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Pharmacognostic, physicochemical, phytochemical and pharmacological studies on *Careya arborea* Roxb.; A review

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ABSTRACT

Since the birth of humans on this planet, plants have been utilized for diagnosis, treatment and prevention of various ailments. *C. arborea* belonging to family Lecythidaceae is one the most utilized plants. It is a tree having large sessile yellowish flowers and large green berry type fruits with persistent style and calyx. Traditionally is has been used to treat cough and cold, infertility, jaundice developed after delivery, piles, blood dysentery, scorpion sting, sores in intestine, bed sores, ear pain, snake bite, inflammation, ulcer, spermatorrhoea and wounds in humans and corneal opacity and weakness in animals. Many pharmacological activities of this plant are reported viz. antiarrhoeal, anti-inflammatory, analgesic, hypoglycemic, antibacterial, antifungal, antileishmanial, α -glucosidase inhibitory, antioxidant, hepatoprotective, cytotoxic, CNS depressant and anticoagulant. Various phenolic compounds, sterols, terpenes, saponins and tannins have been isolated from this plant. Pharmacognostic studies for its authentication have also been carried out. Hamdard Ghutti® is one of the available polyherbal formulations containing *C. arborea*. This review provides adequate information about ethnomedicinal uses, general morphology, pharmacognostic and physicochemical parameters, phytoconstituents, pharmacological properties, and available formulations of this plant.

Keywords: *Careya arborea*, Wild guava, Kumbhi, Ghutti, Jigrine.

INTRODUCTION

Plants are the most important and the oldest source of medicines. Information from fossil records reveals the use of plants as medicines some 60,000 years ago^[1]. Currently 25% of prescribed drugs are derived from higher plants and this value goes to 50% if animal and microbial products are also included^[2]. This highlights the importance of natural products as a good source of new drugs in future.

Careya arborea Roxb. is commonly known as Kumbhi in Hindi and Wild Guava in English. It is widely distributed in Sri Lanka, India, Peninsula and Malay up to an altitude of 1500 meters^[3, 4]. This plant is very important in the field of medicines and is being used for treatment of various ailments. It is also used for other purposes e.g. methanolic extract of the leaf is a good indicator in acid-base titrations^[5], crushed bark of the root is mixed with water to stupefy fishes^[6], stem bark is used for clothing and to produce yellow colored dye^[7] and leaves are used as green manure^[8]. Brief taxonomic information about *C. arborea* is described below^[9].

Kingdom Plantae
Phylum Tracheophyta
Class Magnoliopsida
Order Ericales
Family Lecythidaceae
Genus *Careya*
Species *arborea*

Various stages of the plant are shown in figure 1.

Ethnomedicinal uses

C. arborea has a history of very important ethnomedicinal uses such as; persistent calyx, fresh bark juice and flowers are used to treat cough and cold^[10, 11]; paste of flowers of *C. arborea* and fruits of *Terminalia chebula* and *Emblica officinalis*, prepared by macerating in ghee, is taken orally in empty stomach to treat infertility^[12]; extract of bark in hot water is used to take a bath by the lady for treatment of jaundice developed after delivery^[13]; powder of stem bark is mixed with honey^[12] or 50 g of bark is boiled with water and 1 glass of it is taken in empty stomach for seven days to treat piles^[14]; powder of bark mixed with cow milk is taken orally in empty stomach to treat dysentery^[15]; paste prepared from fresh bark is applied over scorpion sting and fruit infusion is taken orally^[12]; root of *Indigofera*

cassioides mixed with juice of *C. arborea* is used to treat blood dysentery [16]; bark is used to treat sores in intestine and is also effective in bed sores [17]; bark of the root is used to treat *vata* and *kapha* [18]; juice of the bark is applied internally to treat ear pain [19]; dried stem bark of *C. arborea* is one of the most important components of medicated water “vethuvellam” used by a woman to take a bath after delivery to overcome her body weakness [20]; the exudates from the bark are used as repellent to leeches [8]. Other

ethnomedicinal uses of *C. arborea* are in the treatment of diarrhea [21], snake bite, inflammation, ulcer [22], spermatorrhoea [23] and wounds [24].

In ethnoveterinary medicines it is used to treat corneal opacity [25], paste of bark in curd is used to overcome weakness in cattle [26] and ripe fruit is a delicious food of *Semnopithecus entellus* (Hanuman Langur) [27] and *Elephas maximus* (Asiatic elephant) [28].

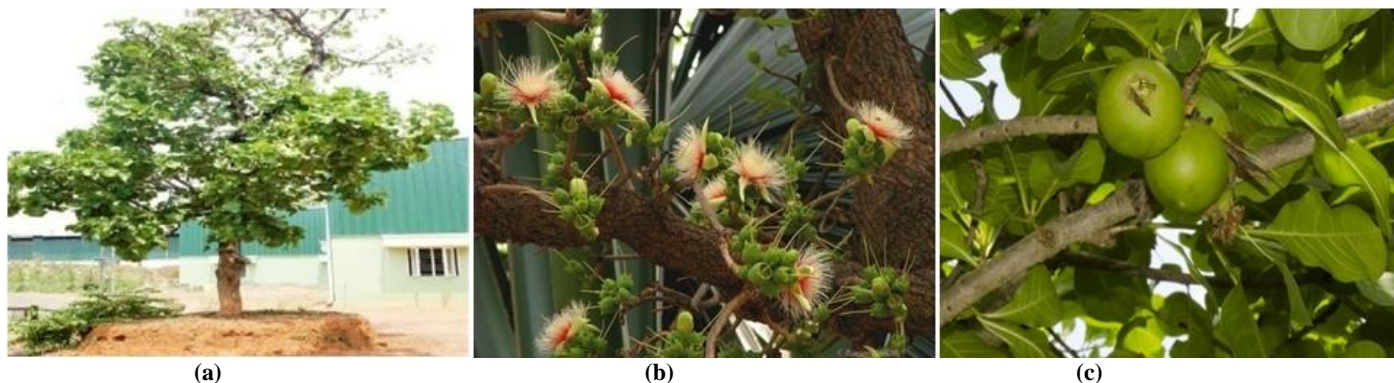


Figure 1: *Careya arborea*: a) mature tree; b) flowers; c) fruits

Morphology of the plant

C. arborea is a tree having a spreading crown and height of about 20 meters. Arrangement of leaves is alternate. Flowers are large, sessile, ill smelling and yellowish white colored. Inflorescence of flowers is racemose. Flowering season is March to April. Fruit is large, round shaped, fleshy and green in color, seeds being embedded in this fleshy pulp. Bark is of dark grey color and usually exfoliates in thin strips [3, 29, 30].

Pharmacognostic characters

Stem Bark

Stem bark of *C. arborea* is of dark grey color, thick and rough having cracks which are usually shallow. It is odorless and has astringent taste. In transverse view, the bark shows 8 to 16 layers of rectangular shaped, brownish black colored, thick walled cork cells. Inside the cork, there are 2 to 3 layers of phellogen which produce phellogen cells centripetally. Parenchymatous cells of cortex are multilayered, polygonal to rectangular in shape. Secondary phloem is also present consisting of phloem parenchyma, fibers, vessels and 1 to 2 seriate medullary rays. Phloem parenchyma and cortex cells contain crystals of calcium oxalate. In powder of the bark, thick walled lignified fibers, about 38 to 66 micrometer in length and crystals of calcium oxalate of 10 to 15 micrometer are characteristic [29].

Leaf

Color of leaf is green, shape is obovate and apex is acuminate with crenate margin. Length and width of fresh leaf is 15-22 cm and 7-12 cm respectively with 0.1-1.8 cm long petiole. In transverse section of leaf through midrib, thick cuticle over the epidermis is prominent on both adaxial and abaxial sides. Inside the epidermis, there is collenchyma tissue, a single layer of palisade cells and few layers of spongy mesophyll cells. In the midrib, one large central and two relatively lateral bundles of vascular tissue embedding in the spongy mesophyll cells are found. These vascular bundles are surrounded by lignified sclerenchyma fibers. Xylem tissue consists of fibers, tracheids, parenchyma and vessels forming the shape of a cup and phloem surrounds it. Stomata are of anisocytic type.

Leaf constants per mm² area are: Stomata number, upper surface (28.00), lower surface (188.00); Stomatal index, upper surface (8.26),

lower surface (31.18); Vein-islet number (6.00-8.00); Veinlet termination number (7.00-9.00); Palisade ratio (6.00-8.00 per cell) [31].

Fruit

Fruit is berry type, large and green colored. It has persistent style and calyx and weighs about 100 g. Outermost layer of fruit is epidermis with a waxy covering. Inside epidermis there is collenchymatous hypodermis, inside which loosely packed parenchymatous cells are present having scattered vascular bundles. Some of these parenchyma cells have stone cells which provide mechanical support. Placentation of ovules is axial with 4 locules [31].

Physicochemical parameters

Physicochemical parameters of the leaf and the stem bark are listed in Table 1 [3, 32, 33].

Table 1: Physicochemical parameters of leaf and stem of *C. arborea*

Physicochemical constants	Leaf	Stem bark
Foreign matter (% w/w)	0.20	0.80
Total ash (% w/w)	6.00	4.50
Acid insoluble ash (% w/w)	1.40	0.17
Water soluble ash (% w/w)	2.20	1.10
Loss on drying (% w/w)	3.20	6.00
Swelling index (mL)	4.70	3.73
Water soluble extractive (% w/w)	18.4	16.0
Alcohol soluble extractive (% w/w)	8.20	7.20

Phytochemistry of *C. arborea*

Tannins are reported in aerial parts of *C. arborea* [34]. Detail of other phytoconstituents in various parts of the plant is described below.

Flowers

Flowers of *C. arborea* have triterpenoids, steroids and tannins [35].

Fruits

Phenolic compounds viz. gallic acid (1), 3,4-dihydroxybenzoic acid (2), quercetin 3-O-glucopyranoside (3), kaempferol 3-O-glucopyranoside (4) and quercetin 3-O-(6-O-glucopyranosyl)-glucopyranoside (5) were isolated from methanol, n-hexane, ethyl acetate and dichloromethane extracts of *C. arborea* fruit [36].

Seeds

Seeds of *C. arborea* are reported to possess starch [37], α - spinasterone (6), α - spinasterol (7) [38] and triterpenoids viz. 16 desoxy barringtonenol C (8), barringtonenol C (9) and barringtonenol D (10) [39-42].

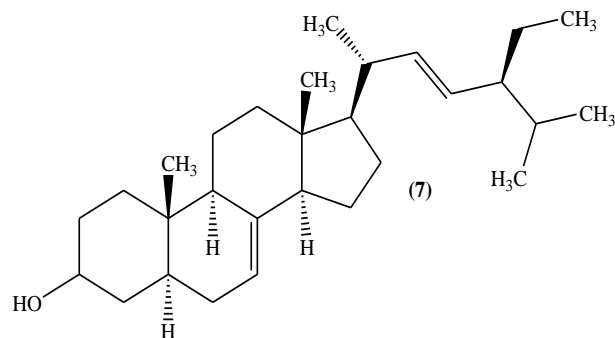
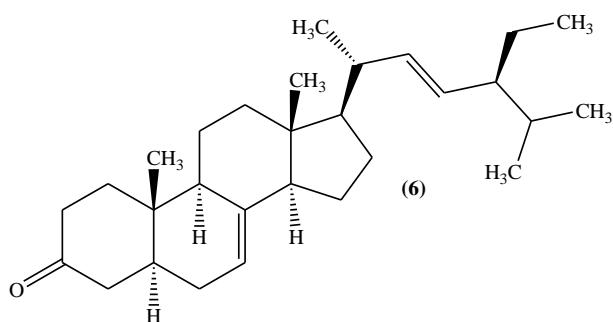
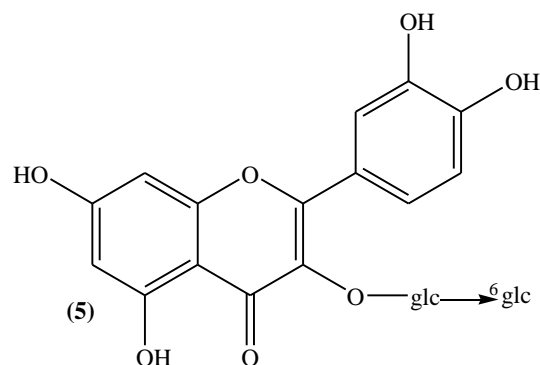
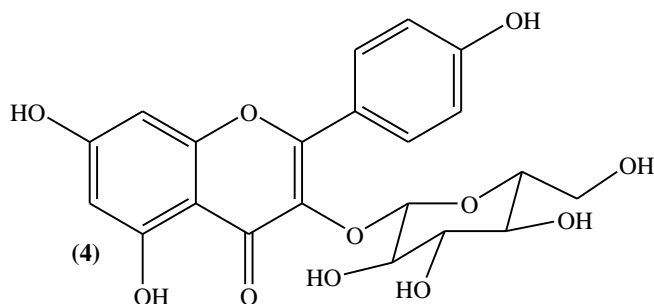
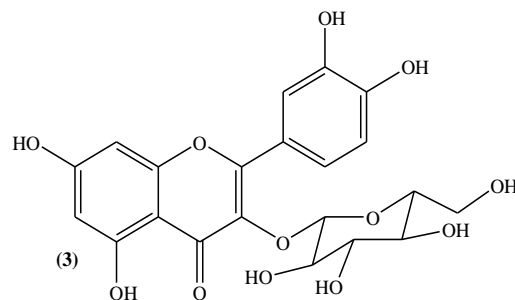
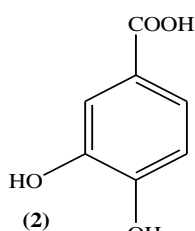
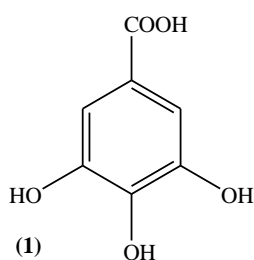
Leaves

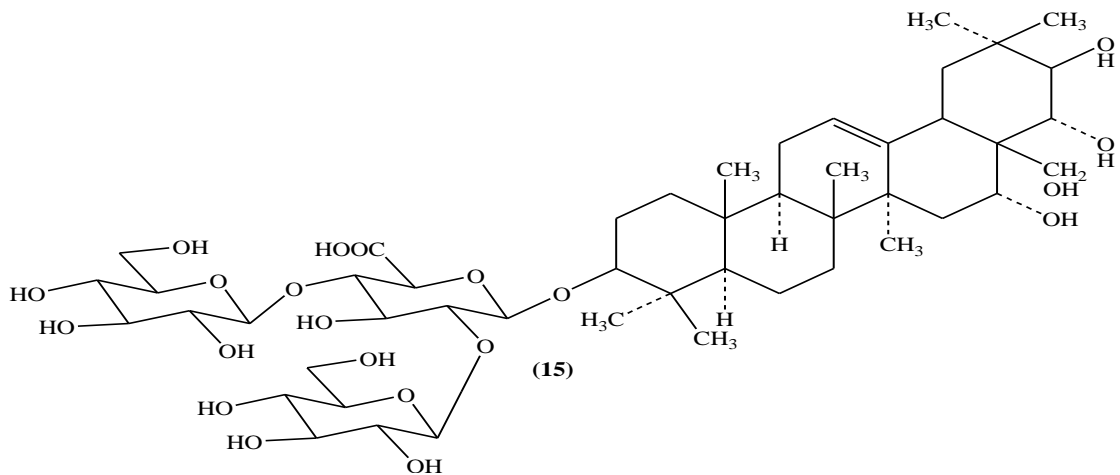
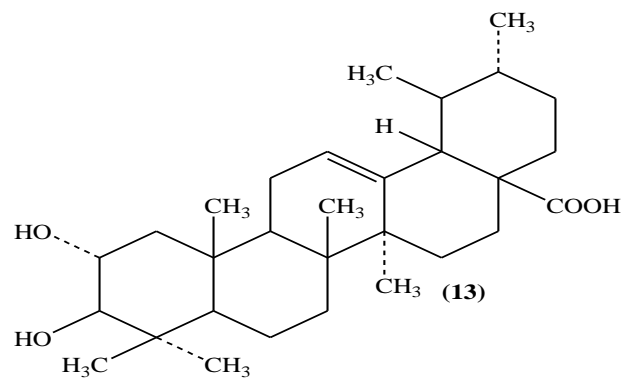
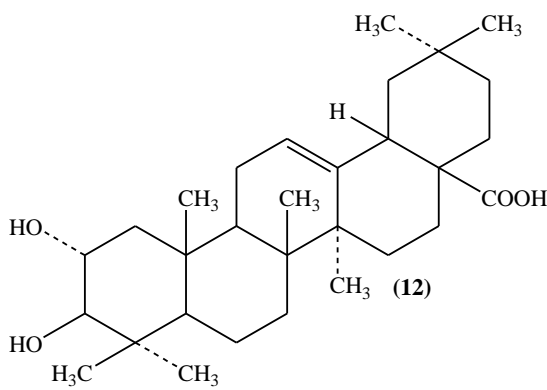
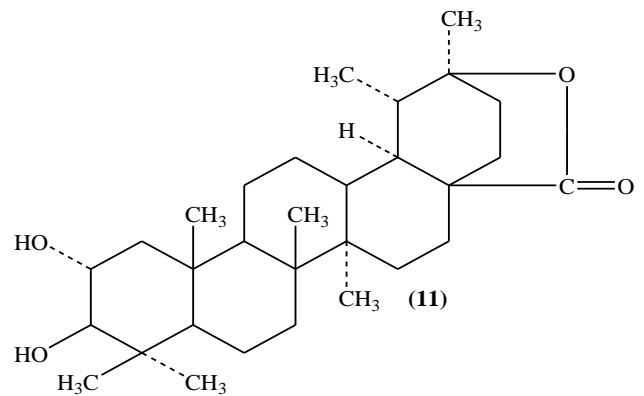
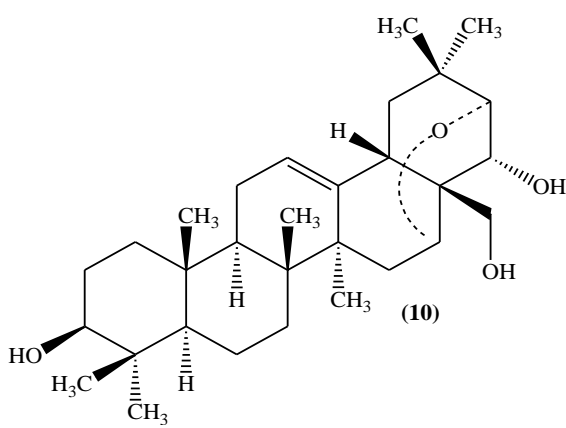
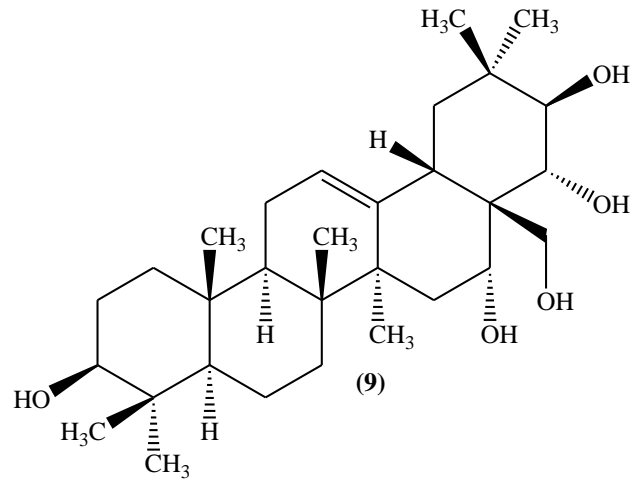
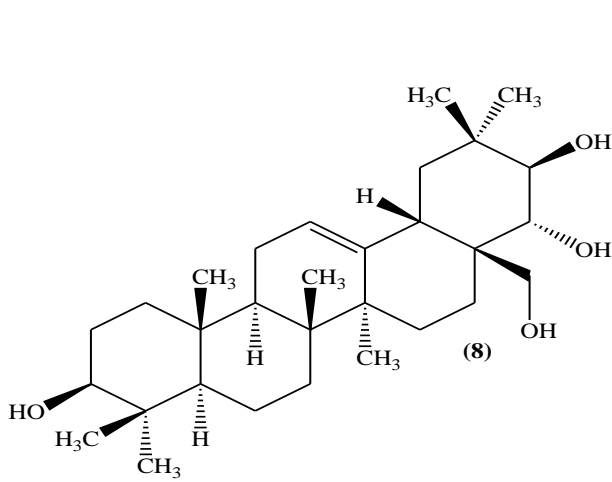
Acid hydrolysis of ethanolic extract of leaf produced a triterpenoid lactone careyagenolide (11), maslinic acid (12) and 2 α -hydroxy ursolic acid (13) [43] and from its methanol extract a triterpenoid saponin arborenin (14) and desacylescins III (15) were isolated [44].

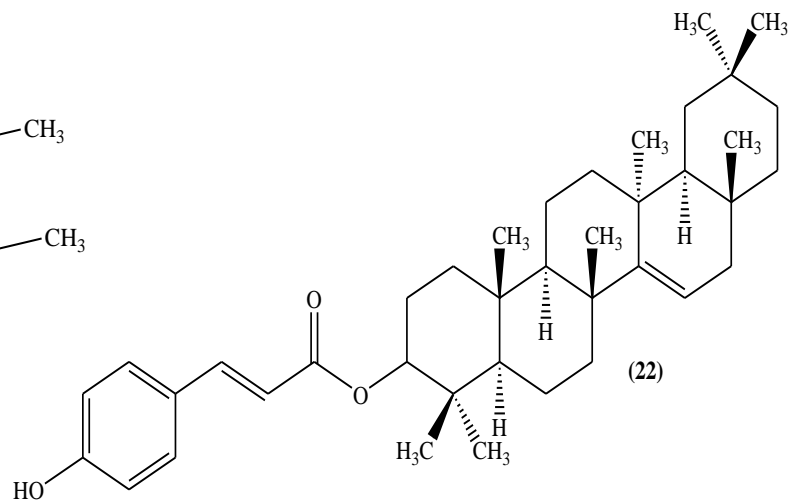
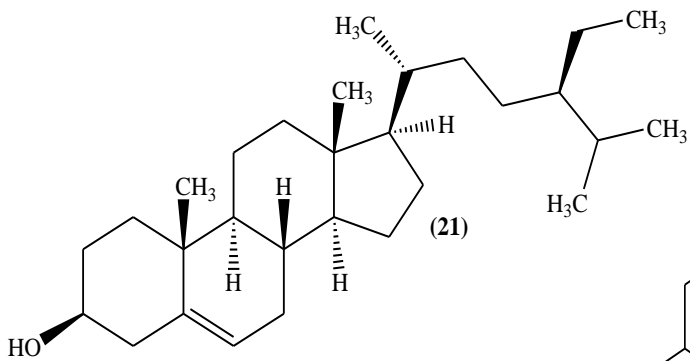
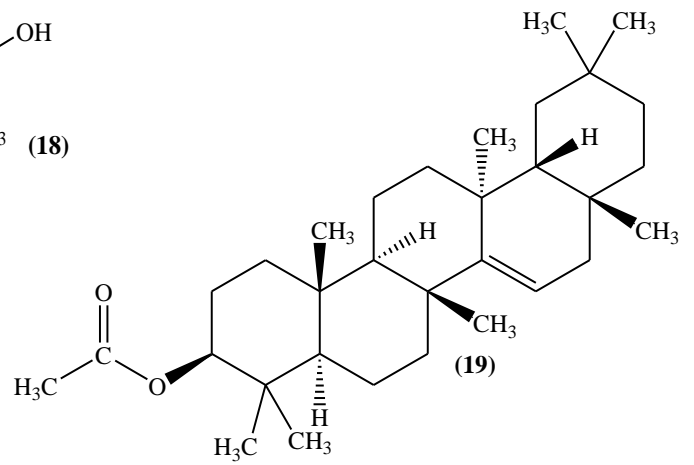
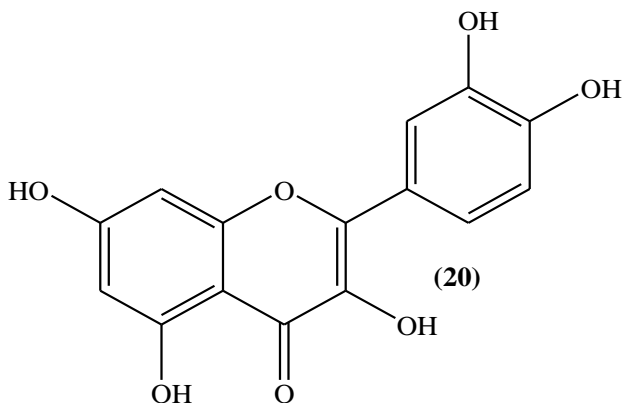
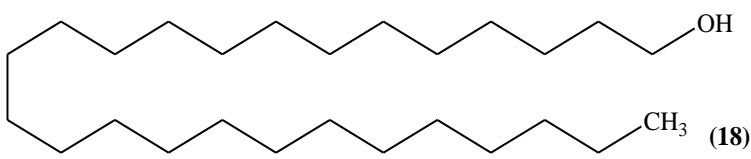
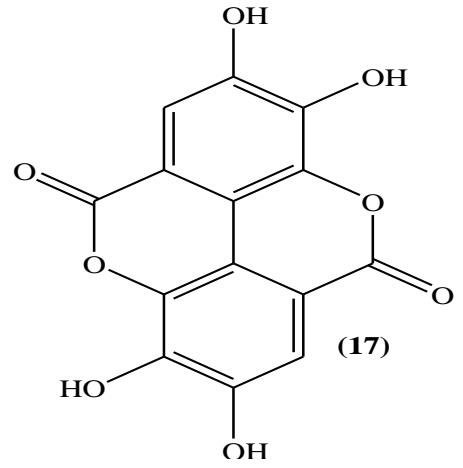
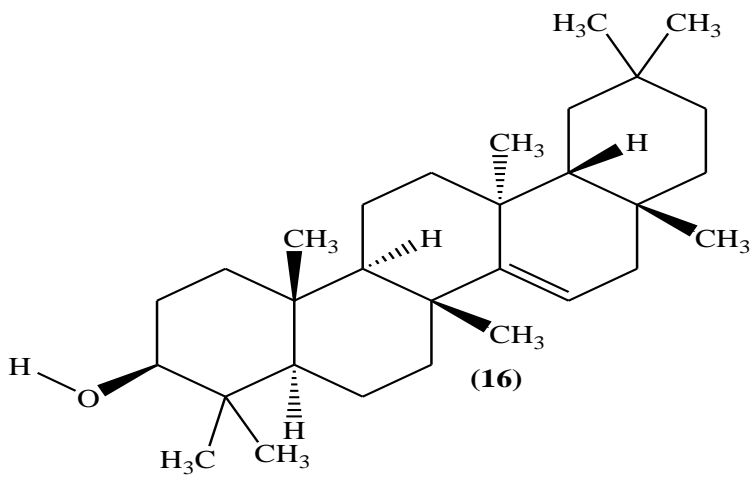
Other reported constituents are taraxerol (16) [45], ellagic acid (17), n-hexacosanol (18), taraxerol acetate (19), quercetin (20) and β -sitosterol (21) [46], careaborin (22) [47] and tannins [48].

Stem bark

Stem bark is reported to contain terpenes, sterols [49], tannins and saponins [50].







Pharmacological activities of *C. arborea*

Antidiarrhoeal activity

Antidiarrhoeal activity of methanolic extract of the bark against castor oil induced diarrhea was testified in mice [51].

Anti ulcer activity

Ethanol extract of the stem bark demonstrated anti ulcer activity against ethanol, pylorus ligation and cold resistant stress induced ulcers in albino rats [52]. In another study, ethanol extract of the leaf showed significant gastroprotective effects in rats against ethanol, aspirin, cold restraint stress and pylorus ligation induced ulcers by decreasing acid volume and simultaneously increasing mucus level on the walls of stomach [53].

Anti-inflammatory and analgesic effects

Methanolic extract of *C. arborea* stem bark showed analgesic and anti-inflammatory effects against dextran, carrageenan, serotonin and histamine induced paw edema and granuloma induced by cotton pellet method in animal models [54] and an alkaloid piperine, isolated from the bark, showed peripheral and central analgesic activity in mice [55]. Several mechanisms are involved in this anti-inflammatory effect including the inhibition of mediators, enzymes and cytokines release [56].

Wound healing potential

Methanolic extract of leaves of *C. arborea* was revealed to possess wound healing potential in rats in a dose dependent manner [57].

Hypoglycemic effect

Root bark of *C. arborea* contains a metformin like compound, having hypoglycemic effect [58].

Antifertility effects

Phenolic compounds present in methanolic extract of the root of *C. arborea* showed reversible antifertility effects in mice by pregnancy inhibition and estrous cycle disturbances [59].

Antibacterial activity

Antibacterial activity of methanolic extract of the bark of *C. arborea* against *Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Vibrio cholera*, *Shigella dysenteriae*, *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Streptococcus pneumoniae* and *Micrococcus luteus* [60], of ethanolic and ethyl acetate extracts of the fruit against *Salmonella typhimurium*, *Escherichia coli*, *Staphylococcus aureus*, *Listeria monocytogenes* and *Staphylococcus epidermidis* [61], of the leaf extract against *Escherichia coli* isolated from UTI patients [62], of methanolic extract of the leaf against *Staphylococcus aureus*, *Enterococcus faecalis*, *Citrobacter freundii*, *Acinetobacter baumannii*, *Escherichia coli*, *Enterobacter aerogenes*, *Proteus mirabilis*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Proteus vulgaris* [63] and of ethanolic extract of the leaf against *Streptococcus pyogenes*, *Escherichia coli*, *Salmonella typhimurium*, *Bacillus cereus*, *Pseudomonas aeruginosa* and *Zymomonas mobilis* [64] has been reported.

Antifungal activity

Antifungal activity of methanolic extract of the bark against *Candida albicans*, *Aspergillus flavus*, *Aspergillus niger* and *Alternaria solani* was revealed [60].

Antileishmanial activity

Methanolic extract of the leaf was effective against leishmaniasis caused by *Leishmania donovani* [44].

α -glucosidase inhibitory action

C. arborea has α -glucosidase inhibitory and antioxidant properties indicating suitable use of this weed as food [65].

Antioxidant activity

C. arborea possesses antioxidant activity, demonstrated by methanolic extract of the bark [60, 66, 67] and dichloromethane and methanol extracts of the fruit [36].

Hepatoprotective activity

Methanolic extract of *C. arborea* stem bark demonstrated hepatoprotective action in mice against carcinoma [67], carbon tetrachloride [68] and N-nitrosodiethylamine [69].

Cytotoxic activity

Methanolic extract of *C. arborea* stem bark showed antitumor activity in mice against Dalton lymphoma [70] and HeLa cell lines [66]. Ethanolic extract of the leaf demonstrated prominent cytotoxic effects when tested against Vero cell lines and HEp-2 cell lines [64].

CNS activity

CNS depressant activity was demonstrated by methanolic extract of *C. arborea* stem bark when tested in albino mice and rats [71].

Anticoagulant effect

Methanolic extract of the bark showed anticoagulant activity comparable to warfarin with a significant increase in the activated prothrombin and thrombin times [72].

Available formulations of *C. arborea*

Various formulations containing *C. arborea* as one of the active components are available in market e.g. Hamdard Ghutti® (Hamdard Laboratories (Waqf) Pakistan), a pediatric preparation used to evacuate bowel and treat constipation of newborn and infants [73], Jigrine® (Hamdard Laboratories (Waqf) Pakistan), a polyherbal formulation used to treat liver ailments [74], Habb-e-Kabid Naushadri® (Hamdard Laboratories (Waqf) Pakistan), an effective product for about all types of liver disorders [75], Kumbhajatu® (Ayurveda Rasashala, Pune, India), a good formulation to treat hyperlipidemia [76] and Obenyl® (Charak Pharmaceuticals), used as appetite suppressant to treat obesity [77].

Conflict of interest

None.

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