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A REVIEW ON A MIRACLE PLANT *ANNONA GLABRA* LINN

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ABSTRACT: Plants serve humans as primary sources for food, shelter, and medicines. So, understanding the plant's uses in treating diseases is very important for leading a healthier life. Our ancestors have used various plants as medicines, and there is a need to provide scientific evidence for the same. *Annona glabra* is one of the plants natives to Florida in the United States, the Caribbean, and central and west Africa. It is an invasive species in Sri Lanka and Australia, and it is also distributed in India. It is commonly called pond apple, alligator apple, or bob wood. These plants contain mostly flavonoids, glycosides, saponins, tannins, steroids, acidic compounds, and anthraquinones. Not much scientific support was given to the folklore claims of the plant, and some of its traditional uses have been investigated, including anti-leishmanial activity, anti-microbial activity, anti-cancer activity, anti-inflammatory activity, burn-healing properties, larvicidal efficacy, wine production, and anti-oxidant activity. This article is a review of research done on the plant *Annona glabra.* As a part of it, the taxonomy, common names, vernacular names, description, distribution, phytochemicals, and pharmacological activities have been discussed.

INTRODUCTION: Nature has been one of the main sources for the traditional medicine for thousands of years, and large number of modern drugs have been isolated from natural sources [1]. Plant-derived natural products have extremely high potential to developed as medicines. Traditional herbal medicine and its preparation are widely used in the developing and developed countries due to their natural origin and lesser side effects [2]. Utilizing natural products is considered to have safety, efficacy and quality [3].

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In medicinal history, so far, we have come across many medicinal plants used by our ancestors as their primary source for the treatment of various ailments. In consideration of their medicinal uses and phytochemicals, they were widely used in the traditional system of medicine like Ayurveda, Unani and Siddha, each of which had its own medicinal uses. Some of them are scientifically proven, and some are still to be prove [4].

One such plant is *Annona glabra*, belonging to the genus Annona and the family Annonaceae. It is a very large family of plants, comprising about 120 genera and more than 2000 species. These seem to be one of the least chemically as well as pharmacologically known families compared with other families. This family has economic importance due to its edible fruit and seed oils. Flowers and seeds of certain Annonaceae plants are

used in soap preparation, edible oil preparation, and perfumery products. Many members of this family are used in folk medicine to treat various types of tumours and cancers [5].

Annona glabra L., popularly known as Pond Apple, is a tropical fruit tree in the family Annonaceae. It is a natural introduction to the mangroves of southern Kerala and has widely spread along the backwaters. *A. glabra* is a small-woody tree that grows up to 3–12 m hight [1]. *A. glabra* is made up of small plants (shrubs or trees), is fruitful, has a wide geographic distribution, and is found on the banks of lakes and rivers [6]. The members of this family are rich sources of secondary metabolites with high biological activities. Phytochemical compounds of medicinal plants have received more attention in recent years due to their potential role in preventing many human diseases. Many active compounds have been found in *A. glabra*, mainly flavonoids, glycosides, saponins, tannins, steroids, acidic compounds, and anthraquinones. Recently, a novel class of bioactive compounds called annonaceous acetogenins has aroused tremendous interest [1]. *Annona* plants have several scientifically proven pharmacological effects, such as anticancer, antidiabetic, antidiarrhea, antiulcer, antimalarial, anti-inflammatory, antioxidant, antileishmanial, antibacterial, antifungal, antidepressant, anticonvulsant, antinociceptive, anti-acetyl cholinesterase and dengue vector control activity [3].

Plant Biography [7]:

FIG. 1: *ANNONA GLABRA* PLANT

FIG. 2: *ANNONA GLABRA* FLOWER

FIG. 3: *ANNONA GLABRA* FRUIT

FIG. 4: *ANNONA GLABRA* FRUIT

Taxonomical Classification:

Scientific name: *Annona glabra Linn.*

Taxonomy:

Kingdom: Plantae

Phylum: Tracheophyta

Subphylum: Angiospermae

Class: Magnoliopsida – Dicotyledons

Order: Magnoliales

Family: Annonaceae

Genus: Annona

Species: Annona glabra

Botanical name: *Annona glabra Linn.*

Synonyms [8]**:**

- ✓ Annona australis
- ✓ Annona palustris
- ✓ Annona laurifolia
- ✓ Annona peruviana
- ✓ Annona chrysocarpa
- ✓ Annona uliginosa
- ✓ Guanabanus palustris
- ✓ Asimina arborea

Common names: Pond apple, alligator apple, monkey apple, swamp apple, cow apple, corkwood, bob wood, mangrove Annona [9].

Vernacular Names:

English:	Pond apple, alligator apple, bob wood, corkwood, cow apple, mangrove Annona, monkey apple
Malayalam:	Kattathi, Kattu-Aatha, and Kadalatha
Germany:	Alligatorapfel, Alligator-Binnbaum, Annone
Netherlands:	Zuurzak
Brazil:	Araticum bravo, Araticum do brejo, Araticum-caca, Araticupana
China:	Yuan Hua Fan Li Zhi, Niu xin guo
France:	Anone des marais, Bois flot, Cachiman cochon, and Corossol des narais
Spanish:	Anona Lisa, Anon Liso, Anon de Puerco, and Anonillo Cabuye
Japanese:	Pondo appuru
Portuguese:	Jaca de pobre, Araticum do brejo, and Araticurana

Description [10, 11, 12]**:** *A. Glabra* is a semi-deciduous tree, usually growing up to 3–15 m in height. Usually it has a single bole, with a swollen base when young or narrowly buttressed when mature. Stems are grey with prominent lenticels. The leaves are arranged alternately and are oblong-epithelial, with acute or shortly acuminate tips. They measure between 7 and 13cm in length and up to 6cm in width. The upper surface is light to dark green, while the underside is paler, with a prominent midrib and a distinctive small fold where the leaf blade joins the leaf stalk. Flowers are short-lived and rarely noticed, 2-3 cm in diameter, pale-yellow to cream with three leathery outer petals and three smaller inner petals; pedicel curved, expanded distally; sepals 4.5 mm long, 9 mm broad, apiculate; outer petals valvate, ovate-cordate, cream coloured with a crimson spot at base within, 2.5–3.0 cm long, 2.0–2.5 cm broad; inner petals sub imbricate, shortly clawed, 2.0–2.5 cm long and 1.5–1.7 cm broad, whitish outside, bright-red to dark-crimson within; stigmas sticky, deciduous. When ripened, the fruit changes its colour from green to either yellow or orange, displaying either a spherical or elongated form with a size ranging from 5 to 15cm in diameter. Its appearance resembles that of a smooth-skinned custard apple, and its pulp tends to be rather dry with a distinct pungent-aromatic scent, containing 100–200 light-brown seeds, each 1.5 cm long and 1 cm broad.

Origin	Florida, the Bahamas, the Caribbean, Central and South America, and West Africa
Distribution	coastal areas of northern and central Queensland, cook pastoral district, and North Kennedy and South Kennedy pastoral districts; it is also known to be naturalized in tropical Asia and on several Pacific islands.
Habitat	This species prefers wetter tropical and sub-tropical habitats. It generally grows in freshwater and brackish swamps, along creeks and rivers, in rainforests and along rainforest margins, in coastal environs, and along roadsides.
U.S.D.A. Zone	10A-12B (30°F Minimum)

Plant Type	Large shrub to medium-sized tree
Growth Rate	Moderate
Typical Dimensions	30-40’ tall x 10-20’ wide
Reproduction and dispersal	Reproduces by seed and may also produce suckers from damaged roots and trunks. Plants have ability to spread through suckering, lead to the eventual formation of dense thickets.
Leaf Persistence	Deciduous, semi-deciduous
Leaf Type	Simple
Nutritional Requirements	Low
Flowering Months	Abundant in spring, but can be year-round.
Salt Tolerance	Moderate
Light Requirements	Medium, high
Soil Requirements	Wide
Environmental Concerns	Low
Major Potential Pests	Fruit, root
Drought Tolerance	Medium
Propagation	Seeds
Human Hazards	None

Ethnomedical uses: The *A. glabra* fruit is edible and can be made into jam. In the Maldives, it is a popular ingredient in fresh fruit drinks. The crushed seed was cooked with coconut oil and applied to get rid of head lice in older days. *A. glabra* is used in traditional medicines against several ailments, such as fever, constipation, ulcers, and tumours, including cancer. It is a kind of survival food [13]. The leaves and young stems, sometimes combined with the leaves and stems of *Passiflora foetida*, are boiled to make a tea, which is drunk to destroy worms and nematodes. The bark and leaves, combined with the bark and leaves of Annona squamosa, are used as sedatives and cardiotonic infusions. *Annonamuricata* grafted on *A. glabra* rootstock receives a dwarfing effect. The wood is used to make bottle caps, oars, and as a substitute for cork in fishing nets. Seeds and leaves are insecticidal, leaves placed in hen nests kill lice on the fowl. Auseful fibre is obtained from the bark. It is sometimes used locally [14].

Phytochemicals: 28 pure compounds were isolated from the fresh fruit of the *A. glabra*, including 19 kauranediterpenoids,1)16α-hydro-19-acetoxy-ent-kauran - 17 - al, 2) 16β - hydro - ent - kauran - 17-oicacid[15],3)16α-hydro-ent-kauran-17-oic acid[16], 4)19-nor-ent-kauran-4α-ol-17-oic acid[16], 5)16α-hydro-19-ol-ent-kauran-17-oic acid[16], 6)ent-kauran-16-en-19-oic acid[15,16], 7)16α-hydroxy-ent-kauran-19-oic acid[16], 8)16α,17-dihydroxy-ent-kauran-19-oic acid[17], 9)16β,17-dihydroxy-ent-kauran-19-oic acid[16], 10)16α-hydro-ent-kauran-17,19-dioic acid[16], 11)16β-hydroxy-17-acetoxy-ent-kauran-19-oic acid[15], 12)16β-hydro-17-hydroxy -ent-kauran-19-al[17],13)16α-hydro-17-hydroxy-ent-kauran-19-al[18], 14)16β,17-dihydroxy-ent-kauran-19-al[17], 15)16α-hydro-19-al-ent-kauran-17-oic acid[16], 16)16α-hydro-17-acetoxy-ent-kauran-19-al[17], 17)16α-hydro-19-acetoxy-ent-kauran-17-oic acid[15], 18) ent-kaur-15-ent-19-Oic acid[19], and 19)ent-kaur-15-en-17-ol-19-oic acid[16]; Four acetogenins, 20) annomontacin[20], 21) annonacin[21],22) isoannonacinone[22], and 23) squamocin[23]; four steroids, 24) β-sitosterol[24], 25)stigmasterol[24], 26) β-sitosteryl-D-glucoside[24], and 27) stigmasteryl-D-glucoside[24]; and one oxoaporphine, liriodenine[24].

TABLE 1: ETHYL ACETATE EXTRACT OF *ANNONA GLABRA* FRUIT: CHEMICAL COMPOSITION [25]

Sl. no.	Compound name
1	Cyclotetradecane
2	1-Butene
3	n-Tridecan-1-ol
4	(-)-Spathulenol
5	1-Hexadecene
6	Benzene, (1-butyloctyl)-
7	3-(4-isopropylphenyl)-2-methylpropionaldehyde
8	Aromadendrene oxide-(1)
9	1H-Cycloprop [e] azulen-7-ol ‹decahydro-1‹1‹7-trimethyl-4-methylene- ‹ [1ar- (1aα ‹4aα ‹7β ‹7aβ ‹7bα)] -
10	1-Cyclohexene-1-methanol, 2,6,6-tetramethyl

11	Isoaromadendrene epoxide
12	9-Eicosene, (E)-
13	7,10-Pentadecadiynoic acid
14	Benzene, (1-methylundecyl)-
15	Cedren-13-ol ‹8-
16	(7,7-dimethyl-1,4-dioxo-2,3,4,5,6,7-hexahydro-1H-inden-2-yl) acetic acid
17	3,5-Decadiyne, 2,2-dimethyl-
18	3-Isopropyl-6,7-dimethyltricyclo[4.4.0.0(2,8)]decane-9,10-diol
19	Aromadendrene oxide-(2)
20	5,7-Dioxatetracyclo [7.4.0.0(3,10)0. (4,8)]tridecane,2-methylene-11-(1-methy lethyl)-1,6,6-trimethyl
21	Caryophyllene oxide
22	Hexadecanoic acid, methyl ester (CAS)
23	Cis-Z-a-Bisabolene epoxide
24	9,12,15-docosatetraenoic acid, methyl ester
25	9,12-Octadecadienoic Acid (Z, Z)-, methyl ester
26	3-Eicosene, (E)-
27	Methyl stearate
28	9-Octadecenoic acid (Z), - methyl ester (CAS)
29	Cycloeicosane
30	Podocarp-7-en-3-one, 13β-methyl-13-vinyl-
31	n-Tetracosanol-1
32	Biformene
33	n-Propyl5,8,11,14,17-eicosapenta enoate
34	Androstan-17-ol, 2,3-epoxy, -(2à,3à,5à,17á)-
35	Kaur-16-en-18-oic acid, methyl ester, (4β)-
36	6á- Hydroxytestosterone
37	Dihydro-isosteviol methyl ester
38	Kauran-18-al, 17-(acetyloxy)-, (4á)-

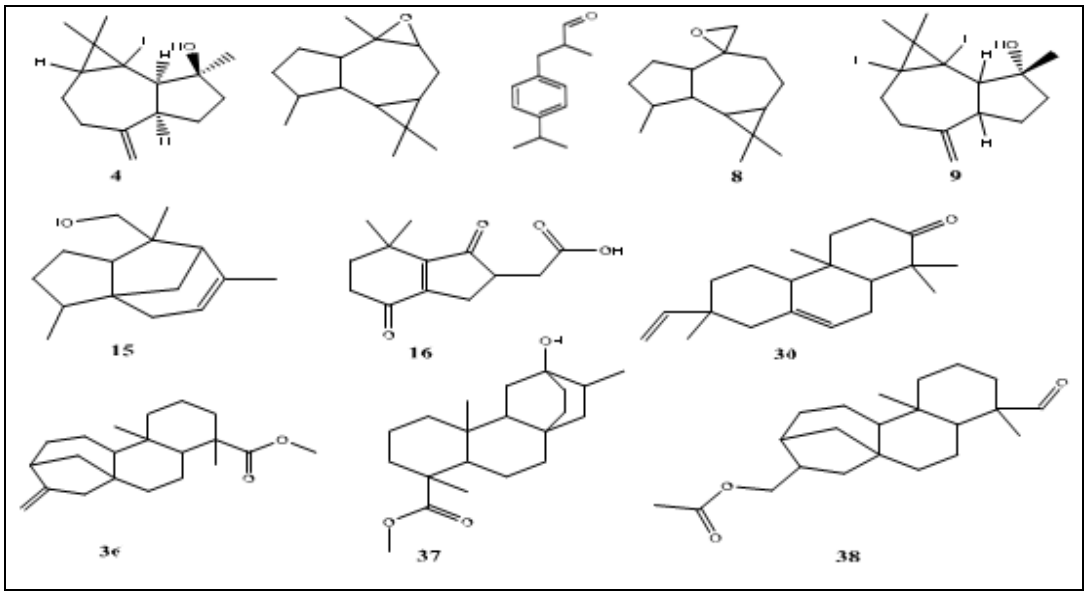

FIG. 5: CHEMICAL STRUCTURES OF THE ETHYL ACETATE EXTRACT OF SOME SELECTED IDENTIFIED COMPOUNDS

TABLE 2: METHANOLIC EXTRACT OF *A. GLABRA* FRUIT: CHEMICAL COMPOSITION

S. no.	Compound Name
1	(-)-Spathulenol
2	1,2,3,4,4a,5,6,8a-octahyd ro-4a,8-dimethyl-2-(2-propenyl)-
3	2,5-Octadecadiynoicacid,methylester
4	tau-Cadinol
5	Aromadendrenepoxide
6	Ledeneoxide
7	Caryophylleneoxide

8	Pentadecanoicacid,methylester
9	9-Hexadecenoicacid,methylester,(Z)-
10	Hexadecanoicacid,methylester
11	Octadecanoicacidmethylester
12	Androsta-1,4-dien-3-one17-hydroxy-17-methyl, -, (17à)-
13	Calarene
14	Heneicosanoicacid,methylester
15	Kaur-16-ene‹ (8β‹13β)
16	9,12-octadecadienoic acid, methyl ester
17	9-Octadecenoic acid (Z), methyl ester (CAS)
18	Methylstearate
19	Doconexent
20	Methyl7,10,13,16,19-docosapentaenoate
21	Dihydrorimuene
22	Naphthalene, decahydro-1,1,4a-trimeth yl-6-methylene-5-(3-methyl-2,4-pentadienyl)-, [4aS- (4aà,5à,8aá)] -
23	Podocarp-7-en-3-one,13β-methyl-13-vinyl-
24	Oxiraneundecanoic acid, 3-pentyl ester, methyl ester, cis-
25	Octadecanoicacid,9,10-dihydroxy-,methylester(CAS)
26	6-Acetylbenzo[b]naphtho[2,3-e]- [1,4]-dioxin
27	13,16-Octadecadiynoicacid,methylester
28	6,9,12,15-docosatetraenoic acid, methyl ester
29	Bicyclo[2.2.1] heptan-2-ol, 2-allyl-1,7,7-trimethyl-
30	[17-(14-C]-18-hydroxyaphidicol-16-ene
31	10,13-eicosadienoic acid, methyl ester
32	Androstan-3-one17-(acetyloxy)-, (5à,17á)-
33	Dihydroisopimaric acid methyl ester
34	Trans-Geranylgeraniol
35	1,2,3,3a,4,5,6,8,9,9a,10,10 a-dodecahydro-7-(1-Methylethyl)-1,9a-dimethyl -4- methylene
36	Kauren-18-ol, acetate, (4á)-(CAS)
37	Atis-16-ene, (5á,8à,9á,10à,12à)
38	Dihydro-isosteviol methyl ester
39	Isosteviol methyl ester
40	Androstane-6,17-dione,3-hydroxy-, (3á,5à)-
41	cis-5,8,11,14,17-Eicosapentaenoic acid

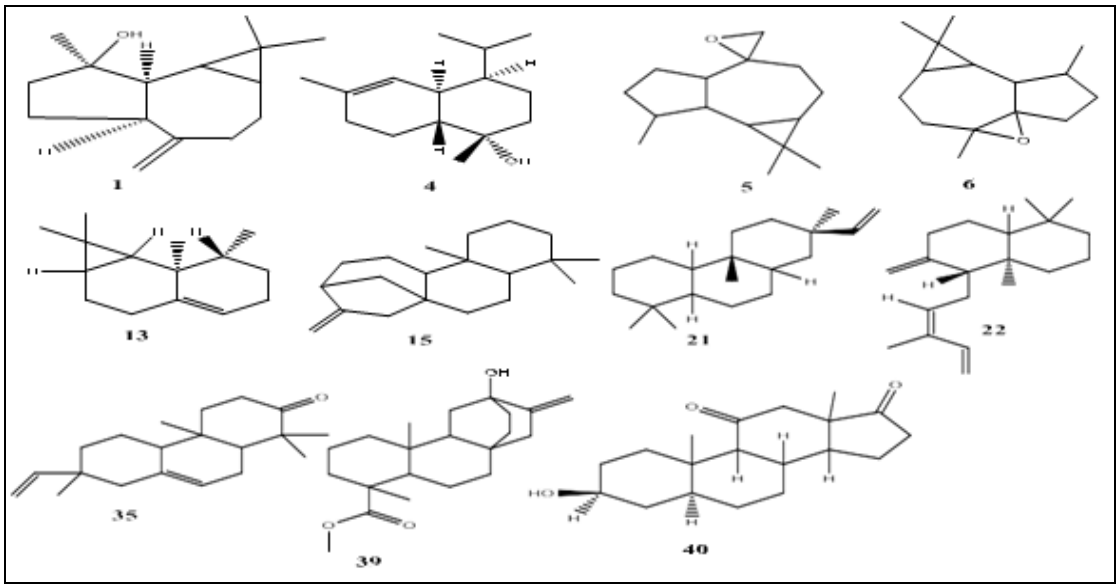

FIG. 6: CHEMICAL STRUCTURES OF THE METHANOLIC EXTRACT OF SOME SELECTED IDENTIFIED COMPOUNDS

TABLE 3: N-BUTANE EXTRACT OF *A. GLABRA* FRUIT: CHEMICAL COMPOSITION

S. no.	Compound Name
1	Tridecanol
2	(-)-Spathulenol

3	6,9,12-octadecatrienoic acid, methyl ester
4	Soaromadendreneepoxide
5	Ambrosin
6	Ledeneoxide-(II)
7	Alloaromadendrenoxid-(1)
8	(E)-4-(5',5'-Epoxymethano-1',2',2'-trimethyl-6'-oxo-1'-cyclohexyl)-3-buten-2-one
9	4a,7-Methano-4aH-naphth[1,8a-b]oxirene,octahydro-4,4,8,8-tetramethyl
10	Isoaromadendreneepoxide
11	Aromadendreneoxide-(2)
12	(Z)-9-Tetracosene-1,24-diol
13	9,12,15-Octadecatrienoicacid
14	Pregn-4-ene-1,20-dione, 12-hydroxy-16,17-dimethyl-
15	Hexadecanoicacid,methylester
16	11-Octadecenalspectrumdisagrees
17	2-[4-methyl-6-(2,6,6-trimethylcyclohex-1-enyl)hexa-1,3,5trienyl] cyclohex-1-e-n-1-carboxaldehyde
18	9,12-Octadecadienoicacid,methylester,(E, E)
19	9-Octadecenoicacid(Z)-,methylester
20	Octadecanoicacid, methylester
21	Methyl6-cis,9-cis,11-trans-octadecatrienoate
22	Estran-3-one, 17-hydroxy (5à, 17á) -
23	(5à, 17á): Androstan-2-one, (5à)
24	Androstane-3,11-diol,(3á,5à,11á)-
25	5à,14á-Androstane,16à,17à-epoxy-
26	Podocarp-7-en-3-one,13á-methyl-13-vinyl-
27	Androstan-3-one,17-(acetyloxy)-,(5α,17β)-
28	Preg-4-en-3-one,17à-hydroxy-17á-cyano-
29	Kaur-16-en-19-ol
30	Cyclooctenone, dimer (CAS)
31	1-Phenanthrenecarboxyli c acid, 7-ethenyl-1,2,3,4,4a,4b,5, 6,7,8,10,10a-dodecahydr o-1,4a, 7-trimethyl-methyl ester, [1R-(1à,4aá,4bà,7à,10aà)]
32	17-Pentatriacontene
33	1-Heptatriacotanol
34	Ergost-22-en-3-ol,(3á,5à,22E,24R)-
35	Diisooctyl-phthalate
36	Isosteviolmethylester
38	Dihydro-isosteviolmethylester
39	1-Naphthalenepropanol, à-ethyldecahydro-5-(hydroxymethyl)-à,5,8a-trimet hyl-2-methylene

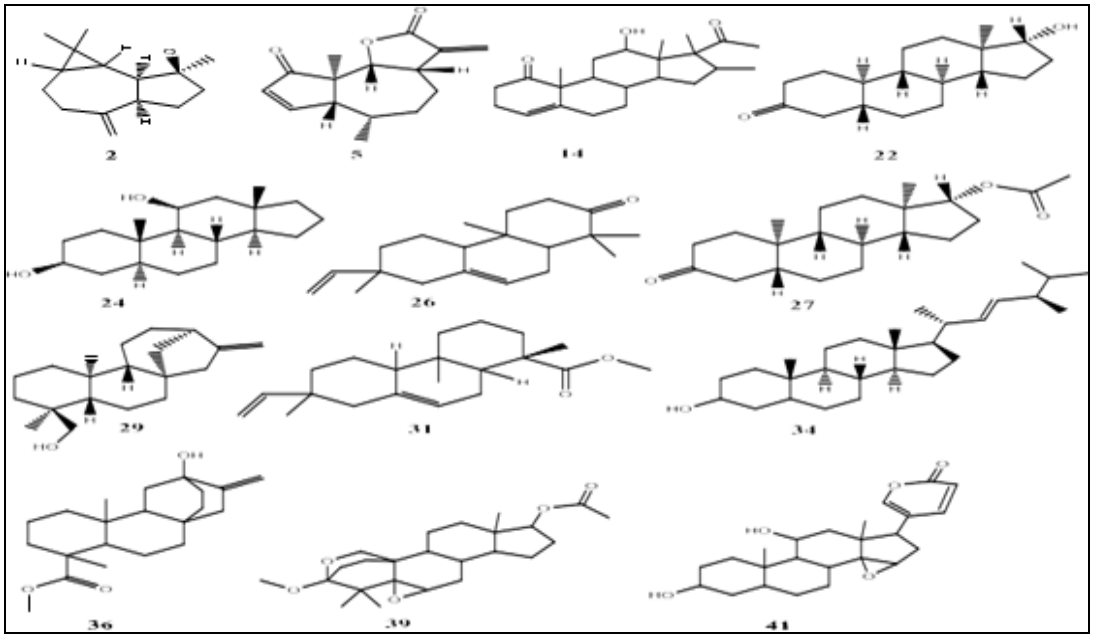

FIG. 7: CHEMICAL STRUCTURES OF THE N-BUTANE EXTRACT OF SOME SELECTED IDENTIFIED COMPOUNDS

TABLE 4: PHYTOCHEMICALS ISOLATED FROM THE LEAVES OF *A. GLABRA* [3]

Sl. no.	Compound Name
1	Glabracin A
2	Glabracin B
3	Glacins A, Glacins B
4	Javoricin
5	Bullatanocin
6	(-) -(6aS,7R) -7-hydroxyactinodaphnine
7	(-)-actinodaphnine
8	(-)-anolobine
9	(-)-asimilobine
10	(-)-pallidine
11	(-)-N-methylactinodaphnine
12	(-)-roemeroline
13	(+)-1S,2S-reticuline N-oxide
14	(+)-boldine
15	(+)-magnoflorine
16	(+)-norisodomesticine
17	(+)-reticuline
18	(+)-stepharine3-
19	3-O-α-L-arabinopyranoside
20	Liriodenine
21	Quercetin, Quercetin-3-O-β-D-galactopyranoside

Phytochemicals Present in the Aqueous Leaf Extract [13]: Flavonoids, glycolipids, alkaloids, aromatic hydrocarbons, phenols, sugars, steroids, terpenes. The oil samples predominantly contain mono- and sesquiterpenoids.

TABLE 5: EIGHTEEN COMPOUNDS WERE ISOLATED FROM THE HEXANE EXTRACT OF THE SEED OF *A. GLABRA* [26]

Sl. no.	Compound Name
1	Bullatencin
2	Glabrencin A
3	Glabrencin B
4	Uvariamicin-
5	Uvariamicin- II
6	Uvariamicin- III
7	Eticulatain-l
8	Desacetyluvaricin
9	4-deoxyasimicin
10	Bullatacin
11	Asimicin
12	Squamocin
13	Motrilin
14	Cherimolin-2
15	Palmitic amide
16	Stigmasterol
17	Arachidic amide
18	Stearic amide

Pharmacological Activities:

Anti-leishmanial Activity: Leishmaniasis is mainly caused by the protozoan parasites of the genus *Leishmania* and is one of the most neglected tropical diseases, and characterized by the formation of skin ulcers. Despite the global prevalence of numerous cases, the treatment of the disease remains a topic of extensive discussion and is still inadequately understood, despite the considerable attention it has received. In-vitro evaluation of the different *Annona* species showed antileishmanial activity.

Alkaloids are the substances that show leishmanicidal activity in *Annona glabra.* Among the alkaloids isolated from the genus species that have already demonstrated anti-*Leishmania* activity are coronaridine, O-methylarmepavine, 18-methoxycoronaridine, and liriodenine. In addition, the acetogenins corosolone and anonacinone were also promising as leishmanicide. Among kaurenoic acids, terpenes showed activity against the Human Immunodeficiency Virus (HIV) and *Trypanosoma cruzi*), besides showing antimicrobial activity [27].

Anti-cancer Activity: Recently one of the bioactive compounds called acetogenin has aroused considerable interest. Annonaceous acetogenins from the annonaceae family are a very important source for future antitumor drugs. The acetogenin fractions found in present in *A. glabra* leaves were detected using Kedde's reagent, and they were isolated through column chromatography [7]. It has long been used in traditional medicine as an anti-cancer agent.

The various parts of the *A. glabra* cytotoxic study reveal its potential use as an anticancer agent. Previous reports showed that treatment of extract in human leukemia cell lines resulted in reduced mitochondrial fragmentation, reduced ATP content, reduced oxidative stress, and induced apoptosis.

The Ethanolic extract of the *A. glabra* leaves showed the presence of annoglacins A and B, and it suppressed the proliferation of pancreatic carcinoma and human breast cell lines, and it exerted more pronounced antitumor activity than adriamycin. Icariside D2 is one of the anticancer bioactive compounds; it alters the expression of apoptosis-related proteins decreases the phosphorylation of AKT in HL-60 cells. Studies performed on the methanolic extract of *A. glabra* seeds on bio-assay guided fraction led to the isolation of the components annonin I, squamocin-C, and squamocin-D.

Among them, annonin I exert higher activity against lung carcinoma A-549, breast adenocarcinoma, and breast adenocarcinoma. Annoglabasin H, a component isolated from the fruits of *A. glabra*, it showed significant cytotoxic activity in LU-1, MCF-7, SK-Me12, and KB, with IC_{50} values ranging from 3.7 to 4.6 μM. Some of the reports also showed that *A. glabra* extract showed cytotoxicity to drug sensitive (CEM) and multidrug-resistant leukemia (CEM/VLB) cell lines.

The seed extract induces necrosis and apoptosis in both sensitive and resistant leukemia cells in a concentration-dependent manner; it also enhances the action of cyclin kinase inhibitors and leads to the arrest of cells at the G0/G1 phase. The cytotoxic activity observed in the hexane extract of the stem bark of *A. glabra* was associated with the isolation of Kaur-16-en-19-oic acid from a fractionation, indicating its potential therapeutic applications. Annomontacin is one of the anticancer compounds that causes variations in mitochondrial transmembrane and induces apoptosis in the human liver cancer cell line (Hep G2) [28]. Cunabic acid and entkauran-19-al-17-oic acid, two diterpenoid compounds isolated from *A. glabra*, can obviously inhibit the proliferation of the HLC cell line SMMC-7721. The mechanism is correlated with the induction of cell apoptosis by down-regulating the gene expression of the*bcl*-2 gene and up-regulating that of the *bax* gene [29].

Anti-inflammatory Activity: Inflammation is a normal and instant response by living tissue to any type of injury. If the inflammation process occurs repeatedly or continuously, it leads to several diseases like rheumatoid arthritis, inflammatory bowel disease, asthma, psoriasis, atherosclerosis, and some cancers. Inflammation, mainly mediated by secretory phospholipase A_2($_S$PLA$_{2S}$), is known to regulate the arachidonic acid pathway by which pro-inflammatory mediators are released. *A. glabra* plant showed the presence of several bioactive compounds, like alkaloids, flavonoids, tannins, steroids, terpenoids, glycosides, and phenols, and these could be responsible for its various medicinal properties. To evaluate the mechanism of action of anti-inflammatory activity of the acetone extract of the *A. glabra* leaves, $_S$PLA$_2$ was subjected to inhibition. The extract showed a good inhibition zone. The synergistic action of the potent active principles of *A. glabra* leaves may be the reason to inhibit the $_S$PLA$_2$ enzyme to a greater extent [30].

Anti-Microbial Activity: Indian herbal medicines have served as important sources of medicines for the prevention and treatment of many diseases, including microbial infections. The increasing prevalence of multidrug resistance has greatly reduced the available treatment options for antibiotics worldwide, underscoring the critical importance of monitoring bacterial resistance to these drugs. Traditional herbal medicine usage in refined or crude form is very helpful in the treatment of microbial infections with two advantages, i.e., the cure is made by minimizing the chances of microbes becoming resistant. Herbal medicines are very useful in not producing major side effects when compared to antibiotics.

Therefore, in the previous research, *A. glabra* plant material was tested for its antibacterial activities on the selected strains of bacteria namely, *Bacillus cereus, Pseudomonas aeruginosa* and *Shigella flexneri*. These activities were compared with standard antibiotic, namely broad-spectrum antibiotics, ampicillin, and penicillin. The Antimicrobial activity assessment followed the conventional technique of diffusion disc plates on agar. Subsequently, the minimum inhibitory

concentration (MIC) was determined by employing the dilution method. Results clearly shown that *A. glabra* has antimicrobial properties. The plant extract showed more activity than that observed by broad spectrum antibiotic activities. The standard ampicillin and penicillin had MIC values varying between 0.244 mg/mL and 0.488 mg/mL. The results revealed that the antimicrobial potency of the extract of *A. glabra* exhibits superior antimicrobial efficacy compared to conventional antibiotics. Throughout history, herbs have been recognized for their diverse antimicrobial properties [31].

Ethyl acetate fraction (EAF) was obtained from the leaf hydroalcoholic extract of *A. glabra*. EAF has bactericidal activity against different strains of *Pseudomonas aeruginosa*. The viability of *P. aeruginosa* was observed to be influenced by both time and concentration in the ethyl acetate fraction. Upon testing various subfractions of the ethyl acetate fraction, it was found that subfraction 32-33(SF32-33) exhibited the highest efficacy against *P. aeruginosa*, displaying a time and concentration-dependent effect. The examination of SF32-33 showed a high content of flavonoids. When incubating *P. aeruginosa* with this active sub-fraction, ATCC 27983 induces an endothermic reaction. This reaction coincided with an observable increase in electric charge, indicating a strong affinity of SF32-33 compounds for bacterial cell walls. Collectively, flavonoids in the *A. glabra* are useful for treating infections caused by *P. aeruginosa* [32]. *A. glabra* fruit extracts showed noticeable *in-vitro* antimicrobial activity against some tested microbes, including *Escherichia coli*, *Staphylococcus aureus*, *Aspergillus niger*, and *Candida albicans*. Further, it provides evidence that the antimicrobial activity of the tested extracts could be due to the co-activity between their major and minor constituents. These extracts could be considered an effective therapy to treat various infectious diseases. Therefore, *A. glabra* fruit could be used as a very good source of naturally occurring antimicrobial remedies [25].

Wood Protection against Termites: *A. glabra L.* belongs to the family of Annonaceae. *A. glabra* seed extract contains bioactive substance that is toxic to some organisms, however, the effectiveness to control wood degrading termites has not yet been scientifically reported. Some research analyzes the efficacy of *A. glabra* seed extract to wood degrading termites. The process of Seed extraction involved the utilization of both n-hexane and ethyl acetate as solvents. This method enabled the retrieval of desired compounds from the seeds efficiently. The extract of *A. glabra* by paper disc test showed toxic to *Coptotermes curvignathus* (subterranean termites) and Cryptotermes cynocephalus (dry-wood termites). If the extract concentration (up to 63%) is higher resulted in a higher termite mortality (up to 100%) and lower weight loss of paper sample (less than 1%). When compare to n-hexane extract of the *A. glabra* seeds, ethyl acetate extract has a better toxicity effect against subterranean termites and dry wood termites [33].

Burn Healing Properties: Burn wounds are the most common accidental injuries. Not only do burn injuries disfigure the skin, but they can also cause severe consequences for body function. These burn injuries can be healed completely with minimal scarring. The whole process of wound healing is a dynamic and intricate process which involves an ordered cascade of events to restore the integrity of damaged tissue. The burn healing process involves different overlapping phases and processes, including haemostasis, inflammation, proliferation, tissue remodelling, and formation of granulation tissue with angiogenesis.

An array of cytokines and growth factors also contribute to the interaction between epidermal and dermal cells, the extra cellular matrix, controlled angiogenesis and plasma-derived proteins in order to facilitate a wound repair process. The phytoconstituents that were detected in the ethanol leaf extract of *A. glabra* are flavonoids, glycosides, saponins, tannins, steroids, acidic compounds, and anthraquinones. The alginate films impregnating *A. glabra* leaf extract exerted wound healing activity and also enhanced the rate of wound contraction. It is believed that the phytochemicals present in the leaf extract play a key role in the promotion of the healing process. Ata dose of 3.0% (w/v) *A. glabra* leaf extract, burn wounds recovered well without dermalirritation. Administration of the *A. glara* contained dressing promotes burn healing, as evidenced by decreased healing time and faster

wound contraction. It could be stated that *A. glabra* leaves possess wound healing properties [34].

Larvicidal Efficacy: In recent mosquito control programs, larvicides have been the main tool. The most widely used larvicides organophosphates such as Methoprene, Temephos, and biological control by *Bacillusthuringiensis israelensis* (Bti). Since the larvicides are applied to either natural or artificial bodies of water, they must be harmless to beneficial and other nontarget organisms, including humans. It is reported that the genus *Annona* shows strong insecticidal properties. According to reports,*A. crassiflora* shows larvicidal activity against *Ae. Aegypti*. *A. squamosa* shows larvicidal activity against *Ae. Aegypti* and *Culex quinquefasciatus*. *A. muricata* seed extract shows larvicidal activity against *Ae. aegypti*.

Ethanol stem bark extract of *A. glabra* is larvicidal to Ae. aegypti. Aqueous leaf extract of*A. glabra*shows larvicidal properties on Ae. aegypti and Ae. Albopictus (5.94 mg/L, and 5.00 mg/L respectively). Nanoformulations of*A. glabra* silver has shown enhanced larvicidal efficacy on Ae. aegypti and Ae. Albopictus (LC50 = 2.51 mg/L and 2.43 mg/L, respectively) [13].

Wine Production: Pond apple (*Annona glabra L.*) trees were highly distributed in swamp regions of the Mekong Delta, Vietnam. When ripening, *A. glabra* fruits turned from green to yellow. Ripen *A. glabra* fruits contained large phenolic constituents with valuable phytochemical benefits. However, ripened pond apple fruits are not as successfully utilized as other commercial fruits. The quality of wine production from pond apple is affected by the different technical variables of fermentation. Ripen *A. glabra* fruits were peeled, blended, deseeded, crushed, enzyme-treated (pectinase 25 mg/l), added with sugar (5-13%w/w), pasteurized (sulfite 30 mg/l), inoculated with the yeast *Saccharomyces pastoria-nus* ratio (0.1-0.5%), and macerated at the temperature 14-22°C in different time (6- 14 days). Malolactic fermentation was carried out in anaerobic condition at 12 °C for different durations (4-20weeks). After the completion of the malolactic fermentation, the wine was racked and clarified with different fining agents like wheat gluten, bentonite, kaolin, polyvinylpyrrolidone, gelatine, and kaolin at 0.03% (v/v). Results showed that must be added with 9% sugar and 0.4% yeast inoculation, fermentation temperature of 16^{O}C in 10 days. Malolactic fermentation could be completed in 12 weeks. During the pond apple wine production, gelatine was shown to be the best candidate among different clarifying agents to remove turbidity in the wine while retaining the most total phenolic content and antioxidant capacity. Fermentation gave a high ethanol content (4.26±0.02%v/v) under the above technical variable conditions. The total phenolic content (32.79±0.00 mg GAE/100 ml), 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging (11.84±0.01 %), overall acceptance (8.34±0.01 score), and low turbidity (24.41±0.00 NTU) were also noticed.

The elevated ethanol level and preservation of phytochemicals were key factors in achieving the favourable sensory rating of pond apple wine, meeting the standards expected for an alcoholic beverage. Ripen Pond apple fruit would be a promising carbohydrate source to convert into a new fruit wine with a pleasant alcoholic flavour and attractive appearance [35].

Anti-oxidant Activity: Antioxidants are compounds which retard or prevent oxidation and prolong the life of oxidizable matter. Free radicals / oxidants play a crucial role in various biochemical processes and are integral to aerobic life and metabolic functions. They have high reactivity, a very short half-life, and damaging activity towards macromolecules like proteins, lipids, and DNA. These species can originate from oxygen or nitrogen [36]. *A. glabra* extract showed moderate antioxidant activity. The standard used was quercetin, a compound that belongs to the most common class of flavonoids. And stands out for its great anti-class of the most common flavonoids and stands out for its great antioxidant potential. The extracts with the best antioxidant activity were ethyl acetate and methanol from the inner bark and methanol from the seeds, which correspond to those containing phenolic compounds [37].

CONCLUSION: Plants are the natural sources of bioactive compounds used to treat various life-threatening diseases. *A. glabra* showed various phytochemicals, which means that it can be used for treating various diseases. The review shows the activity of various parts of the plant and its

pharmacogenetic profile. Extract and phyto-constituents isolated from this plant have been shown to produce different pharmacological responses, which include anti-leishmanial activity, anti-microbial, anti-oxidant, anticancer, anti-inflammatory, wood protection against termites, larvicidal efficacy, burn healing properties, and wine production. Considering all the above medicinal importance of *A. glabra*, it can be concluded that further studies on this plant may be helpful for further researchers to develop some new drugs.

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