

## Traditionally Available Citrus Germplasm in Assam and Its Importance

Minti Gogoi, Arunima Gogoi, A. C. Barbora

Received 30 May 2022, Accepted 7 September 2022, Published 10 November 2022

### ABSTRACT

Citrus fruit belonging to the family of *Rutaceae* is one of the most prominent nutritive fruits of Assam. Out of 27 numbers of citrus species still reported 23 number of species belong to Assam is a major citrus producing state of north east India. The citrus fruit list covering the innumerable citrus fruits such as lime, lemon, grapefruit, mandarin, sweet orange pummelo most of them are indigenous fruit of Assam. All those citrus fruits are known for their tangy flavors and a combination of sweet-sour aromas, which is probably one of the reasons why they are among the top fruits in the list of favorite fruits of people. Usually, they are juicy and the juice contains the main acidic

component with characteristic sharp flavor and have great potential in improvement of human health. Among varieties of citrus most popular and world-wide accepted fruit khasi mandarin (*Citrus reticulata* Blanco) locally known as orange is the power package of vitamin C and anthocyanins. Assam lemon (*Assam limon* Burmf.) a seedless fruit with unique flavor is now able to get geographical Indication in the year, 2019 has great value in our food pattern. Pummelo is also a rich source of nutrients and fibers indigenous to Assam. Varieties of Grape fruits are produced in the state to meet the requirement of citrus fruits for sugar patients. Besides these *hati nemu*, *jara tega*, *bor tenga*, *rabab tenga*, *kazi nemu*, *gul nemu*, *bira jora*, *bonjora*, *holong tenga*, *gandharaj*, *mitha chakala*, *sapai*, *sumathira tenga* are traditionally available in Assam. Numbers of citrus diversified products such as pickles, squash, fruit juice, orange peel powder, candy, concentrated juice, essential ingredients for beverages, confectioneries, cosmetics, aromas and fragrances, aromatic oils and food essences can be prepared from those varieties. The center also provides opportunity to its stakeholders to reflect the sustainable use of citrus resources and ensure livelihood security of citrus grower of Assam. Considering the importance of citrus fruit for healthy life it was planned to study the quality analysis of different traditional citrus fruit available in Assam. Importance was also given on value addition of those seasonal fruits in order to make it commercially available for every customer and for the whole year.

**Keywords** Khasi mandarin, Medicinal value, Bio-active compounds, Nutritional importance, Citrus Germplasm.

---

Minti Gogoi  
Scientific Assistant, Office of the Registrar, Assam Agricultural University, Jorhat 786013. Assam, India

Arunima Gogoi\*  
Jr. Scientist, Regional Agricultural Research Station, AAU, Nagaon 782002, Assam Agricultural University

A.C. Barbora  
Retired Chief Scientist, Citrus Research Station, AAU, Tinsukia 786125  
Email : arunima\_gogoi123@yahoo.co.in  
\*Corresponding author

## INTRODUCTION

Citrus (*Citrus* L.) is a most economically important exotic fruit crops, distributed in the tropical and subtropical regions of the world (They are grouped under the family Rutaceae and sub-family Aurantioideae.) In India, citrus holds a prominent place among the major commercial fruits covering an area of about 1003 thousand ha with an annual production of 12546 thousand metric tons and productivity of 12.5 t ha<sup>-1</sup> (Anonymous 2018). Citrus is the third most important fruit crop in India and Assam is center of origin and rich in diversity of *Citrus* (L.) species representing several wild and cultivated species. Out of 27 numbers of citrus species, still reported 23 number belong to Assam. The three ancestral (sometimes characterized as “original” or “fundamental”) species in the genus *Citrus* associated with modern *Citrus* cultivars are the mandarin orange, pomelo, and citron. Almost all of the common commercially important citrus fruits (sweet oranges, lemons, grapefruit, limes, and so on) are hybrids involving these three species with each other, their main progenies, and other wild *Citrus* species within the last few thousand years (Wu *et al.* 2018, Velasco and Licciardello 2014).

The generic name of citrus originated from Latin, where it referred to either the plant now known as citron (*C. medica*) or a conifer tree (*Thuja*). It is related to the ancient Greek word for cedar, (*kédros*). This may be due to perceived similarities in the smell of citrus leaves and fruit with that of cedar. Collectively, Citrus fruits and plants are also known by the Romance loanword *agrumes* literally “sour fruits”.

## Evolution

The large citrus fruit of today evolved originally from small, edible berries over millions of years. Citrus species began to diverge from a common ancestor about 15 million years ago, at about the same time that *Severinia* (such as the Chinese box orange) diverged from the same ancestor. About 7 million years ago, the ancestors of *Citrus* split into the main genus, *Citrus*, and the genus *Poncirus* (such as the trifoliolate orange), which is closely enough related that it can still be hybridized with all other citrus and used as rootstock. These estimates are made using genetic mapping of

plant chloroplasts. Wu *et al.* (2018) reported that the genus *Citrus* first evolved in the foothills of the Himalayas, in the area of Assam (India), western Yunnan (China), and northern Myanmar.

The citrus fruit list of Assam covering the innumerable citrus fruits such as mandarin, lime, lemon, grapefruit, sweet orange pummelo which are indigenous fruit of Assam. All those citrus fruits are known for their tangy flavors and combination of sweet-sour aromas, usually they are juicy and the juice contains the main acidic component with characteristic sharp flavor and have great potential in improvement of human health. Among various types of citrus grown in Assam the most commercially important fruits are mandarin (*Citrus reticulata* Blanco), sweet orange (*Citrus sinensis* Osbeck) and Assam lemon (*Assam limon*), lime (*Citrus aurantiifolia* (Christm.) Many diversified products such as pickles, squash, fruit juice, orange peel powder, candy, concentrated juice, essential ingredients for beverages, confectioneries, cosmetics, aromas and fragrances, aromatic oils and food essences can be prepared from those citrus fruits. Besides these different indigenous sub-varieties of citrus product available in the region are- *hati nemu*, *jara tega*, *bor tenga*, *rabab tenga*, *kazi nemu*, *gul nemu*, *bira jora*, *bonjora*, *holong tenga*, *gandharaj*, *mitha chakala*, *sapai*, *sumathira tenga* which can be used for preparation of different value-added citrus products.

Considering the importance of valuable citrus wealth for human health this study was conducted with the following objectives-

- > To collect traditional citrus fruits scattered in the state and nearby states through Citrus Research Station, AAU, Tinsukia.
- > Fruit Characteristic / Quality analysis of collected citrus fruits.
- > Study the nutritional status of those fruits.

## Methodology

Citrus fruits available in the state were collected and the plants are maintained carefully in the orchard of the Citrus Research Station. Traditionally available fruit bearing plants are species of *Citrus* of Rutaceae family are-

- > Khasi Mandarin (*Citrus reticulata* Blanco)
- > Sweet orange (*Citrus sinensis* Osback)
- > Mitha chakala (*Citrus sinensis*)
- > Lemon (*Citrus limon*)
- > Lime (*Citrus aurantiifolia*. Christm.)
- > Grape fruit (*Citrus paradisi*. Macf.)
- > Pummelo (*Citrus grandish*. Osback)
- > Citron (*Citrus medica*. L.)

### Review of plant profile available in Assam (Citrus Research Station)

*Khasi mandarin (Citrus reticulata Blanco)*: Mandarin locally known as orange is the most important citrus fruit of north east India as well as Assam. Mandarin is known for its color, quality, sugar contents, acid blend and self-life and its commercial value. Among the Citrus fruits, Khasi mandarin covering an area of 14.95 thousand ha, and production of 203.72 thousand metric tons in Assam (Anonymous 2018), whereas it occupies 1.47 thousand ha area and 24.37 thousand metric tons production in Tinsukia with highest productivity of 15.8 t ha<sup>-1</sup> (Anonymous, 2018).

Tinsukia district of Assam is known as Mandarin growing area whereas the four districts of BTAD, Kokrajhar district provides a suitable agro-climatic condition for large-scale citrus cultivation which is bounded by Bhutan in North, Dhubri district in South, Bongaigaon and Chirang district in East and West



Fig. 1. Khasi mandarin.

Bengal in West Citrus Research Station, Tinsukia, Assam Agricultural University developed four varieties of mandarin known as CRS-1, CRS-2, CRS-3, CRS-4, CRS-5, CRS-6, CRS-7, CRS-8. Among them CRS-4 is found to be the best type of mandarin in respect of its growth, yield attributes and quality parameter (Fig. 1, Table 1).

Fruit depressed globe, 5-8 cm diameter, contain tengerin, sweet and juicy, orange in colour, seed poly-embryonic. It contains vitamin C, like glucoside, hesperidin mostly (75-80%) present in the rind, rag and pulp.

The health benefits of oranges are well known for centuries. The oranges are not just known for its high vitamin C content; these are also a good source of beta-carotene, a powerful antioxidant to check free radical damage, magnesium for blood pressure, potassium for cardio vascular health and thiamin for converting food to energy. It is also rich in dietary fiber and contains foliates, niacin, pantothenic acid, pyridoxine, riboflavin, vitamins A, E and K, phyto-nutrients.

### Use of Mandarin:

- > The dried peel is used for abdominal swelling, to increase digestion, and to reduce phlegm, and its various parts are used to cure cutaneous problem, hemiplegia, snake bite, fever, loss of taste, chronic rheumatism, stomach ache, menorrhagia, splenomegaly, edema and cardiac diseases, bronchitis and asthma.
- > Seeds are traditionally used for the treatment of infectious diseases, frequent, urination, a major symptom of urinary tract infection, as well as inflammation of the breast and scrotum.
- > Pectin found in oranges is a dietary fiber reported to reduce the serum cholesterol, hypercholesterolemia and promote the excretion of fats, bile acid, cholesterol and possess growth suppression of prostate cancer cell.
- > Citrus fruit extracts represent an excellent candidate for nutraceuticals and functional foods geared towards the management of diabetes, cardiovascular diseases and cancer.
- > The infusion of immature fruit is used for the treatment of stomach and intestinal problems.

**Table 1.** Fruit characters.

Sl. No.	Characters	Khasi	Sweet orange	Mitha chakala	Assam lemon	Rough lemon	Hati nemu	Grape fruit	Pummelo
1.	Fruit length (cm)	5.5 cm	5.9 cm	6.4 cm	4.5 cm	4.5 cm	4.5 cm	8.0 - 12 cm	8.0-14 cm
2.	Fruit diameter(cm)	5.9 cm	6.2 cm	7.3cm	3.7 cm	3.7 cm	3.7 cm	9 -10.5cm	9 -12.5cm
3.	Fruit weight (g)	134 g	175 g	140g	50 g	95 g	50 g	310 - 700 g	500-900 g
4.	Number of segments	10-14	14-15	12	10-14	10	12	10-14	14-19
5.	Fruit shape	Concave	Spheroid	Spheroid	Spheroid	Spheroid	Spheroid	Ellipsoid	Ellipsoid
6.	Shape of fruit base	Truncate	Convex	Truncate	Convex	Convex	Convex	Convex concave collard	Convex concave collard
7.	Shape of fruit apex	Rounded	Rounded	Rounded	Rounded	Rounded	Rounded	Rounded depressed	Rounded depressed
8.	Pulp (flesh) color	Orange	Light yellow to orange	Light yellow green	Colorless to Light green	Colorless to Light green	Colorless to Light green	Colorless	Pink light, red, colorless
9	Juice content/fruit (ml)	48	41	45	39	36	17	33	38
10	TSS(°Brix)	11	8	3	2	3	2	6	9
11	Acidity (%)	0.38	0.45	0.56	1.2	1.47	1.08	0.47	0.5

Undoubtedly, in present context, the Khasi mandarin has enormous potential for its commercialization.

#### Sweet orange (*Citrus sinensis* Osbeck)

Sweet oranges locally known as Mousumbi are hybrid between pummelo and mandarin (Fig. 2, Table 1). Fruits ripen in the month of November seeds varies from 20-25 per fruit. The color of rind at ripening turns light yellow. The flavor is sweet and mild when drink fresh in juice, the juice is acidless. Sweet Oranges are good for distance transportation. Among 14 varieties of Sweet oranges tested, Soh-niang riang has been found highest yielder of fruits (450 Nos/plant)

*Uses of sweet orange:* The fruit is used as table purpose, juice, squash. It is an appetizer and blood purifier. The fruit rind is carminative and act as tonic. The dried peel is used in the treatment of anorexia, colds, coughs.

#### Mitha chakala (*Citrus sinensis*)

Tree is spreading with light green foliage. Stout thorns present on twinges. Fruit medium globose to ellipsoid. Skin smooth with distinct aroma. Juice abundant, non-acidic and insipid. Seed 5-6 per fruit. Skin smooth with distinct aroma(Fig, 3, Table 1).

Juice abundantly. The fruit is appetizer and blood purifier. Fruits ripens in the month of September.

The fruit rind is carminative. The dried peel is used in the treatment of anorexia, colds, coughs etc.

#### Assam lemon (*Assam limon*)

Assam lemon regionally known as 'Kazi Nemu' is one of the most important seedless fruits with unique flavor. The lemon, extensively grown in the north-eastern parts of India. It is a dwarf cultivar suitable for high density planting. This is a popular variety of lemon and is resistant to vagaries of climate and it can be grown commercially in subtropical humid climate of NE states. Period of fruiting is June to November. The fruits of variety are oblong, medium large in size, highly juicy and can be used commercially for preparation of juice, cordial (Fig 4. Table 1).



**Fig. 2.** Sweet orange .

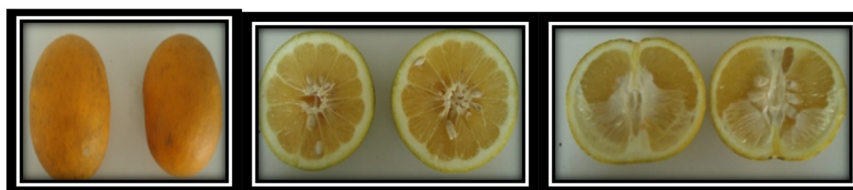


Fig. 3. Mitha chakala.

Assam lemon produces two distinct flowering flush in a year viz. Spring (Feb- March) and autumn (Sept-Oct) besides sparse flowering round the year. Fruits should be harvested when they attain full size, develop attractive green to little yellow color. Fruits are ready for harvesting during the month of June to July and December to January from 3<sup>rd</sup> year-old tree about 40-50 fruits may be harvested.

**Use of Assam lemon :** It is used for culinary, beverages, industrial and medicinal uses. Citrus Research Station, Tinsukia, Assam Agricultural University developed four other varieties of lemon known as CRS-AL-1, CRS-AL-2, CRS-AL-3, CRS-AL-4. Lastly in the year 2019, Assam lemon fruit is able to get Geographical Indication (GI) in the year 2019.

**Rough lemon/Gul Nemu (*Citrus jambhiri*):**

Rough lemon or gul nemu is the traditional fruit of Assam. Trees of rough lemon turns out to be high yielder, but having poor fruit quality though the flavor is unique and very popular among Assamese people. It is tolerant to tristeza and fairly tolerant to saline and calcareous soils, but susceptible to foot rot and blight. It is hardy and used as rootstock (Fig 5, Table 1

**Uses of Rough Lemon:** Juice is used as an ingredient in a variety of dishes. The peel is used as a facial cleanser. Daily consumption of lemonade decreases the rate of kidney stone formation. It is more helpful to abase people.

**Grape fruit (*Citrus paradise*)**

It is traditional variety of citrus fruit available in Assam. The fruit is round in shape, bigger than mandarin. It requires shorter day and cooler temperature in winter for production of fruits. The tree bear fruit in cluster form 3-4 number in the same branch. Grape fruits produced to meet the requirement of citrus fruits for sugar patients. Another form of grape fruit known as tula tenga is also popular in Assam (Fig. 6, Table 1). It is often eaten as a dessert, either raw or sprinkled with sugar. The peel is used to make marmalade may be candied, or dipped in chocolate. Peel is also used as insect repellent. Fruit juice can be used to lower blood pressure.

**Uses of grape fruits :**

- \* It is often eaten as a dessert, either raw or sprinkled with sugar.



Fig. 4. Assam lemon.

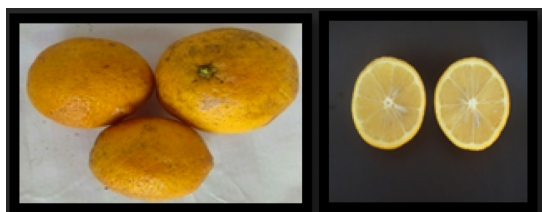


Fig. 5. Rough lemon.



Fig. 6. Tula tenga.

- \* The peel is used to make marmalade, may be candied, or dipped in chocolate
- \* Peel is also used as insect repellent
- \* Fruit juice can be used to lower blood pressure

### Pummelo (*Citrus grandish*)

Pummelo is the largest citrus fruit and very much similar in appearance to a large grapefruit (Fig. 7a, Table 1). It is progenitor of the grapefruit the tangelo among other modern citrus hybrids. North-eastern Himalayan region and foothills of the central and western Himalayan tracts in India is considered to be one of the important centers of origin for pummelo. The fruit is like a large globe or pear shape. 10-30 cm in diameter. Different sub-varieties of pummelo with large red, pink flash or white flash fruit are available in Assam. Juice vesicle pink colored variety called jumbura are also found in some districts of Assam.

*Sour pummelo (Citrus megaloxycarpa)* : Sour pummelo locally known as **Bartenga** (Fig. 7b, Table 2) used as fresh fruit and sometimes used as souring agent for pickles.

The fruit pummelo is also a rich source of nutrients and fibers. Used for making marmalade and other citrus products like fruit juice. It reported to show distinct functionality as antioxidant and anti-obesity.

### Citron(*Citrus medica* L.)

#### *Holong tenga (Citrus medica)*

It is unique variety of found in Assam. The size is big and outer covering of the fruit is very rough because of which fruit is known as Holong tenga (Fig. 8a, Table 2).

*Uses of Holong Tenga* : The fruit is used for pickle preparation. Peel is used in cakes, puddings, biscuits and candy and also can eaten as raw fruit. Dried fruits act as moth repellents.

#### *Ada jamir (Citrus. assamensis):*

It is another round fruit variety of citrus traditionally available in Kokrajhar district of Assam possess similar quality of other citrus fruits (Fig. 8b, Table 2).



Fig. 7a. Pummalo (Rabab tenga) (white, pink, red), Fig. 7b. Sour pummalo.

**Hati nemu (*Citrus jambhiri* Lush)**

Hati nemu is a big size of lemon indigenous to Assam (Fig. 9, Table 1). Juice is used as an ingredient in a variety of dishes. The peel is used as a facial cleanser. Daily consumption of lemonade decreases the rate of kidney stone formation. It is hardy and used as rootstock.

**Sinduri lemon (*Citrus jambhiri*):**

Indigenous Assamese lemon with red colored flesh (Fig. 10, Table 2). Average height of a plant is 3.89 m & weight of a lemon is 133 g. It contains Vit-C.

**King orange/Jeneru tenga (*Citrus nobilis* Lorn)**

Semi-domesticated variety of citrus locally called jeneru tenga (king orange). Constant research is going on this particular fruit in Citrus Research Station Assam (Fig. 11, Table 2). It is known to us that king orange fruit is used for culinary purpose and the peel

is used in cosmetics industry.

**Citrus limon (*Elachi nemu*):**

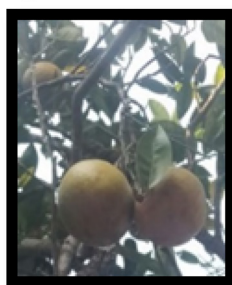
It is indigenous fruit of Assam. A small plant or a shrub, 8-10 ft high drooping habit, moderately branched, foliage open, thorny, fruiting season mainly from July-sept (Fig 12, Table 2). Vitamin C content of the fruit can more easily be retained by the body than from other citrus fruits. Lemon oil is used in the perfume industry and as insect repellent. Fruits have distinct cardamom flavor and mainly found in Karimgang district of Assam. The plant is available in Citrus Research Center, Tinsukia of Assam Agricultural University.

**Gandharaj (*Citrus medica*)**

A huge size of lemon with the fragrance of sublime never yield much juice but overpowering scent that travels to other rooms and invites one to the dining table. Gandharaj had the maximum fruit weight (1316 g) and size, while lowest fruit weight (16.2 g) and size



a



b

Fig. 8a. Holong tenga. Fig. 8b. Ada jamir.



Fig. 9. Hati nemu.

(2.26 × 3.4 cm) (Fig. 13, Table 2).

**Uses of Ghandharaj:** Fruit is used for pickle preparation. Peel is used in cakes, puddings, biscuits and candy. The peel is also eaten raw. Dried fruits act as moth repellents. Fruits have a unique flavor.

#### Jara tega (*Citrus medica*)

There are three different types of jara tenga in Assam they are, Bira jara, pati jara, bonjara ( Figs. 14 a, 14 b, 14 c, Table 2) . Fruit jacket is thick, soft and edible. These fruit is used for pickle preparation, peel is used in cakes, puddings, biscuits and candy. The peel is also eaten raw, dried fruits act as moth repellents.

#### Quality parameter of jara tenga or citron

In traditional medicine, ripe fruits were used in sore

throat, cough, asthma, thirst, hiccough, earache, nausea, vomiting, anti scorbutic, stomachic, tonic, stimulant, expellant of poison, correct fetid breath; distilled water of the fruit was sedative, fruits and seeds were cardiac tonic and used in palpitation, fruit decoction is analgesic. Roots, flowers, seeds, peels and leaves were used in many ailments. The fruit wrapped in cloth was used to protect clothes from moths indicating its insect repellent activity. In ancient literature, citron was mentioned as an antidote for various kinds of poison.

**Uses of this fruit variety :** Fruit is used for pickle preparation. Peel is used in cakes, puddings, biscuits and candy .The peel is also eaten raw. Dried fruits act as moth repellents

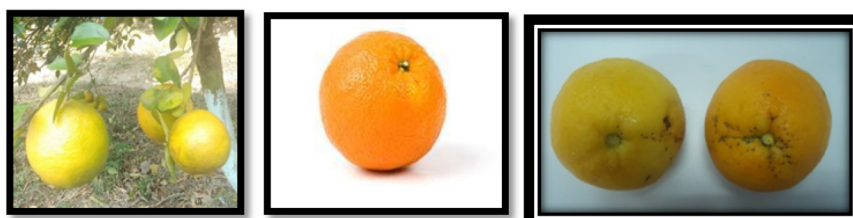


Fig. 10. Sinduri lemon.



**Table 2.** Fruit characters.

Sl. No.	Characters	Sour pummelo	Holong tenga	Ada jamir	Sinduri lemon	Elachi nemu	Gandharaj	Jara tenga	Galgal
1.	Fruit length (cm)	14.5 cm	4.5 cm	8.0 cm	4.5 cm	4.5 cm	12.5 cm	13.8 cm	8.2 cm
2.	Fruit diameter(cm)	13.7 cm	3.7 cm	9.2 cm	3.7 cm	3.7 cm	9.5cm	12.6 cm	10.6 cm
3.	Fruit weight	1.1kg	50 g	150g	50 g	50 g	450 g	560 g	100 g
4.	Number of segments	15-18	10-14	10-14	9-10	10-14	9	9-10	10
5.	Fruit shape	Spheroid	Spheroid	Spheroid	Spheroid	Spheroid	Ellipsoid	Spheroid	Spheroid
6.	Shape of fruit base	Convex	Convex	Convex	Convex	Convex	Convex	Convex	Convex
7.	Shape of fruit apex	Truncate	Rounded	Mammiform	Rounded	Rounded	Mammiform	Rounded	Truncate
8.	Pulp (flesh) color	colorless	Colorless to light green	Colorless to light green	Colorless to light green	Colorless to light green	Colorless to light green	Colorless to light green	Colorless to light green
9	Juice content/fruit (ml)	39	39	39	26	39	39	46	25
10	TSS (°Brix)	4	2	3	3	4	2	1	2
11	Acidity	1.6	2.6%	0.68	0.91	1.6	1.6	1.34	1.06

### Galgal (*Citrus pseudolimon*)

Fruit is medium is size and oval in shape. Peel yellow smooth and glossy. Prevalent in the foot. Hills of Himalayas in the north East India specially in Assam.

Juice is very acidic (5-6% acidity), with 5-8 seeds per fruit. It ripens in November-December. Galgal or Citron is a large fragrant citrus fruit, widely used in Indian cuisine as well as traditional medicines (Fig. 15, Table 2).

### Importance

Citrus contained nutrients and phytochemicals that were beneficial for health. Citrus fruits and juices contain a wide range of substances including carbohydrates, fiber, vitamin C, potassium, folate, calcium, thiamine, niacin, vitamin B6, vitamin A, phosphorus, magnesium, copper, riboflavin, pantothenic acid and a variety of phytochemicals. These substances are necessary for proper functioning of the body but some confer additional protection against chronic disease over and basic nutrition. Citrus fruits are also

low in fat and in overall dietary energy – a major consideration given the increasing rate of obesity in both adults and children. One review of preliminary research on diets indicated that consuming citrus fruits was associated with a 10% reduction of risk for developing breast cancer. Citrus juice particularly grapefruit juice contains enzymes particularly P-45 enzyme which considered a natural tool for obesity control and contained a range of different protein which burns human fats. The lemon fruits have numerous bioactive compounds, and the juice of lemon possesses more than 200 compounds which involve regulators of the human body. However, lemon and sweet orange juices have a wide range of bioactive compounds controlled about 60-70% of liver diseases



**Fig. 11.** King orange/ Jeneru tenga.



**Fig. 12.** Elachi nemu.



Fig. 13. Gandharaj.



Fig. 14a. Bon jara

Fig:14b. Pati jara

Fig. 14c. .Bira jara

through control lipids.

Citrus fruits also contained many phytochemicals including essential oils, alkaloids, flavonoids, coumarins, psoralens and carotenoids. The previous pharmacological studies revealed that citrus fruits possessed antimicrobial, anthelmintic, insect repellent, antioxidant, anticancer, cardiovascular, central nervous, anti-inflammatory, analgesic, antidiabetic, reproductive, gastrointestinal, immunological, respiratory and many other pharmacological effects (Abolotta 2019).

#### Diversified products prepared from different Citrus fruits

- (1) Pickles,
- (2) Squash: It refers to the processed juice extracted from the lemon to which preservatives certain other edible ingredients are to be added for better flavor and taste,
- (3) Fruit juice: lemon juice, orange juice, pummelo juice

- (4) Orange peel Powder,
- (5) Candy, concentrated juice,
- (6) Essential ingredients for beverages, confectioneries, cosmetics, aromas & fragrances,
- (7) Aromatic oils and food essences.

#### CONCLUSION

Among the citrus crops available in northeastern region, Khasi mandarin is the most economically important one and plays a vital role in the socio-economic



Fig. 15. Galgal.

conomic development of the people in this region. Khasi mandarin is well known for its quality, fruit color, unique sugar-acid blend and shelf life which make it the most popular citrus cultivar in northeastern region of the country. Assam lemon is now becoming a very marketable product due to its unique quality and attractive flavor which is now going to achieve Geographical Indication (GI). Rare varieties like *Citrus nobilis* (Jeneru tenga) and *Citrus limon* (Elachi lebu) are required to be conserved immediately by adopting adequate strategies. Considering the importance of valuable citrus wealth of the region the emphasis has been laid on the collection and maintenance of the traditional citrus species scattered in the state and nearby states through Citrus Research Station, AAU, Tinsukia. The center also provides opportunity to its stakeholders to reflect the sustainable use of citrus

resources and ensure livelihood security of citrus grower of Assam.

#### REFERENCES

- Abolotta NF (2019) Nutritional benefit of Citrus Fruit. American journal of bio-Medical Science and Research. Review article ISSN-2642-1742, 303-306.
- Anonymous (2018) Horticultural Statistics at a glance, Government of India, Ministry of Agriculture and Farmers Welfare, Department of Agriculture, Cooperation and Farmers Welfare. Horticulture Statistics Division.
- Velasco R, Licciardello C (2014) A generalology of the citrus family. *Nature Biotechnol* 32(7) : 640-642.
- Wu GA, Terol J, Ibanez V, Lopez Garcia A, Perez Roman E, Borreda C, Domingo C, Tadeo FR, Carbonell Caballero J, Alonso R, Curk F, Du D, Ollitrault P, Roose ML, Dopazo J, Gmitter FG, Rokhsar DS, Talon M (2018) Genomics of the origin and evolution of citrus. *Nature* 554(7692): 311-316.