

CHAPTER 3

REVIEW OF LITERATURE

3.1: Review of literature on *Phyllanthus acidus* (L)Skeels

3.1.1 The genus *Phyllanthus*:

Phyllanthus acidus (L)Skeels belongs to the botanical family *Phyllanthaceae*. *Phyllanthus*, the generic name is derived from the Greek 'phullon'-leaf and 'anthos'-flowers from the fact that members of this genus have flowers in dense clusters in leaf axils. *Phyllanthus* is the largest genus in the family *Phyllanthaceae*. *Phyllanthus* has a remarkable diversity of growth forms including annual and perennial herbaceous, arborescent, climbing, floating aquatic, pachycaulous, and phyllocladous. *Phyllanthus acidus* is an annual erect little branched herb, 10-50 cm high.

(www.tropilab.com/phyllanthus-acidus.htm)

3.1.2 Origin and Distribution:

This species is believed to have originated in Madagascar and to have been carried to the East Indies. It is more commonly grown in Indonesia, South Vietnam and Laos, and frequently in northern Malaya, Myanmar, Philippines, Thailand, Colombia, Indonesia and in India in home gardens (*Prasad, 1986*). The tree is a familiar one in villages and on farms in Guam, where the fruit is favored by children, and occurs in Hawaii and some other Pacific Islands. It was introduced into Jamaica from Timor in 1793 and has been casually spread throughout the Caribbean islands and to the Bahamas and Bermuda. It has long been naturalized in southern Mexico and the lowlands of

Central America, and is occasionally grown in Colombia, Venezuela, Surinam, Peru and Brazil. Formerly an escape from cultivation in South Florida, there are now only scattered specimens remaining here as curiosities (*Morton et al., 1987*).

3.1.3 Cultivation:

The Otaheite gooseberry prefers moist soil. Although it usually grows from seeds, the tree can also be multiplied from budding, greenwood cuttings or air-layers. It bears two crops per year in India, one in April-May and the other in August-September. Elsewhere, it is mainly harvested in January.

Otaheiti gooseberry grows well in the tropics at low and medium altitudes in places with a short or prolonged dry season. The tree prefers hot, humid tropical lowlands. In north-eastern Brazil, the tree has been found in coastal forest and in Southeast Asia it is cultivated on humid sites, upto 1000m altitude (*Morton et al., 1987*).

3.1.4 Uses of *Phyllanthus acidus* (L)Skeel as food:

The flesh must be sliced from the stone, or the fruits must be cooked and then pressed through a sieve to separate the stones. The sliced raw flesh can be covered with sugar and let stand in the refrigerator for a day. The sugar draws out the juice and modifies the acidity so that the flesh and juice can be used as a sauce. If left longer, the flesh shrivels and the juice can be strained off as clear, pale-yellow syrup. In Indonesia, the tart flesh is added to many dishes as a flavoring agent. The juice is used in cold drinks in the Philippines. Bahamian cooks soak the whole fruits in salty water overnight to reduce the acidity, then rinse, boil once or twice, discarding the water,

then boil with equal amount of sugar until thick, and put up in sterilized jars without removing seeds. The repeated processing results in considerable loss of flavor. Fully ripe fruits do not really require this treatment. If cooked long enough with plenty of sugar, the fruit and juice turn ruby-red and yield a sprightly jelly. In Malaya, the ripe or unripe Otaheite gooseberry is cooked and served as a relish, or made into a thick sirup or sweet preserve. It is also combined with other fruits in making chutney and jam because it helps these products to "set". Often, the fruits are candied, or pickled in salt (*Morton et al., 1987*).

In the Philippines, they are used to make vinegar. The young leaves are cooked as greens in India and Indonesia. The root bark has limited use in tanning in India. In India, the fruits are taken as liver tonic, to enrich the blood. The syrup is prescribed as a stomachic; and the seeds are cathartic. The leaves, with added pepper, are poulticed on sciatica, lumbago or rheumatism. A decoction of the leaves is given as a sudorific. Because of the mucilaginous nature of the leaves, they are taken as a demulcent in cases of gonorrhoea

(http://en.wikipedia.org/wiki/Phyllanthus_acidus, last accessed on 19-May-12)

The root is drastically purgative and regarded as toxic in Malaya but is boiled and the steam inhaled to relieve coughs and headache. The root infusion is taken in very small doses to alleviate asthma. Externally, the root is used to treat psoriasis of the soles of feet. The juice of the root bark, which contains saponin, gallic acid, tannin and a crystalline substance which may be lupeol, has been employed in criminal poisoning. The acrid latex of various parts of the tree is emetic

and purgative. The juice can be used in beverage, or the fruit pickled in sugar. When cooked with plenty of sugar, the fruit turns ruby red and produces a kind of jelly, which is called *mútchùm ruột* in Vietnamese. It can also be salted. The fruit is called "Grosella" in Puerto Rico. Since the fruit is tart, it is often eaten in "Dulce de Grosellas". The preparation of this dessert consists in simmering the berries with sugar until they are soft and turn red in color. The liquid from the cooking is also used as a beverage (*Morton et al., 1987*).

3.1.5 The food value of *Phyllanthus acidus* (L) Skeels:

The food value of the edible portion of *Phyllanthus acidus* (L) Skeels (per 100gm) is shown in the table below Table 3.1.5(a) (*Morton et al., 1987*).

Table 3.1.5(a): Food value per 100 g of Edible Portion of *Phyllanthus acidus* (L)Skeels.

Moisture	91.9 g
Protein	0.155 g
Fat	0.52 g
Fiber	0.8 g
Ash	0.51 g
Calcium	5.4 mg
Phosphorus	17.9 mg
Iron	3.25 mg
Carotene	0.019 mg
Thiamine	0.025 mg
Riboflavin	0.013 mg
Niacin	0.292 mg
Ascorbic Acid	4.6 mg

3.1.6 Other uses of *Phyllanthus acidus* (L) Skeels:

The root bark is used in India as tanning agent (*Rizk, 1987*). The tree is used as fuel wood. The wood is fairly hard, strong, tough and durable if seasoned. The seasoned wood is used for making utensils and other small objects (*Mackeen et al., 1997, Rizk, 1987*).

3.1.7 Ethnomedicinal utility of *Phyllanthus acidus* (L) Skeels:

Exhaustive literature survey showed that the plant is a good remedy for different types of ailments like emetic and purgative (*Lemmens et al., 1999*), hypertension and respiratory (*Sausa et al., 2007*), hepatoprotective (*Lee et al., 2006*), anti-diabetics (*Banik et al., 2010.*), antinociceptive (*Catapan et al., 2000*). Poisoning, coughs, asthma and bronchitis, poulticing and soles, cathartic (*Caius et al., 2003*), rehabilitation (*Vongvanich et al., 2000*), addiction (*Mahidol et al., 2002*), liver tonic, laxative, urticaria, eruptions & bronchial catarrh (*Prasad, D., 1986*) sciatica, lumbago or rheumatism, sudorific & gonorrhoea, skin disorders (*Morton et al., 1987*) .

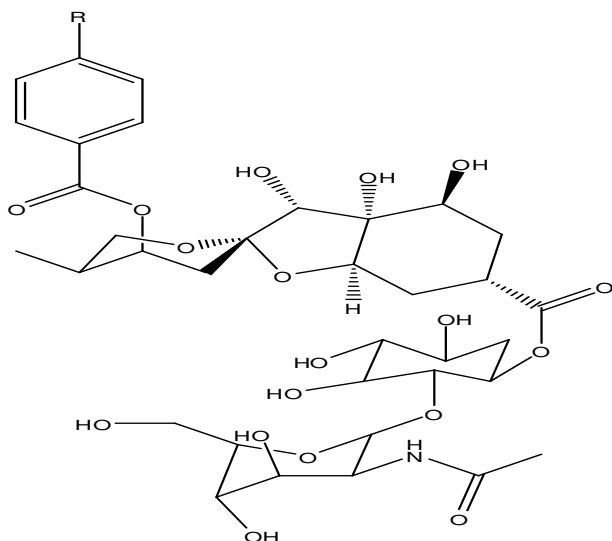
3.1.7 The scientific work carried with *phyllanthus acidus* (L) skeels.

- i) Methanolic extracts of 79 Malaysian plants were assessed for antinematodal activity against *Bursaphelenchus xylophilus*. *Phyllanthus acidus* showed strong antinematodal activity (*Muhammad and Mackeen, 1997*).
- ii) Removal of Brill Red 5B from an aqueous solution using *Cicca acidia* biomass (*Karthik et al., 2009*).

- iii) Effect of Auxin and Cytokinin on Phyllanthusol A Production by Callus Cultures of *Phyllanthus acidus* Skeels (**Duangporn and Siripongm, 2009**).
- iv) Rat fed with the extracts from *P.acidus* showed a hepatoprotective effect against acute liver damage induced by carbon tetrachloride (**Lee et al., 2006**).
- v) Methanolic extracts of *P.acidus* possess strong antibacterial activity *in vitro* (**Melendez et al., 2006**).
- vi) An extract from the medicinal plant *Phyllanthus acidus* and its isolated compounds induce airway chloride secretion: A potential treatment for cystic fibrosis (**Sousa et al., 2007**).
- vii) Selective Antimicrobial properties of *Phyllanthus acidus* leaf extract against *Candida albicans*, *Escherichia coli* and *Staphylococcus aureus* using Stokes Disc diffusion, Well diffusion, Streak plate and a dilution method (**Jagessar et al., 2008**).
- viii) Antibacterial properties of tropical plants from Puerto Rico. In the study, *Phyllanthus acidus* was one of the plants that showed the highest antibacterial activity against *E-coli* and *Staphylococcus aureus* (**Melendez et al., 2006**).

3.1.8 Compounds isolated from *phyllanthus acidus* (L) skeels:

Phyllanthusols A and B, Aglycon. Saccharide has been isolated from the MeOH extract of the roots of *Phyllanthus acidus*.



1. Phyllanthusol A, R = OH.

2. Phyllanthusol B, R = H

Phyllanthusol A and B has been isolated from *Phyllanthus acidus*, has been proposed as possible antitumor agent (*Mahidol et al., 2002*). Phyllanthusol A and B have attracted considerable attention as it exhibits cytotoxicity against BC and KB cell lines in vitro.

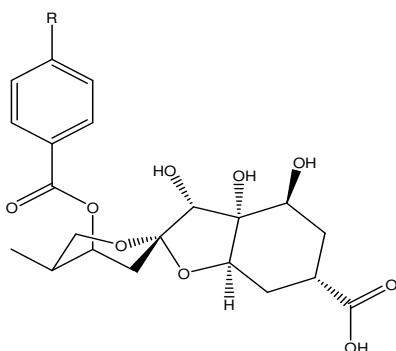


Fig:-The norbisabolane aglycon

The norbisabolane skeleton is rare in nature.

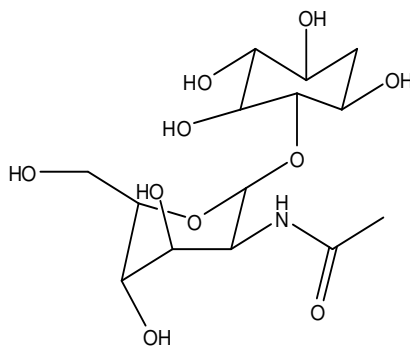


Fig: - The Saccharide Structure

The norbisabolane aglycon and the Saccharide showed no cytotoxicity

3.2: Review of literature on *Croton caudatus* Geiseler

3.2.1. The genus *Croton*:

The genus *Croton* belongs to the flowering plant family Euphorbiaceae which include 313 genera and over 8100 species that are cosmopolitan in distribution. *Croton* is a “giant genus,” with 1223 species accepted in The World Checklist and Bibliography of Euphorbiaceae by *Govaerts et al., (2000)*. But others put the number of species under *Croton* at 1797 starting with *Croton abaitensis* (1st species) and ending in *Croton zeylanicus* (1797th species). All the species under *Croton* are herbs, shrubs, trees and occasionally lianas (climbers) that are ecologically prominent and important elements of secondary vegetation in the tropics and subtropics worldwide (*Webster, 1993, Govaerts et al., 2000*).

Croton belongs to subfamily Crotonoideae, which is characterized by mostly lactiferous taxa having pollen with an unusual (crotonoid) exine pattern of triangular supratectal elements attached to a network of muri with short columellae (*Nowicke, 1994*). Most of the

subfamily, including Croton, is also characterized by inaperturate pollen, which is an unusual condition in the angiosperms. The subfamily has been divided into as many as 12 types (*Webster, 2001, 1994, Radcliffe-Smith, 2001*).

3.2.2 Origin and Distribution:

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The plant is native to Southern China (SW Yunnan) and southward to Sumatra, Java, Christmas Islands, Borneo, Philippines,

Bangladesh, Bhutan, Brunei, Cambodia, Laos, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Thailand, Singapore, Sri Lanka, Vietnam and North Australia and tropic and subtropic worldwide (*Webster, 1993, Govaerts et al., 2000*).

In India the plant is reported from the north eastern states like Assam, Meghalaya, Arunachal Pradesh and Sikkim. It is also reported from Western Ghats, West Bengal, Orissa and Manipur and grows wild in Saikot area of Churachandpur District and Jiribam sub-division of Imphal East District (*Deb, 1961, Maheshwari, 1996, 2000*).

3.2.3 Cultivated:

Croton caudatus Geiseler is not yet cultivated in commercial as it is a wild herb but is ecologically prominent and important elements of secondary vegetation in the tropics and subtropics worldwide (*Webster, 1993, Govaerts et al., 2000*).

3.2.4 Ethnomedicinal utility of *Croton caudatus* Geiseler:

Exhaustive literature survey showed the plant is a good remedy for different types of ailments like malaria, ardent fever, convulsions, rheumatic arthritis, and numbness etc.

- i) In Assam leaves used in urinary troubles (*assamplants.sulekha.com/bolg /post/ 2011/05/.../01/ comments.htm/*). The plant is known as Bonmahudi and the barks and roots are used as antidysentric and in relieving pains (*Jain and Rao, 1977*).
- ii) In Tirap District of Arunachal Pradesh, the leaves are used in liver complaints and the poultice in trauma and injury, fruits are used for treatment of vomiting, root extracts drank for the treatment for

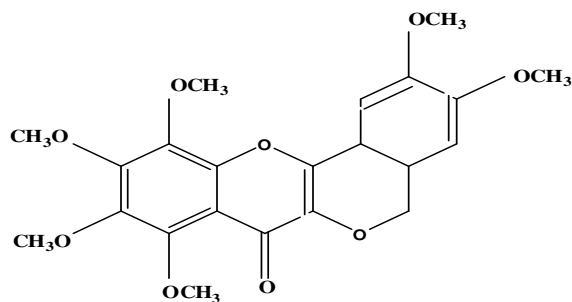
- the treatment of dysentery, the decoction of the leaves and roots are used in cold and cough. (*Rawat and Choudhury, 1998, Maikhuri and Ramakrishnan, 1992*). In Tirap District of Arunachal Pradesh, the leaves are used in liver complaints and the poultice in trauma and injury. In the Subansiri District of Arunachal Pradesh, the decoction of the leaves and roots are used in cold and cough (*Dutta and Ghosh, 1984, Bhuyan, 1999, 2000*).
- iii) *Croton caudatus* Geiseler. Var. *tomentosus* Hook. is a traditional Dai nationalistic medicine, the stems and leaves of which have been used for the treatment of malaria, ardent fever, convulsions, rheumatic arthritis, and numbness (*Jiangsu, 1975*)
 - iv) Leaf and shoot extract used for malaria and cholera (*Rao, 1979, 1981, Kumar et al., 1980, Puspangadan and Atal, 1984*).
 - v) The root and leaf paste is applied topically for one week in arthritis, and for paralysis, for about a month or more (*Yusuf et al., 2005, Yusuf et al., 2006*).
 - vi) According to *Kirtikar and Basu (1935)* and *Caius (2003)*, the leaves are applied as a poultice to sprains.
 - vii) *Burkil and Haniff (2002)* reported that a decoction of the root causes purging and so it is administered for constipation; and as purging may help fevers, it is used for them also. Cold are similarly treated.
 - viii) Leaves are claimed to have anticancer properties and the people of Manipur region used to take the juice of leaves (*groups .yahoo.com, 458*).
 - ix) In China, the stem and leaves which have been used for the treatment of malaria, ardent fever, convulsions, rheumatic,

arthritis and numbness. It also forms an important part of Dai medicine (*Jaingsu, 1975*).

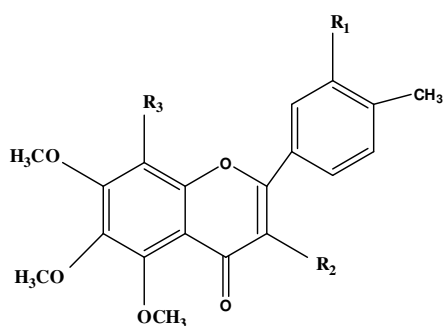
- x) In the Balphakram Wild Life Sanctuary area of Meghalaya (Garo Hills), the decoction of the roots is used in malaria (*Rao and Neogi, 1980, Rao, 1981, Kumar et al., 1980*).
- xi) In the Jiribam sub-division of Manipur the Meitei community used the plant in the treatment of ringworms. It is also used in treating wounds of cattle. The plant has curative medicinal qualities for cancer, diabetes, malaria and indigestion, etc. Leaves are claimed to have anticancer properties and people from Manipur region use to take juice of leaves. ([http://groups.yahoo.com /group/thangkhal/message/458](http://groups.yahoo.com/group/thangkhal/message/458))

3.2.5: Scientific work carried with *Croton caudatus* Geiseler

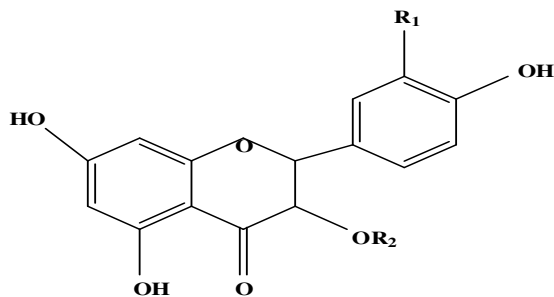
- i) In vitro antioxidant activity and Phenolic content of *Croton caudatus* Geiseler were determined by *Deore et al. (2009)*.
- ii) *Zou et al.*, isolated a new flavone, named crotoncaudatin (1), from the stems of *Croton caudatus* Geisel. var. *tomentosus* Hook., together with nine known analogues: 3,5,6,7,8,3',4'-heptamethoxyflavone (2), tangeretin (3), nobiletin (4), 5,6,7,4'-tetramethoxy-flavone (5), sinensetin (6), kaempferol (7), tiliroside (8), kaempferol-3-O-rutinoside (9) and rutin (10) by a combination of spectroscopic methods including HR-ESI-MS, ¹H-NMR, ¹³C-NMR, HMQC and HMBC spectra (*Zou et al., 2010*):



Cotoncaudatin (1) isolated from *Croton caudatus* Geiseler.



3, 5, 6, 7, 8, 3', 4'-heptamethoxyflavone **2** ($R_1=R_2=R_3=OCH_3$)
 Tangeretin **3** ($R_1=R_2=H, R_3=OCH_3$)
 Nobiletin **4** ($R_1=R_3=OCH_3, R_2=H$)
 5, 6, 7, 4'-tetramethoxy-flavone **5** ($R_1=R_2=R_3=H$)
 Sinensetin **6** ($R_1=OCH_3, R_2=R_3=H$)



Kaempferol **7** ($R_1=R_2=H$)
 Tiliroside **8** ($R_1=H, R_2=Glu-6-E-Courmatoyl$)
 Kaempferol-3-O-rutinoside **9** ($R_1=H, R_2=Rutinose$)
 Rutin **10** ($R_1=OH, R_2=Rutinose$)

3.2.6: Need Statement

The above cited literature shows that certain chemical and biological aspects of *Croton caudatus* Geiseler and *Phyllanthus acidus* (L)Skeels have been studied. We also intended to carry out the phytochemical and biological properties of these two selected medicinally important plants growing in Jiribam, Manipur and Silchar Assam, North-East India.

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