy aril. It starts to blossom in early November and bears fruit till July. The aril of the fruit, like that of mangosteen, is highly flavoured and is eaten with relish. The plant has been recommended as a suitable rootstock for mangosteen. The ripe fruits are eaten. Leaves are used to treat roundworm. Wood is moderately hard used for house building, firewood. (Maheswari 1964; Baruah *et al.*, 2012) ^[2].

2.14 *Garcinia kydia*

G. kydia Roxb. is also known as *Kuji thekera* in Assamese. It is a dioecious tree with 7.5-13 m in height. Wood is white and turns yellowish which is heavy, coarsely fibrous, and very perishable. It is found in forest areas and sometimes in

backyard of household as domesticated plants. (Kar *et al.*, 2008) ^[14] Fruit is 2.5 - 4 cm in diameter, dark purple-brown, smooth and globular. Aril is soft, acidic and juicy. It flowers from December to May and start fruiting from May till August. It is locally distributed in tropical forests of Assam; it was discovered by Col. Kyd in the Andaman Islands and introduced into the Indian Botanic Garden, Calcutta in 1794. (Maheswari 1964). Pericarps of fruit are used as acidifying agents for traditional curry. The fleshy outer cover of seeds of ripe fruits is eaten as raw. Dry sliced pericarp of the fruits are preserved for its medicinal value, it is used as medicine against dysentery, constipation. The juice prepared from the dry sliced pericarp is eaten as sherbet because of its sour test. The extract of dry sliced fruit is used as medicine for high blood pressure and stomach disorder for human as well as domestic animals. The tree yields an inferior gamboges. The acid fruit is considered as a specific for dysentery and also for external application in obstinate cases of headache. The stem is used as pole for construction of traditional house, making "dhaki" - the traditional rice husking implements, fuel wood. (Dutta *et al.*, 2017) ^[10].

2.15 *Garcinia atroviridies*

G. atroviridies Griff. ex T. Anderson in Hook. F is a medium-sized, graceful trees with robust branches. Fruit is globular, 8 - 10 cm in diameter, yellowish-green with firm textured. It has translucent pulp surrounding the seeds which is edible. It is distributed all over the north-east districts of Assam. The fruit is used as a fixative with alum in the dyeing of silk. A decoction from leaves and roots is used in the treatment of earaches. The sour fruit rind is used in curries. (Maheswari 1964)

2.16 *Garcinia anomala*

G. anomala Planch. & Triana is a small evergreen trees with robust branches. Fruit is ellipsoid, pruniform, about 42 x 35 mm, smooth and olivaceous having 1-2- seeds. It flowers in November to May and starts fruiting till February. It is distributed across the Northeast region. It is known as Thechu by Garo. (Maheswari 1964)

2.17 *Garcinia keeniana*

G. keeniana is a small shrub with moderately thick branches. Fruit is globule and fleshy. Flowering & Fruiting takes place between April to September. Its wood serves as good timber. (Kanjilal 1934) ^[13]. This species has not been recorded of its occurrence in recent literature.

Table 2: Some of the *Garcinia* spp. from Assam

	<p>A. <i>Garcinia pedunculata</i> collected from Chirang District</p>
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	<p>B. <i>Garcinia xanthochymus</i> Raw and ripe Fruit. Collected from Chirang District.</p>
	<p>C. <i>Garcinia morella</i>. Gogoi <i>et al.</i> 2012 ^[12]</p>
	<p>D. <i>Garcinia assamica</i>. Sharma <i>et al.</i> 2016 ^[23]</p>

3. Phytochemical properties of *Garcinia* spp.

Many researchers have reported *Garcinia* spp. to be rich in phytochemical properties to aid in many lifestyle diseases like obesity, hypertension, stomach disorder and certain metabolic syndrome which is summarized in Table 3.

- Pator *et al.*, 2011 ^[21] have reported that *G. morella* fruit extract has great potentiality as a lipid lowering agent based on the proven ability of the extract to lower cholesterol, glycerides and LDLc.
- Mudoi *et al.*, 2012 ^[18] have shown in his study that *G. pedunculata* is a good source of natural antioxidant and it exhibited significantly higher antioxidant activity. *G. pedunculata* has high phenolic, flavonoid and ascorbic acid content.
- Gogoi *et al.*, 2012 ^[12] have also reported in his study that *G. pedunculata* has high potent antioxidant activity but *G. pedunculata*, *G. Morella* and *G. xanthochymus* have low phenolic content.
- Gogoi *et al.*, 2016 ^[11] have reported that *G. pedunculata* has high content of ascorbic acid and *G. xanthochymus* has high content of phenol which explains their good antioxidant activity.
- Sarma *et al.*, 2015 ^[24] in his study indicated that Cold water extract of *G. pedunculata* and *G. morella* exhibit higher reducing power, free radical scavenging and antifungal activity than hot water extract. His study suggested that *Garcinia* extracts have a great antioxidant potential and have great importance as therapeutic agents in preventing or slowing the progress of aging and oxidative stress related degenerative diseases.
- Negi *et al.*, 2008 ^[19] have studied antibacterial activity of the extracts of the fruit rinds of *G. cowa* and *G. pedunculata* against food borne pathogens and spoilage bacteria and found that extracts of *Garcinia* have inhibitory effect against the Gram- positive bacteria. So it has a possible scope as food Bio preservative.
- Choudhury *et al.*, 2012 have reported through his study that fruit extract of *G. lanceifolia* were highly effective against Gram-positive bacteria compared to Gram negative bacteria. He stated that the presence of alkaloids, cardiac glycosides, terpenoids, saponins, tannin, flavonoids and steroids in the ethanolic extract were responsible for its antimicrobial activity.
- Bora NS *et al.*, 2014 ^[5] in his study revealed that methanolic extract of the bark of *G. lanceifolia* has significant antibacterial activity against four strains of bacterium, namely *B. subtilis*, *S. aureus*, *P. aeruginosa* and *E. coli*. *G. lanceifolia* is found to be more effective against Gram positive bacteria than gram negative bacteria and in a dose dependent manner. He suggested that further studies can help to find new antibacterial drugs.
- Many such studies all over the world have suggested *Garcinia* spp to be rich in phytochemical and bioactive compounds which have significant pharmacological properties that include anti- oxidant, anti-microbial, anti-cancer, and cardiovascular protection. Thus, there is little doubt about the potential of *Garcinia* as an important resource for novel therapeutic agents.

Table 3: Pharmacological Values of *Garcinia* spp. found in Assam

Sl. No	<i>Garcinia</i> Species	Pharmacological values	References
1.	<i>G. morella</i>	Lipid lowering agent	Pator <i>et al.</i> , 2011 [21]
2.	<i>G. pedunculata</i>	High phenolic, flavonoid and ascorbic acid content.	Mudoi <i>et al.</i> , 2012 [18]
3.	<i>G. pedunculata</i>	High Antioxidant	Gogoi <i>et al.</i> , 2012 [12]
4.	<i>G. pedunculata</i>	High content of ascorbic acid	Gogoi <i>et al.</i> , 2016 [11]
5.	<i>G. xanthochymus</i>	High content of phenol	Gogoi <i>et al.</i> , 2016 [11]
6.	<i>G. pedunculata</i> and <i>G. morella</i>	Higher reducing power, free radical scavenging and antifungal activity, great antioxidant potential	Sarma <i>et al.</i> , 2015 [24]
7.	<i>G. cowa</i> and <i>G. pedunculata</i>	Antibacterial activity	Negi <i>et al.</i> , 2008 [19]
8.	<i>G. lanceifolia</i>	Antimicrobial activity	Choudhury <i>et al.</i> , 2012
9.	<i>G. lanceifolia</i>	Antimicrobial activity	Bora NS <i>et al.</i> , 2014 [5]

4. Conclusion

Review of literature have revealed that very less scientific work has been done on *Garcinia* spp. of Assam. Hence it gives us a clear indication that a lot has to be done to explore the importance of plant regarding its nutraceutical and therapeutic values. Status of the conservation of the plant is not known. Literature has recorded of its scarce availability in Assam because of deforestation, awareness of its importance by locals and its less importance as cash plant. Some work has been recorded on *G. pedunculata*, *G. Morella*, *G. xanthochymus*, *Garcinia cowa* and *G. lanceaeifolia*.

Garcinia spp. being rich in pharmacological properties and bioactive components. The fruit could be standardized in making refreshing drink which could be commercialized at the large scale or other food products and made easily available for the consumers. It is also found that most of the work has been done on *Garcinia* spp. from Upper Brahmaputra Valley of Assam and scanty records are available from Lower Brahmaputra Valley of Assam on its occurrence. Hence, further research could give us a new breakthrough to discover an innovative product out of it.

5. Conflict of interest

The authors have no conflicts of interest regarding this investigation

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