J Biosci (2021)46:25
DOI: 10.1007/s12038-021-00146-6

© Indian Academy of Sciences

Review

Ethnobotanical, phytochemical, and pharmacological properties of *Cerbera manghas* L.

PRADEEP KUMAR MAHARANA

Department of Biotechnology, Utkal University, Bhubaneswar, Odisha, India

(Email, pradeepmaharana@mail.com)

MS received 23 August 2020; accepted 25 January 2021

In this review article, the ethnobotanical, phytochemical, and pharmacological properties of *Cerbera manghas* L. (Apocynaceae) are discussed. This plant has applications in traditional folk medicine as analgesic, anticonvulsant, a cardiotonic and for hypotensive activity. Phytoconstituents of this plant are secondary metabolites like saponins, terpenoids, and alkaloids along with phenolic acids, flavonoids, cardiac glycosides, steroids, iridoids, lignans, and other compounds. The major phytochemical compounds are cardiac glycosides followed by terpenoids and phenolic acids. Again, the leaf has greater types and numbers of phytochemicals, followed by the fruit, seed, stem, and root. The plant also shows many pharmacological activities such as antioxidant, anticancer, anti-inflammatory, DNA damage protection, and antimicrobial. This review could help researchers in further investigations in these directions.

Keywords. Apocynaceae; *Cerbera manghas*; mangrove; ethnobotany; phytoconstituents; pharmacology

1. Introduction

Cerbera manghas (Family: Apocynaceae) is a poisonous plant and is common along the coasts of south Asia and Southeast Asia, northern Australia, and Polynesia. This mangrove species is classified as vulnerable (Ved *et al.* 2008) and is an endangered species in the Bhitarkanika National Park, Odisha, India (Upadhyay *et al.* 2008). This plant is widely used for greening as well as an ornamental plant. This plant fights infectious diseases. Swallowing any part of Cerbera tree, particularly the fruits, can cause nausea, vomiting, abdominal pain, and cramping (Scott and Thomas 2000). Deaths may occur following intentional self-poisoning with *C. manghas* plants (Eddleston and Persson 2003).

The taxonomic position of *C. manghas* L. is described by the IUCN (Yu and Qin 2019) and GBIF (GBIF database 2019). This species is also known by several vernacular names as it is distributed in the mangrove region of various parts of India (Ved *et al.* 2016). The details of taxonomic position and vernacular names are mentioned in table 1. It is widely distributed from the islands of the Indian Ocean, tropical Asia, tropical Australia, the islands of the Pacific Ocean, and tropical Africa (Leeuwenberg 1999; Govaerts *et al.* 2003; Lemmens *et al.* 2006). It is indigenous to Southeast Asia, Australia, and also some islands of Polynesia (Scott and Thomas 2000).

C. manghas L. is a small tree which usually grows up to 20 m in height and up to 70 cm in diameter. The branches are thick and succulent. The stem has large lenticels and soft wood. The leaves are dark-green and arranged spirally. The fruits are nearly oval shape, turn bright red at maturity, single-seeded, and seedling with hypogeal germination (Lemmens *et al.* 2006). Vegetative propagation of this species takes place through stem-cuttings and air-layering by standard methods (Eganathan *et al.* 2000; Basak *et al.* 1995, 2000). This review article gives a critical description of the complete profile of the mangrove plant *C. manghas* L., mainly highlighting the various ethnobotanical uses, phytochemical constituents isolated, and pharmacological studies conducted on this plant.

Published online: 10 March 2021

Table 1. Taxonomical classification and Vernacular names of *Cerbera manghas* L.

Taxonomical Classification		Language	Vernacular names
Kingdom	Plantae	Sanskrit	Auddalakah, Svanamarah
Phylum	Tracheophytes	Hindi	Dabur, Pilikirbir, Sukanu
Class	Magnoliopsida	Tamil	Kadalma, Kadama, Kadamoth, Udalai,Utalai, Kottuma
Order	Gentianales	English	Beach milkwood , Grey milkwood, Sea mango
Family	Apocynaceae	Malayalam	Cattankaya, Chattankaya, Chatthankai, Pona, Ponna, Utalam
Genus	*Cerbera*	Marathi	Kharo-uro, Sukanu
		Kannada	Cande, Chande, Chende, Honde, Monde, Tende
Species	*manghas*	Odia	Paniambo

2. Ethnobotanical information

Cerberin of this mangrove species has been used as medicine in very small amounts to treat cardiac disorders (Barceloux *et al.* 2012). Traditionally, the fruit of Cerbera is used as to treat diseases, as analgesic, anticonvulsant, cardiotonic, and hypotensive activity (Chang *et al.* 2000). Some of the allelochemicals from this sea mango are used in pest control in agriculture as termiticides (Tarmadi *et al.* 2014) and bactericides (Rajathi and Nambaru 2014). *C. manghas* is a medicinal plant which is traditionally known for cardiotonic, analgesic, anti-inflammatory activity, etc. (Jeong *et al.* 2014).

The seeds are used externally to treat scabies and itch, and hair tonic preparation. The bark is used for the treatment of dysuria and ringworm. The flowers are used to treat haemorrhoids. The roots, bark, latex, and leaves of *C. manghas* can be used as emetic and purgative. In Asia, the wood of this species is occasionally used for the preparation of interior trim, fruit cases, matches, shuttering, clogs, plain furniture, and carving, and also for charcoal (Fern 2014). *C. manghas* is also used for the treatment of fever, malaria, pain, diabetes, gastrointestinal ailments, skin diseases, and ectoparasitic diseases (Wiart 2006).

3. Phytochemistry

The extract of *C. manghas* contains reducing sugars, tannins, steroids, alkaloids, glycosides, polyphenols, terpenoids, flavonoids, saponins, etc. (Hossain *et al.* 2013; Anwar *et al.* 2013; Xiaopo *et al.* 2010). *p*-Hydroxybenzaldehyde, benzamide, *n*-hexadecane acid monoglyceride, loliolide, β-sitosterol, cerberin, neriifolin, cerleaside A, and daucosterol are the compounds present in the leaves of *C. manghas* (Chan *et al.* 2016; Zhang *et al.* 2010). Air-dried *C. manghas* leaves have 17α-digitoxigenin and 17α-tanghinigenin. Fresh leaves contain oleagenin glucosyl- thevetoside, digitoxigenin gentiotriosyl-thevetoside, glycosides, and glucosyl-thevetosides of digitoxigenin and tanghinigenin (Yamauchi *et al.* 1987).

The major phyochemical compounds of *C. manghas* are cardiac glycosides followed by terpenoids, phenolic acids, iridoids, flavonoids, steroids, lignans, and others. Seventeen terpenoids, 13 cardiac glycosides, 7 steroids, 7 iridoids, 5 flavonoids and 4 phenolic acids are only present in leaves. Also, 9 phenolic acids (only in fruits), 6 cardiac glycosides (only in seed), and 3 flavonoids (only in stem) are the other components of this species. Cerbinal (in all parts) and ursolic acid (in leaf and fruit) are the other terpenoids are present in *C. manghas*. p-Hydroxybenzaldehyde (in leaf and fruit) and vanillic acid (in fruit, stem, and root) are the other phenolic acids present in this species. Cerberin (leaf, fruit, and seed), 17β-neriifolin (leaf, stem, root, and fruit) and 17β-digitoxigenin-β-D-glucosyl-(1→4)-α-Lthevetoside (stem and root) are the other cardiac glycosides present in *C. manghas*, while a few iridoid compounds are present in stem, bark, and root. Lignans are present in stem and root. Besides these, other compounds are also present in *C. manghas* (figure 1; table 2).

4. Pharmacological activities

4.1 *Antioxidant activity*

The extracts of *C. manghas* have antioxidant properties (Lee *et al.* 1998; Hossain *et al.* 2013). The antioxidants in *C. manghas* leaves can be due to the presence of phytoconstituents (Anwar *et al.* 2013). Phenolic

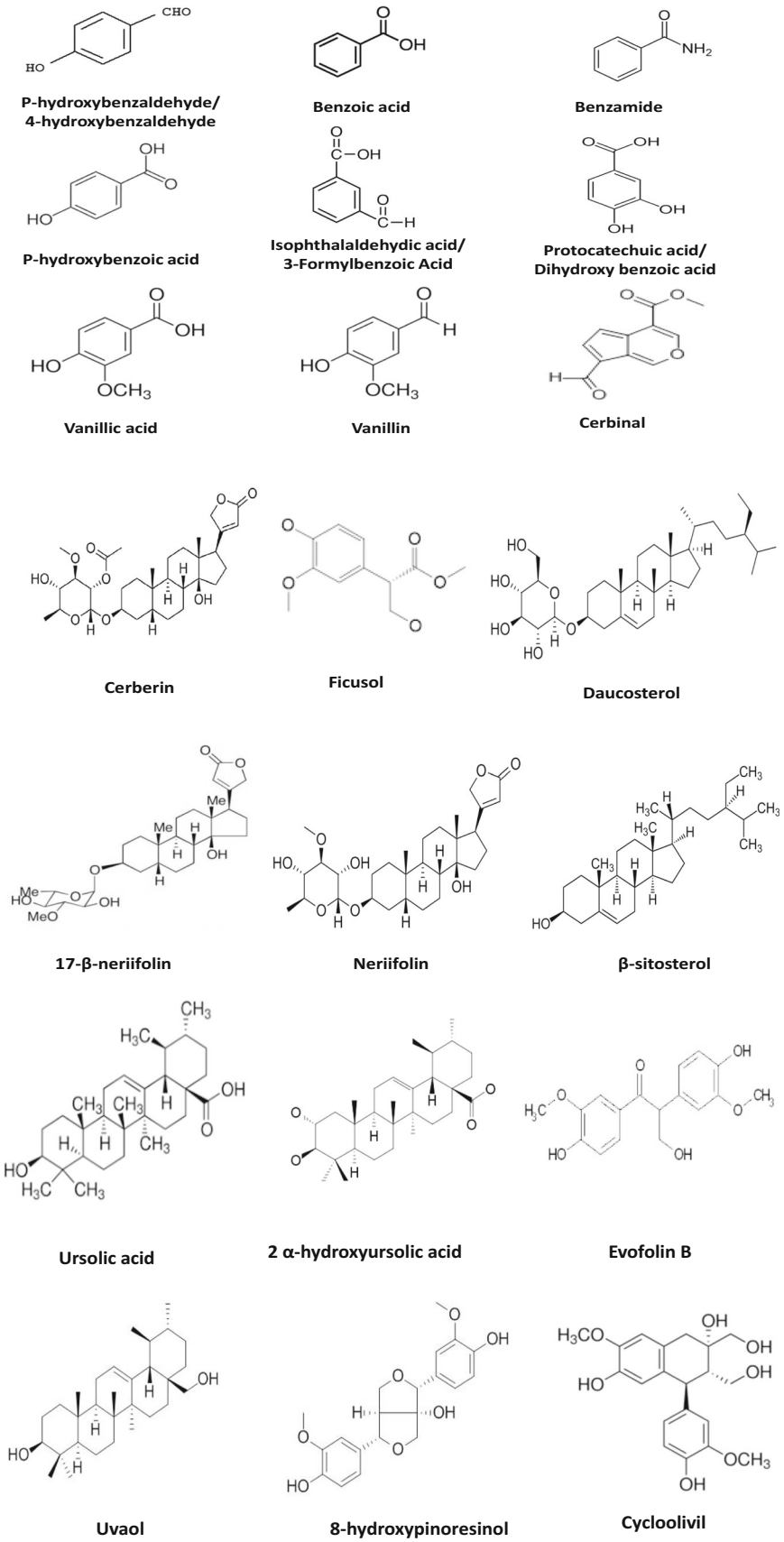

Figure 1. Chemical structures of some phytoconstituents present in *Cerbera manghas* L.

Table 2. Phytoconstituents isolated from *Cerbera manghas* L.

Chemical compound/ Component (parts of tree)	References
Terpenoids	
Uvaol (leaf)	Zhang *et al.* (2011)
(23Z)-9, 19-cycloart-25-ene-3β,24-diol (leaf)	Zhang *et al.* (2011)
Euphorbol (leaf)	Zhang *et al.* (2011)
2α-hydroxyursolic acid (leaf)	Zhang *et al.* (2011)
3-O-acetyl ursolic acid (leaf)	Zhang *et al.* (2011)
Blumenol A (leaf)	Chan *et al.* (2016)
Cerberidol-3 (leaf)	Chan *et al.* (2016)
10-bis-*O*-β-D allopyranoside (leaf)	Chan *et al.* (2016)
Cerberidol (leaf)	Chan *et al.* (2016)
Cerberidol-3-*O*-β-D allopyranoside (leaf)	Chan *et al.* (2016)
Cyclocerberidol (leaf)	Chan *et al.* (2016)
Cyclocerberidol-3-*O*-β-D allopyranoside (leaf)	Chan *et al.* (2016)
Cyclocerberidol-3-*O*-β-D glucoside (leaf)	Chan *et al.* (2016)
Euscaphins AB (leaf)	Chan *et al.* (2016)
Epoxycerberidol (leaf)	Chan *et al.* (2016)
Epoxycerberidol-3-*O*-β-D allopyranoside (leaf)	Chan *et al.* (2016)
Epoxycerberidol-3-*O*-β-D glucoside (leaf)	Chan *et al.* (2016)
Cerbinal (leaf, stem, bark, fruit, root)	Chan *et al.* (2016), Yan (2010), Cao *et al.* (2013)
Ursolic acid (leaf, fruit)	Zhang *et al.* (2011), Chan *et al.* (2016), Cao *et al.* (2013)
Phenolic acids	
Succinic acid (leaf)	Chan *et al.* (2016)
m-carboxyphenylacetic acid (leaf)	Chan *et al.* (2016)
p-hydroxycinnamic acid (leaf)	Chan *et al.* (2016)
Isopthalic acid (leaf)	Chan *et al.* (2016)
Benzoic acid (fruit)	Chan *et al.* (2016), Cao *et al.* (2013)
Vanillic acid (fruit, stem, root)	Chan *et al.* (2016), Yan (2010), Cao *et al.* (2013)
Vanillin (fruit)	Chan *et al.* (2016), Cao *et al.* (2013)
p-hydroxybenzaldehyde (leaf, fruit	Xiaopo *et al.* (2010), Chan *et al.* (2016), Zhang *et al.* (2010), Cao *et al.* (2013)
Isophthalaldehydic acid (fruit)	Chan *et al.* (2016), Cao *et al.*(2013)
β-hydroxygpropiovanillone (fruit)	Chan *et al.* (2016), Cao *et al.* (2013)
Ficusol (fruit)	Chan *et al.* (2016), Cao *et al.* (2013)
Evofolin B (fruit)	Chan *et al.* (2016), Cao *et al.* (2013)
3, 4'-dihydroxypropiophenone (fruit)	Chan *et al.* (2016), Cao *et al.* (2013)
p-hydroxybenzoic acid (fruit)	Chan *et al.* (2016), Cao *et al.* (2013)
Protocatechuic acid (fruit)	Chan *et al.* (2016), Cao *et al.* (2013)
Flavonoids	
Clitorin (leaf)	Chan *et al.* (2016)
Manghaslin (leaf)	Chan *et al.* (2016)
Nicotiflorin (leaf)	Chan *et al.* (2016)
Rutin (leaf)	Chan *et al.* (2016)
3-O-(2-Rhamnosyl-rutinosyl)7-O- β-glucosylquercetin) (leaf)	Chan *et al.* (2016)
Aromamadedrin (stem)	Chan *et al.* (2016)
(+)-Dihydroquercetin (stem)	Chan *et al.* (2016)
Naringenine (stem)	Chan *et al.* (2016)
Naringenine-7-glucoside (stem)	Chan *et al.* (2016)
Cardiac glycosides	
17α-Tanghinigenin (leaf)	Yamauchi *et al.* (1987), Chan *et al.* (2016)
17β-Tanghinigenin (leaf)	Chan *et al.* (2016)
17α-Solanoside (leaf)	Chan *et al.* (2016)
17β-Solanoside (leaf)	Chan *et al.* (2016)
Neriifolin (leaf)	Xiaopo *et al.* (2010), Zhang *et al.* (2010), Chan *et al.* (2016)
17α-neriifolin (leaf)	Chan *et al.* (2016)
17α-Cerdollaside (leaf)	Chan *et al.* (2016)
17β-Cerdollaside (leaf)	Chan *et al.* (2016)
Cerleaside A (leaf)	Xiaopo *et al.* (2010), Zhang *et al.* (2010), Chan *et al.* (2016)
Cerleaside B (leaf)	Chan *et al.* (2016)
Deacetyltanghinin (leaf)	Chan *et al.* (2016)
17α-Deacetyltanghinin (leaf)	Chan *et al.* (2016)
17β-Deacetyltanghinin (leaf)	Chan *et al.* (2016)
17β-neriifolin (leaf, stem, root, fruit)	Yan (2010), Cao *et al.* (2013), Chan *et al.* (2016)
Tanghinin (seed)	Chan *et al.* (2016)
Thevetin B (seed)	Chan *et al.* (2016)
2'-O-Acetyl cerleaside A (seed)	Chan *et al.* (2016)
2'-O-Acetyl thevetin B (seed)	Chan *et al.* (2016)
7,8-Dehydrocerberin (seed)	Chan *et al.* (2016)
Deacetyltanghinin (seed)	Chan *et al.* (2016)
Cerberin (leaf, fruit, seed)	Xiaopo *et al.* (2010), Zhang *et al.* (2010), Cao *et al.* (2013), Chan *et al.* (2016)
17β-Digitoxigenin-β-D-glucosyl-(1→4)-α-Lthevetoside (stem, root)	Yan (2010)

Table 2. (continued)

Chemical compound/ Component (parts of tree)	References
Steroids	
Bornesitol (leaf)	Chan *et al.* (2016)
β-sitosterol (leaf)	Zhang *et al.* (2010), Chan *et al.* (2016)
Daucosterol (leaf)	Xiaopo *et al.* (2010), Zhang *et al.* (2010), Chan *et al.* (2016)
3α,12β- Dihydroxy-pregname-16- en-20- one (leaf)	Chan *et al.* (2016)
3β,12β- Dihydroxy-pregname-16- en-20- one (leaf)	Chan *et al.* (2016)
12β- Hydroxy-5α-pregname-16- en-3,20-dione (leaf)	Chan *et al.* (2016)
12β- Hydroxy-pregname-4,16- diene-3,20- dione (leaf)	Chan *et al.* (2016)
Iridoids	
10- *O*- Benzoyltheveside (leaf)	Chan *et al.* (2016)
10- *O*- Benzoyltheviridoside (leaf)	Chan *et al.* (2016)
10-Carboxyloganin (leaf)	Chan *et al.* (2016)
10-Dehydrogeniposie (leaf)	Chan *et al.* (2016)
Loganin (leaf)	Chan *et al.* (2016)
Theveside (leaf)	Chan *et al.* (2016)
Theviridoside (leaf)	Chan *et al.* (2016)
Cerberic acid A, B (bark)	Chan *et al.* (2016)
Cerberinic acid (bark)	Chan *et al.* (2016)
Coniferaldehyde (stem, root)	Yan (2010)
Lignans	
Cerbera lignin A-I (stem)	Chan *et al.* (2016)
Cerbera lignin J-N (stem)	Chan *et al.* (2016)
(-)-Cycloolivil (stem, root)	Chan *et al.* (2016), Yan (2010)
(+) – Cycloolivil (stem)	Chan *et al.* (2016)
(-)-Olivil (stem, root)	Chan *et al.* (2016), Yan (2010)
Olivil 4-*O*-β- D glucose (stem)	Chan *et al.* (2016)
Olivil 4'-*O*-β- D glucose (stem)	Chan *et al.* (2016)
Others	
17α-digitoxigenin (leaf)	Yamauchi *et al.* (1987)
Oleagenin glucosyl-thevetoside (leaf)	Yamauchi *et al.* (1987)
Digitoxigenin gentiotriosyl-thevetoside (leaf)	Yamauchi *et al.* (1987)
Benzamide (leaf)	Zhang *et al.* (2010)
Loliolide (leaf)	Xiaopo *et al.* (2010), Zhang *et al.* (2010)
n-hexadecane acid monoglyceride (leaf)	Zhang *et al.* (2010)
8-Hydroxypinoresinol (stem, root)	Yan (2010)
1,3-bis(*m*-carboxylphenyl)-propan-2-one (bark)	Zhang *et al.* (2009)
2-(*m*-carboxylphenyl)- 3-(*m*-carboxylbenzyl) succinic acid (bark)	Zhang *et al.* (2009)

contents, flavonoid contents, etc., are the phytoconstituents present in *C. manghas* that determine its antioxidant activity (Maharana *et al.* 2015, 2020; Iawsipo *et al.* 2017).

4.2 *Anticancer activity*

Cardiac glycoside (Neriifolin) from *C. manghas* reduced viability of HepG2 cells, induced S and G2/M phase arrests of the cell cycle, and stimulated apoptosis of HepG2 cells. Neriifolin can be considered for the treatment of hepatocellular carcinoma (Zhao *et al.* 2011). Cardiac glycoside (Tanghinigenin) is found in the seed of *C. manghas.* This compound can reduce the viability of human promyelocytic leukemia HL-60 cells and can efficiently induce apoptosis in HL-60 cells (Wanga *et al.* 2010). Cardenolides present in the roots of *C. manghas* have antiproliferative properties against a human colon cancer cell line (Col2) and the Ishikawa cell line (Chang *et al.* 2000). New cytotoxic Cardenolides glycosides (7, 8-sehydrocerberin, deacetyltanghinin, and tanghinin) of *C. manghas* seed also have antiproliferative properties against oral human epidermoid carcinoma (KB), human breast cancer cell (BC), and human small cells lung cancer (NCI-H187) (Cheenpracha *et al.* 2004). Cerberin compound has potential anti-carcinogenic properties (Kour 2014; Liu *et al.* 2008). *Apocynaceae* family species contains cardioactive glycosides, as in *C. manghas* (Sakushima *et al.* 1976). Cardiac glycoside, i.e., β-D-glucosyl-(1–4)-α-L-thevetosides of 17β-digitoxigenin (GHSC-73) of *C. manghas* seed can reduce the viability of human hepatocellular carcinoma HepG2 cells (Feng *et al.* 2012).

4.3 *Anti-inflammatory activity*

Methanolic extracts of *C. manghas* have anti-inflammatory actions on LPS-stimulated macrophages. These actions are mediated by targeting c-Jun N-terminal

kinase (JNK) in the AP-1 signalling pathway (Yi *et al.* 2016). Inhibition of Syk/Src and the NF-κB pathway by kaempferol could play a key role in the anti-inflammatory pharmacological action of *C. manghas* (Jeong *et al.* 2014).

4.4 *DNA damage protective activity*

GHSC-74, i.e., 2′-epi-2′-O-Acetylthevetin B (cardiac glycoside), present in seeds of *C. manghas* inhibit human hepatocellular carcinoma HepG2 cells by inducing S and G2 phase arrest of the cell cycle and by triggering apoptosis (Feng *et al.* 2010).

4.5 *Antimicrobial activity*

Plants from the genus *Cerbera* have potential antifungal properties (Iqbal *et al.* 2017; Susilo *et al.* 2019). Water extract of *C. manghas* leaf has the effect of killing fungi like *Aspergillus* species and *Penicillium* species (Sukmawati 2016). Water extract of *C. manghas* leaves are effective against many bacteria (Rajathi and Nambaru 2014). Both butanol and hexane extract of *C. manghas* leaves have antibacterial activity against *Klebsiella pneumoniae*. Butanol leaf extract is more powerful than the Hexane leaf extract of *C. manghas* (Musdja *et al.* 2018).

Ethanolic extracts of *C. manghas* are effective against vesicular stomatitis (VSV) viruses (Ali *et al.* 1996). Both ethyl acetate and dichloromethane extracts of *C. manghas* leaf have antibacterial activity against *Staphylococcus aureus* and *Escherichia coli.* Dichloromethane leaf extract has a little stronger antibacterial activity than the ethyl acetate leaf extract in *C. manghas* (Musdja *et al.* 2019).

5. Conclusion

Several *in vitro* studies reported that *C. manghas* has therapeutic potential which includes antioxidant, antimicrobial, anti-inflammatory, analgesic, anticancer, and DNA damage protection activities. The maximum numbers of compounds present in this species are cardiac glycosides followed by terpenoids, phenolic acids, iridoids, flavonoids, steroids, and lignans. The majority types of compounds are present in the leaf followed by fruits or seed, stem, and root. This review highlighted several ethnobotanical, pharmacological, and phytochemical properties of *C. manghas.*

References

Ali AM, Mackeen MMM, EI-Sharkawy, *et al.* 1996 Antiviral and cytotoxic activities of some plants used in Malaysian indigenous medicine Pertanika. *J. Trop. Agric. Sci.* **19** 129–136

Anwar HM, Amirul IM, Suman S, Mushfiqur R and Afjalus SM 2013 Assessment of phytochemical and pharmacological properties of ethanolic extract of *Cerbera manghas* L. leaves. *Int. Res. J. Pharm.* **4** 120–123

Barceloux DG 2012 *Medical Toxicology of Natural Substances: Foods, Fungi, Medicinal Herbs, Plants, and Venomous Animals* (Wiley) p 857

Basak UC, Das AB and Das P 1995 Metabolic changes during rooting in some cutting of 5 mangroves species of Orissa. *Plant. Growth. Regul.* **17** 141–148

Basak UC, Das AB and Das P 2000 Rooting response in stem cuttings from five species of mangrove trees: effect of Auxins and enzyme activities. *Mar. Biol.* **136** 185–189

Cao LL, Tian HY, Wang YS, Zhou X, Jiang R and Liu YH 2013 Chemical constituents in fruits of mangrove plant *Cerbera manghas* L. *J. Chin. Pharm. Sci.* **48** 1052–1056

Chan EWC, Wong SK, Chan HT, Baba S and Kezuka M 2016 *Cerbera* are coastal trees with promising anticancer properties but lethal toxicity: a short review. *J. Chin. Pharm. Sci.* **25** 161–169

Chang LC, Gills JJ, Bhat KP, Luyengi L, Farnsworth NR, Pezzuto JM and Kinghorn AD 2000 Activity-guided isolation of constituents of *Cerbera manghas* with antiproliferative and antiestrogenic activities. *Bioorg. Med. Chem. Lett.* **10** 2431–2434

Cheenpracha S, Karalai C, Rat-A-Pa Y, Ponglimanont C and Chantrapromma K 2004 New cytotoxic cardenolide glycoside from the seeds of *Cerbera manghas*. *Chem. Pharm. Bull.* **52** 1023–1025

Eddleston M and Persson H 2003 Acute plant poisoning and antitoxin antibodies. *J. Toxicol. Clin. Toxicol.* **41** 309–315

Eganathan P, Rao CS and Anand A 2000 Vegetative propagation of three mangrove tree species by cutting and air-layering. *Wetl. Ecol. Manag.* **8** 281–286

Feng B, Guo YW, Huang CG, Li L and Jiao BH 2012 β-D-Glucosyl-(1–4)-α-L-thevetosides of 17β-digitoxigenin from seeds of *Cerbera manghas* L. induces apoptosis in human hepatocellular carcinoma HepG2 cells. *Exp. Toxicol. Pathol.* **64** 403–410

Feng B, Guo YW, Huang CG, Li L, Chen RH and Jiao BH 2010 2′-epi-2′-O-Acetylthevetin B extracted from seeds of *Cerbera manghas* L. induces cell cycle arrest and apoptosis in human hepatocellular carcinoma HepG2 cells. *Chem.-Biol. Interac.* **183** 142–153

Fern K 2014 Useful tropical plants database. *Cerbera manghas*. http://tropical.theferns.info/query.php?full=Cerbera+manghas

GBIF (Global Biodiversity information Facility) Backbone Taxonomy. *Cerbera manghas* L. in GBIF Secretariat 2019. Checklist dataset. https://doi.org/10.15468/39omei accessed via GBIF.org

Govaerts R 2003 World Checklist of Selected Plant Families Database in ACCESS: 1-216203. The Board of Trustees of the Royal Botanic Gardens, Kew. www.plantsoftheworldonline.org/taxon/urn:lsid:ipni.org:names:60436653-2

Hossain MAASM, Sarkar S, Saha S and HossainHasan MLMM 2013 Biological assessment on *Cerbera manghas* (linn.). *Pharmacol. Online Arch.* **1** 155–160

Iawsipo P, Choksawangkarn W, Promdan C and Nilkasam P 2017 Antibacterial and antioxidant activities of *Cerbera manghas* and *C. odollam* leaf extracts. *Burapha Sci. J.* **22** 1–12

Iqbal Z, Iqbal MS and Mishra K 2017 Screening of antioxidant property in medicinal plants belonging to the family Apocynaceae. *Asian J. Pharm. Clin. Res.* **10** 415–418

Jeong HY, Sung GH, Kim JH, Yoon JY, *et al*. 2014 Syk and Src are major pharmacological targets of a *Cerbera manghas* methanol extract with kaempferol-based anti-inflammatory activity. *J. Ethnopharmacol.* **151** 960–969

Kour A 2014 Plants exhibiting potential for cancer treatment. *Int. J. Pharm. Sci. Rev. Res.* **27** 23–53

Lee SK, Mbwambo ZH, Chung H, Luyengi L, Gamez EJ, Mehta RG, Kinghorn AD and Pezzuto JM 1998 Evaluation of the antioxidant potential of natural products. *Comb. Chem. High Throughput Screen.* **1** 35–46

Leeuwenberg AJM 1999 Flora of Tropical East Africa. Wageningen Agric. Univ. Pap. **98**(3) 5–64. http://www.plantsoftheworldonline.org/taxon/urn:lsid:ipni.org:names:60436653-2

Lemmens RHMJ 2006 *Cerbera manghas* L. in *PROTA (Plant Resources of Tropical Africa/Ressources végétales de l'Afrique tropicale)* (eds) Schmelzer GH and Gurib-Fakim A (Wageningen, Netherlands)

Liu PC, Liu MH, Chen SY, Cherng WJ and Wang CH 2008 Sea mango cardiac intoxication. *Acta Cardiol. Sin.* **24** 9–56

Maharana PK and Basak UC 2015 Salt induced morpho-biochemical changes in vegetatively propagated back mangrove *Cerbera manghas* during hardening. *J. Appl. Environ. Biol. Sci.* **5** 127–133

Maharana PK and Basak UC 2020 Effect of NaCl on bio-molecular changes during hardening of vegetatively propagated mangrove species *Cerbera manghas*. *Int. J. Bot. Stud.* **5** 41–45

Musdja MY, Aeni M and Djajanegara I 2018 Comparison of antibacterial activities leaves extracts of *Cerbera manghas* and leaves extracts of *Azadirachta indica* against *Klebsiella pneumoniae*. *Asian J. Pharm. Clin. Res.* **11** 51–55

Musdja MY and Chadidjah Djajanegara I 2019 Antibacterial activity of dichloromethane and ethyl acetate extracts of bintaro leaf (*Cerbera manghas* L.) against *Staphylococcus aureus* and *Escherichia coli*. *Int. J. Curr. Res.* **11** 398–402

Rajathi FAA and Nambaru VRMS 2014 Phytofabrication of nano-crystalline platinum particles by leaves of *Cerbera manghas* and its antibacterial efficacy. *Int. J. Pharma. Bio. Sci.* **5** 619–628

Sakushima A, Nishibe S, Hisada S, Noro Y and Hisada Y 1976 Studies on the constituents of Apocynaceae plants; isolation of flavonol glycosides and some other components from the leaves of *Cerbera manghas*L. *Yakugaku Zasshi* **96** 1046–1048

Scott S and Thomas C 2000 *Poisonous Plants of Paradise: First Aid and Medical Treatment of Injuries from Hawaii's Plants* (Honolulu, HI: University of Hawaii Press) p 37

Sukmawati D 2016 Antagonism mechanism of fungal contamination animal feed using phylloplane yeasts isolated from the bintaro plant (*Cerbera manghas*) Bekasi in Java, Indonesia. *Int. J. Curr. Microbiol. App. Sci.* **5** 63–74

Susilo A, Haryanta D and Sa'adah TT 2019 Response of *Riptortus linearis* towards the aplication of Bintaro (*Cerbera manghas*) leaf extract, Eurasia. *J. Biosci.* **13** 2217–2224

Tarmadi D, Himmi SK and Yusuf S 2014 The efficacy of the oleic acid isolated from *Cerbera manghas* L. seed against a subterranean termite, *Coptotermes gestroi* Wasmann and a drywood termite, Cryptotermes cynocephalus Light. *Proc. Environ. Sci.* **20** 772–777

Upadhyay VP, Mishra PK and Sahu JR 2008 Distribution of Mangrove Species within Bhitarkanika National Park in Orissa, India. *Trees Life J.* **3** 4

Ved DK, Kinhal GA, Ravikumar K, Sankar RV, Sumathi R, Mahapatra AK *et al.* 2008 Conservation Assessment & Management Prioritisation for Medicinal Plants of Orissa. A synthesis of Regional expertise in medicinal plants Taxonomy & Distribution through a workshop held at Bhubaneswar during 7th-10th October 2007. Regional Plant Resource Centre, Bhubaneswar & FRLHT, Bangalore 2008, pp 45

Ved DK, Sureshchandra ST, Barve V, Srinivas V, Sangeetha S, Ravikumar *et al.* 2016 *Cerbera manghas* L., india biodiversity portal. FRLHT's ENVIS Centre on Medicinal Plants, Bengaluru. FRLHT, Bengaluru and MoEFCC, GoI

Wiart C 2006 *Medicinal Plants of Asia and Pacific* (Boca Raton: CRC Press/Taylor and Francis)

Wanga G, Guo Y, Fenga B, Li L, Huanga C and Jiaoa B 2010 Tanghinigenin from seeds of *Cerbera manghas* L. induces apoptosis in human promyelocytic leukemia HL-60 cells. *Environ. Toxicol. Pharmacol.* **30** 31–36

Xiaopo Z, Yue-hu P, Ming-sheng L, Sheng-li K and Jun-qing Z 2010 Chemical constituents from the leaves of *Cerbera manghas*. *Asian Pac. J. Trop. Med.* **3** 109–111

Yamauchi T, Abe F and Wan ASC 1987 Studies on Cerbera. IV.1 Polar cardenolide glycosides from the leaves of *Cerbera odollam* and *Cerbera manghas*. *Chem. Pharm. Bull.* **35** 4813–4818

Yan LH 2010 Study on the chemical constituents of *Cerbera manghas*. Thesis. Hainan University

Yi YS, Cho JY and Kim D 2016 *Cerbera manghas* methanol extract exerts anti-inflammatory activity by targeting c-Jun N-terminal kinase in the AP-1 pathway. *J. Ethnopharmacol.* **193** 387–396

Yu S and Qin H 2019 Botanic Gardens Conservation International (BGCI) & IUCN SSC Global Tree Specialist Group. *Cerbera manghas*. The IUCN Red List of Threatened Species 2019

Zhang XP, Liu MS, Zhang JQ, Kang SL and Pei YH 2009 Chemical constituents from the bark of *Cerbera manghas*. *J. Asian Nat. Prod. Res.* **11** 75–78

Zhang X, Pei Y, Liu M, Kang S and Zhang J 2010 Chemical constituents from the leaves of *Cerbera manghas*. *Asian Pac. J. Trop. Med.* **3** 109–111

Zhang XP, Pei YH, Liu MS, Kang SL and Zhang JQ 2011 Triterpenoids from the leaves of *Cerbera manghas*. *Nat. Prod. Res. Dev.* **23** 443

Zhao Q, Guo Y, Feng B, Li L, Huang C and Jiao B 2011 Neriifolin from seeds of *Cerbera manghas* L. induces cell cycle arrest and apoptosis in human hepatocellular carcinoma HepG2 cells. *Fitoterapia* **82** 735–741

Corresponding editor: BJ RAO