

Sundarban is a potential source for anticancer and antioxidant plant

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A thesis submitted to the Department of Mathematics and Natural Sciences in partial fulfillment of the requirements for the degree of
Bachelor of Science in Biotechnology

Department of Mathematics and Natural Sciences
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Declaration

It is hereby declared that

1. The thesis submitted is my/our own original work while completing degree at Brac University.
2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The thesis does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. I/We have acknowledged all main sources of help.

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Approval

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Ethics Statement

No human or animal subjects were studied in this experiment. Also no harms of any environmental substances were done by this experiment.

Abstract/ Executive Summary

Different factors, for example, physical, compound, ecological, metabolic and hereditary variables that play a direct as well as aberrant part in the acceptance and disintegration of various kinds of cancer. It was assessed that there were about 10.9 million of new cases, 6.7 million of passings, and over 24.6 million of people influenced with malignant growth all throughout the planet by 2002. Malignancy has now become the subsequent significant reason for human demise solely after cardiovascular disease. The significant reasons for which are smoking, dietary uneven characters, chemicals and constant contaminations prompting persistent inflammation. Albeit numerous engineered drugs have been utilized and much advancement has been accomplished for the therapy of malignant growth infection, nonetheless they are inclined to unfavorable results. The clinical treatments in dealing with malignancy like radiation, chemotherapy, safe balance and medical procedure are restricted, as obvious by their high bleakness and mortality rates. However there are various plants accessible with against carcinogenic properties, still persistent exertion has been given for search of medications of new plant beginning other than normal customary plants sources. Mangroves have been known since the society time to be profoundly helpful and dynamic against different infections and are strong wellsprings of bioactive mixtures including cancer prevention agent, hostile to diarrheal, against aggravation, against diabetic and furthermore anticancer compounds. Countless bioactive mixtures of drug significance have additionally been accounted for from the mangroves ecosystem. Present audit is meant to give a concise status on the most extreme utility of mangrove plants against various types of malignant growth, the potential bioactive mixtures secluded from them and their future imminent for complete destruction of disease.

Keywords: Sundarban, Anticancer, Antioxidant etc.

DEDICATION

I would feel honored to dedicate my work to my late father Sahjahan Kabir Chowdhury. I lost my father in this year's February. He was suffering from cancer and there was hardly any treatment that could have treated him. I hope one day I will be capable enough to work in this topic and will have a potential drug against cancer.

Acknowledgement

I would like to start by thanking the Almighty Allah for granting us to live this long and also fulfilling me with the strength and enough patience to finish my thesis work and accomplish all the objectives successfully.

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List of Acronyms

UNESCO: United Nations Educational, Scientific and Cultural Organization.

FC: Folin-Ciocalteu

QE: Quercetin counterparts

GAE: Gallic corrosive counterparts

AAE: Ascorbic Acid Equivalent

CHAPTER 1

Introduction

Mangroves are woody, particular sorts of trees filling in saline wetlands in the tropical and sub-tropical between flowing waterfront zones and waterway deltas where different plants can't develop. There are about 39.3 million sections of land of mangrove woodlands in the warm coastlines of tropical seas everywhere on the world. Among these the Sundarban (scope $21^{\circ} 31' - 22^{\circ} 30'$ North and longitude $88^{\circ} 10' - 89^{\circ} 51'$ East) is the biggest single square of flowing halophytic mangrove woodland in the world (1). The name Sundarban, in a real sense signifying "wonderful timberland" is accepted to be gotten from Sundari or Sundri (*Heritiera fomes*), perhaps the most plentiful tree species found in this forest (2). The backwoods lies in the Ganges-Brahmaputra Delta along the Bay of Bengal and is spread across spaces of Bangladesh and West Bengal, India, shaping the offshore edge of the delta. The occasionally overflowed Sundarban freshwater swamp woods lie inland from the mangrove backwoods. Of the all out 10,000 km² region, Indian Sundarban mangrove woodland covers 4,266.66 km² and the rest is covered with Bangladeshi Sundarban mangrove forest (2). The biodiversity of Sundarban mangrove backwoods is rich and wide-running for which both of its Indian and Bangladeshi parts have been pronounced as World Heritage Site by UNESCO in 1987 and in 1997 respectively (2,3). Mangroves flourish in very upsetting and threatening climate of high saltiness, elevated and low tides of water, high temperature and dampness, solid breezes and sloppy anaerobic soil. Other than these abiotic stress conditions, factors, for example, bugs and microorganisms contribute to a great extent in fostering the biotic pressure to the local area. There is presumably no other gathering of plants with such profoundly created morphological and physiological variations to such outrageous conditions. To flourish in such antagonistic conditions, changes in their physiological cycles have happened bringing about the amalgamation of novel substance compounds; these synthetic mixtures offer assurance to these plants against different biotic and abiotic stresses referenced above (4-6), some of these mixtures or optional metabolite particles have critical natural and other medicinal properties that can be abused in forming better human medical care needs. Truth be told, numerous

mangrove plant species have their utilizations in people or customary medication as remedies for different sicknesses and for other business purposes (7). These synthetic mixtures got from the normal sources, for example, the mangroves can assume huge parts in the new medication disclosure process (8). However, extraordinary logical works should be completed to dig further into this sparsely investigated at this point promising region to unfurl the rich wellsprings of significant solution for the medical care of humanity. The current survey endeavors conversation on the natural exercises and compound examinations did on mangrove plants *Ceriops decandra*, *Xylocarpus granatum*, *Xylocarpus moluccensis*, *Excoecaria agallocha*, *Sarcolobus globosus*, *Sonneratia caseolaris* and *Acanthus ilicifolius* from the Sundarban estuary traversing India and Bangladesh.

CHAPTER 2

Materials and Methods

Chemicals and Reagents:

Ethanol, Distilled water, Folin-Ciocalteu (FC) reagent, Gallic acid, Na_2CO_3 , H_2SO_4 (0.6M), Ascorbic acid, Na_3PO_4 , Ammonium Molybdate Ethanol, Gallic acid (as positive control), Methanol, Quercetin, 5 % Sodium Nitrite (NaNO_2) solution, 10% Aluminium Chloride (AlCl_3) solution, 1M Sodium Hydroxide (NaOH) solution

Collection of plants: Selected plants were collected directly from the Sundarban, Koromjal range Mongla, Khulna, Bangladesh and identified at Bangladesh National Herbarium, Mirpur, Dhaka, where vouchers have been issued against each plant species.

Preparation of plant extract: The leaves and flying root were cut into little pieces and the shade dried materials were granulated into fine powder which had been made totally without any water content. Then, at that point about 150gm of powdered materials were macerated into adequate ethanol for 10 days. After filtration through Whatman channel paper, the filtrates were accumulated at 400 C with a rotational vanishing. The concentrated concentrates were then saved in singular holders in fridge with demakation.

Determination of total phenolic content: The Folin–Ciocalteu technique (Singleton, Orthofer, and Lamuela-Raventos, 1999) (9) was utilized to decide absolute phenolic content. Each ethanolic test (5 g) was weakened to 50 ml with refined water and separated through Whatman No. 1 paper. This arrangement (0.5 ml) was then blended in with 2.5 ml of 0.2 N Folin–Ciocalteu reagent for 5 min and 2 ml of 75 g/l sodium carbonate (Na_2CO_3) was then added. After brooding at room temperature Absorbance of the combinations was estimated at 750 nm (UV-Visible Ultraspec 2000 spectrophotometer, England). Gallic corrosive (0–200mg/l) was utilized as standard to create the alignment bend. The mean of three readings was utilized and the all out phenolic content was communicated in mg of gallic corrosive counterparts (GAE)/100 g of concentrate.

Determination of Total flavonoid contents: The complete flavonoid content was resolved utilizing the Dowd strategy as adjusted by Arvouet-Grand, et al., 1994 (10). Momentarily, 5 ml of 2% aluminum trichloride ($AlCl_3$) (Labosi, Paris, France) in methanol (Fluka Chemie, Switzerland) was blended in with a similar volume of a nectar arrangement (0.01 or 0.02 mg/ml). The absorbance was estimated at 510 nm against the clear by utilizing spectrophotometer (twofold shaft Shimadzu UV/apparent spectrophotometer (Model 1800, Japan and were taken after 10 min against a clear example comprising of a 5 ml nectar arrangement with 5 ml methanol without $AlCl_3$. The complete flavonoid content was resolved utilizing a standard bend with quercetin (Sigma–Aldrich Chemie, Steinheim, Germany) (0–50 mg/l) as the norm. The mean of three readings was utilized and communicated as mg of quercetin counterparts (QE)/100 g of concentrate.

Determination of total tannin contents: The absolute tannin content was resolved utilizing the Folin-Ciocalteu phenol reagents as revealed by Amorim et al., 2008 (11). Briefly 0.1 ml of the example extricate is added with 7.5 ml of refined water and afterward added 0.5 ml of Folin-Ciocalteu phenol reagent, 1 ml of 35% sodium carbonate arrangement and weaken to 10 ml with refined water. The blend was shaken all around kept at room temperature for 30 min and absorbance was estimated at 725 nm with a twofold bar UV/Visible spectrophotometer twofold shaft Shimadzu UV/noticeable spectrophotometer (Model 1800, Japan). The absolute tannin content was resolved as mg of Gallic corrosive identical per gram of dry concentrate got from a standard Gallic corrosive alignment bend. The mean of three readings was utilized and the complete phenolic content was communicated in mg of gallic corrosive counterparts (GAE)/100 g of concentrate.

Estimation of total antioxidant capacity: The all-out cancer prevention agent limit of the concentrates was dictated by phosphomolybdate strategy by the technique for Prieto et al., 1999 (12). 0.3 ml of concentrate and ascorbic corrosive utilized as standard and clear (ethanol) were joined with 3 ml of reagent combination independently and hatched at 95°C for an hour and a half. Subsequent to cooling to room temperature, the absorbance of each example was estimated at 695 nm against the clear. The complete cancer prevention agent content was resolved utilizing a standard bend by phosphomolybdate strategy utilizing ascorbic corrosive as a standard (13). The

mean of three readings was utilized and communicated as mg of Ascorbic Acid Equivalent (AAE)/100 g of concentrate

Statistical Analysis

Every one of the examines were acted in three-fold and the outcomes are communicated by the mean qualities and standard deviation. Huge contrasts for various correlations were dictated by single direction examination of difference (ANOVA) trailed by Dunnet's test. The investigation was completed utilizing Microsoft® Office Excel (Microsoft® , USA), where upsides of $p \leq 0.05$ were considered measurably huge.

CHAPTER 3

3.1 Anticancer compounds/drugs from medicinal plants

Medicinal plants involve a significant situation for being a central wellspring of medication revelation regardless of its classifications bunches spices, bushes or tree (14). Over the previous decade, generous advancement on the quest for new medications and bioactive mixtures from the plants and their protected and viable conveyance in the treatment of various types of infections has been made (15). Practically 60% of medications supported for malignant growth treatment are of regular beginning and the premium on normal wellsprings of potential chemotherapeutic specialists is consistently expanding with time. These plants have critical anticancer mixtures that acts viably against bosom, lung, stomach, colon, and prostate malignancy, alongside numerous myeloma and leukemia. Plant determined regular items with antitumor properties has been comprehensively characterized into 12 particular substance bunches to be specific; alkaloids, phenylpropanoids, terpenoids, aldehydes, glycosides, lignans, lipids, unsaponified lipids, nucleic acids, polysaccharides, proteins and unidentified compounds (16). Normal items, particularly optional metabolites from plants have been utilized as wellsprings of meds from old occasions. Synthetic substances like alkaloids, phenolic compoundss, steroids, and terpenoids are results of auxiliary digestion and have pharmacological toxicological, and other environmental significance that can be possibly utilized in drugs (18). This cycle has worked with to deliver amazingly an assorted exhibit of more than 1, 39,000 normal items and mixtures containing medicinally helpful alkaloids, glycosides, terpenoid subordinates, polyphenolic mixtures, steroids, thus forth (17). About 25% of the plants have been read for their medicinal properties and more than 3000 types of plants have been accounted for to have against malignancy properties (19,20). Among the most popular plant-determined anticancer medications are the vinca alkaloids, vincristine and vinblastine disengaged from the Madagascar periwinkle (*Catharanthus roseus*) with expected anticancer properties and the taxane paclitaxel disconnected from the Pacific yew (*Taxus brevifolia*) (21). Other plant based anticancer medications incorporate camptothecin subordinates topotecan and irinotecan, etoposide and paclitaxel (22,23). Anticancer properties of plant extricates or secluded results of plant beginning can accordingly be perhaps investigated for

improvement of anticancer medications. Some therapy of malignant growth over the bygone eras are Aloe vera, Euphorbia tirucalli, Zedoary (Curcuma zedoaria), Neem (Azadirachta indica), Turmeric (Curcuma longa), Sunflower (Helianthus annuus) and Tabebuia impetiginosa. A portion of different plants that have likewise been utilized for therapy against malignant growth are summed up in table 1.

3.2 Anticancer compounds/drugs from mangrove plants

Mangrove is quite possibly the most useful environment and a rich wellspring of biodiversity including phytoplanktons, microalgae, endophytes and higher plants. Mangroves are salt open minded woodland environments discovered mostly in tropical and sub-tropical intertidal locales of the world. They flourish in an unconventional climate and fill in as a connecting environment among freshwater and marine systems (24). World's mangrove plants have more than 84 species (counting 12 assortments) in 24 genera and 16 families. The genuine mangrove plants comprises of 70 species (counting 12 assortments) in 16 genera and 11 families, and semi-mangrove plants comprises of 14 species in eight genera and five families (25). These rich biological systems give a wide scope of natural and monetary items and administrations, and furthermore support an assortment of other beach front and marine environments of the customarily significant therapeutic plants utilized in There are restricted explores on utilizing home grown concentrates which are generally bound to earthbound plants. Works identified with the hunt of bioactive mixtures from seaside mangrove plants for their utilization in pharmacological area is to a great extent ignored (26). These plants have higher cell reinforcement and antibacterial potential contrasted with the ordinarily developing plants because of the presence of upgraded level of optional metabolites. Aside from this, mangrove plants have likewise shown various different exercises which are therapeutically and financially valuable. Mangroves wetland biological system has rich bio-prospecting potential attributable to the presence of significant qualities to endure saltiness and flood, it likewise have novel phytochemicals to defeat unfriendly beach front conditions (27,28). Mangroves make due in outrageous climate condition and are known to emit various sorts of auxiliary metabolites. A few mangrove animal categories are utilized in conventional medication or have discovered application as insect sprays and pesticides. They have additionally drawn in the consideration for drug and different enterprises during the new years. These plants address an extraordinary asset of one of a kind optional metabolites. There are a couple of bioactive mixtures

with anticancer properties disengaged from mangroves plants (Table-2, Figure 1). Anticancer mixtures secluded from the mangrove *Xylocarpus granatum* are the tetranor triterpenoids (xylogranatins A–D) which are cytotoxic against different malignant growth cell-lines and the limonoids granaxylocarpins A and B are cytotoxic against the P-388 leukemia cells (29). The naphthoquinones, 3-chlorodeoxylapachol and stenocarpoquinone B, which are isolated from *Avicennia germinans* and *A. marina* separately, are firmly cytotoxic against a wide scope of malignant growth cell-line, including K562 and HeLa (30,31). The cardenolide glycosides classes of compound including 2'- O-acetyl cerleaside A, 17b-neriifolin, and cerberin disengaged from the seeds of *Cerbera odollam* possessing anticancer properties as announced by Laphookhieoa et al.(32). These are cytotoxic against a scope of cell-lines, including KB and NCI-H187. The synthetic constructions of some anticancer compounds from selected mangrove plants are summed up in Table 3.

3.3 Some potential plants:

3.3.1 *Ceriops decandra*

C. decandra (Griff.) Ding Hou (Rhizophoraceae), privately called Jale Goran or Jhamti Goran in Bengali, is an evergreen bush or little tree upto 5 m tall and are normal in Indian Sundarbans. The entire plant is utilized as an astringent and the plant parts are utilized to stop discharge and treat ulcers, torment and hepatitis (33). Though a couple of substance examinations on *C. decandra* from different pieces of India and the globe uncovered the presence of diterpenoids, triterpenoids and lignins (34-36), strikingly little investigations on the science and the organic action of the species from Indian or Bangladeshi Sundarbans have been accounted for till date (36-41). Study by Ghosh et al.,[15] uncovered huge substance of lipids, sterols and triterpenes from the leaves of *C. decandra* from Indian Sundarban area. The examination additionally uncovered the sterol and triterpene creation of the leaves of the species. Misra et al., announced the hydrocarbon and wax ester profile from the leaves of this species from Indian Sundarban alongside six different types of mangroves (42). Uddin et al., announced the antinociceptive movement of ethanol concentrate of leaf and pneumatophore of the species from Bangladeshi Sundarban showing critical hindrance of acidic corrosive instigated squirming in mice (36). An investigation on the leaf, bark and pneumatophore from the types of Bangladeshi beginning showed intense expansive range action

against both Gram-positive and Gram-negative bacteria(43). Another examination by Banerjee et al., exhibited solid cancer prevention agent movement of the stem bark extricate (diminishing force as Ascorbic corrosive same = 13.04 mg/g and diphenyl picryl hydrazyl [DPPH] revolutionary rummaging capacity as IC50 = 0.65 mg/ml) of *C. decandra* (Perr.) Robinson from Indian Sundarban (44) . A new report by Hossain et al., (45) showed the antioxidative property of bark of the species from Bangladeshi Sundarbans which is in accordance with a past report by Banerjee et al. The examination additionally exhibited huge calming movement by the species . Chaudhuri and Guha announced the presence of antifungal action of the leaf and organic product concentrates of the species against *Fusarium oxysporum* (46). Another new examination by Simlai and Royannounced the phytochemical substance and the antimicrobial movement of *C. decandra* separates and the solidness of this movement against outrageous warm and pH treatment (47). The investigation additionally announced the incomplete recognizable proof of the nature of the dynamic constituents displaying the antimicrobial movement utilizing slender layer chromatography (TLC) fingerprinting procedure.

3.3.2 *Xylocarpus granatum*

X. granatum Koeing (Meliaceae), privately called Dhundul in Bengali, is an evergreen tree with dark bark and fills in the between flowing edge timberland and stream bank (2). Extracts of various pieces of the plant are accounted for to be utilized customarily as help for fever including one brought about by intestinal sickness, aggravation, loose bowels, the runs, cholera and other stomach issues in specific pieces of the globe (3,7). Due to its quality rosy dark shaded lumber, the wood is misused for carpentry works, bringing about the shortage of the species in the Indian piece of the Sundarban (2). The bark of the plant is utilized for tanning and for the readiness of golden colors as well (48). Investigation on the concentrates of Bangladeshi *X. granatum* uncovered potential for focal sensory system (CNS) depressant movement and DPPH revolutionary searching activity (49, 50). Chemical examination by Wangenstein et al. (51) from the bark of *X. granatum* of Bangladeshi Sundarban uncovered the presence of four recently revealed limonoids [Figure 1], i.e., xyloccensin O (1), xyloccensin P (2), xyloccensin Q (3) and gedunin (4). The examination additionally uncovered the presence of two flavonoids, catechin (5) and epicatechin (6) and procyanidins of the B1 (7), trimer (8) and pentamer (9) type with catechin as the starter and epicatechin as the extender.

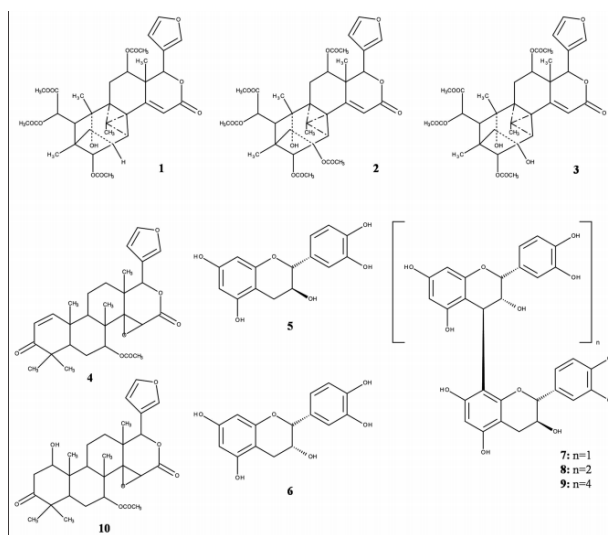


Figure 1 (52) Structures of compounds isolated from *Xylocarpus granatum* (1-10)

Assessment of the cancer prevention agent movement (DPPH extremist rummaging and 15-lipoxygenase [15-LO]) exhibited high action in the event of catechin and procyanidins, of which procyanidin of the pentamer type was found to have the greatest action (IC₅₀: DPPH: 3.3 ± 0.3 μM, 15-LO: 9 ± 1 μM) [Table 1].

Plant species	Isolated compounds reported to possess biological activity	Biological activities of the isolated compounds
<i>Xylocarpus granatum</i>	Xylocensin O (1), xylocensin P (2), gedunin (4), catechin (5), epicatechin (6), procyanidin B1 (7), procyanidin trimer (8), procyanidin pentamer (9)	DPPH radical scavenging activity (compounds 1, 2, 4-9) ^[3,25] 15-LO activity (compounds 1, 2, 5-9) ^[3,25] anti-colon cancer activity (compound 4) ^[26]
<i>Xylocarpus moluccensis</i>	Procyanidin trimer (15), procyanidin pentamer (16), procyanidin hexamer (17), procyanidin decamer (18), procyanidin undecamer (19)	DPPH radical scavenging activity (compounds 15-19) ^[21] 15-LO activity (compounds 15, 17-19) ^[21]
<i>Sarcobolus globosus</i>	Sarcobolin (20), tephrosin (22), 12α-hydroxydeguelin (24), 11-hydroxytephrosin (25), 12a-hydroxyrotenone (26), 6α,12α,12a-hydroxyelliptone (27), 6a, 12a-dehydrodeguelin (28), barbigerone (30), 6,7-dimethoxy-2,3-dihydrochromone (31), genistin (34), vanillic acid 4-O-β-D-glucoside (35), glucosyringic acid (36), tachioside (37), isotachioside (38)	DPPH radical scavenging activity (compounds 20, 22, 25-27, 31, 34, 37, 38) ^[3,25] 15-LO activity (compounds 20, 22, 24-28, 30, 31, 34-38) ^[3,25] brine shrimp lethality (compounds 20, 22, 26) ^[3,25]
<i>Sonneratia caseolaris</i>	Luteolin (39), luteolin 7-O-β-glucoside (40)	DPPH radical scavenging activity (compounds 39, 40) ^[25]

Table 1 (52): Biological activities of the compounds reported to be isolated from the mangrove plants of Sundarban estuary

This is in accordance with another investigation did by Wangenstein et al. (3) Uddin et al. (50) disengaged and distinguished two limonoids [Figure 1], gedunin (4) and 1α-hydroxy-1,2-dihydrogedunin (10) from the bark of *X. granatum* of Bangladeshi Sundarban and revealed the anticolon malignancy movement of gedunin (4) [Table 1]. The IC₅₀ an incentive for cytotoxic

capability of gedunin (4) against CaCo-2 colon malignant growth cell line was discovered to be 16.83 μM . This shows the critical anticancerous property of the compound. Antidiarrheal property of its bark of Bangladeshi Sundarban beginning has likewise been accounted for hence legitimizing its utilization in the customary home grown medicine (48). The methanol concentrate of the bark at oral portions of 250 mg/kg and 500 mg/kg showed critical antidiarrheal movement in the castor oil and magnesium sulfate incited murine models individually. Daula and Basher (53) exhibited the plant rootlet and shoot development inhibitory movement just as antimicrobial action of the species from Bangladeshi Sundarban. The antimicrobial capability of the plant is in accordance with the examinations detailed by Alam et al., (54) and Wangenstein et al. (3) Potent wide range antibacterial action against both Gram-positive and Gram-negative microorganisms was additionally detailed by Uddin et al. (43) from this types of Bangladeshi beginning.

3.3.3 *Xylocarpus moluccensis*

X. moluccensis (Lamk.) Roem. (Meliaceae), a medium estimated tree, for the most part become away from the regular flowing inundation (2). Traditionally the bark of the plant is utilized to treat gastrointestinal issues like looseness of the bowels, the runs, fever including that from intestinal sickness and has astringent properties; the organic product is utilized as a Spanish fly and utilized as a solution for elephantiasis and expanding of the breast. Uddin et al. (55) showed the antidiarrheal action of the methanolic concentrate of the bark of the plant from Bangladeshi Sundarban in the castor oil and magnesium sulfate instigated mice and antibacterial property subsequently approving the plant's utilization in gastrointestinal issues in conventional medication. Alamgir et al. (49) and Sarker et al. (56) showed the neuropharmacological property of *X. moluccensis* from Bangladeshi Sundarban showing the CNS depressant action in mice. However no antimicrobial movement from leaf was seen by Uddin et al. (43), however Haque et al. (57) announced the presence of solid antimicrobial exercises of rough concentrates from stem bark and three segregated unadulterated mixtures (structures not explained) called XM-1, XM-2 and XM-3. The examination additionally recommended the presence of cytotoxic movement towards saline solution shrimp nauplii, showed by the unrefined concentrate of Bangladeshi *X. moluccensis*. Mondal et al. (58) announced antimicrobial movement of pneumatophores of the species and proposed the species as a significant hotspot for antimicrobial mixtures. The pneumatophore

concentrates of the plant of Bangladeshi (Sundarban) beginning exhibited moderate cytotoxic action against human bosom ductal carcinoma cells (MDA-MB-453S) and human gastric adenocarcinoma cells (AGS cell line) (59). In a new report, various procyanidins have been accounted for from this plant by Wangenstein et al. (3) while artificially examining the bark of the plant from Bangladeshi Sundarban. The examination uncovered the presence of flavonoids [Figure 2] catechin (11) and epicatechin (12) and few procyanidins, for example procyanidin B1 (13), procyanidin B3 (14), procyanidin trimer (15), procyanidin pentamer (16), procyanidin hexamer (17), procyanidin decamer (18) and procyanidin undecamer (19).

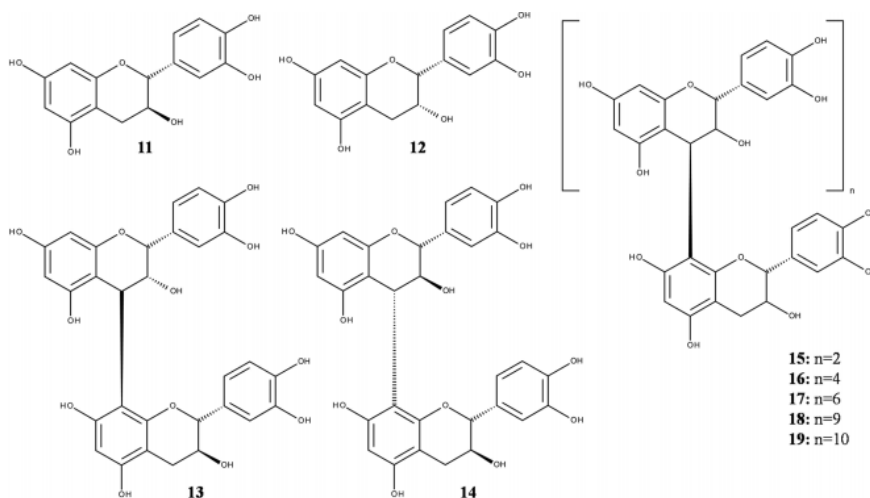


Figure 2 (52): Structures of compounds isolated from *Xylocarpus moluccensis* (11-19)

Their investigations uncovered the presence of DPPH extremist rummaging movement and 15-LO restraining exercises in these confined procyanidins and antimicrobial.

3.3.4 *Excoecaria agallocha*

E. agallocha L. (Euphorbiaceae), privately called Geoa or Gnea in Bengali, is a medium dioecious tree upto 15-20 m tall (2). Parts of the plant have therapeutic properties and are utilized to treat epilepsy, conjunctivitis, dermatitis, hematuria, infection and toothache (7). The species from Bangladeshi Sundarban is accounted for to have neuropharmacological action when tried on mice at higher dosage (49). Subhan et al. (60) announced strong antinociceptive and gastroprotective impact of the rough ethanolic concentrates of bark from *E. agallocha* of Bangladeshi Sundarbans. Another examination by Subhan et al. (61) showed a couple of organic exercises, for example, neuropharmacological, antimicrobial and cytotoxicity impact of the ethanolic extricate from the

plant bark of Bangladeshi beginning. In this examination, the concentrate was found to have possible impact on the CNS, displayed critical antimicrobial movement and considerable cytotoxic impact on saline solution shrimps; be that as it may, the concentrate showed low degree of poisonousness in mice. The investigation by Subhan et al. (62) additionally exhibited the presence of cell reinforcement exercises in the tissue concentrates of this plant from Bangladeshi Sundarban. In another examination, Hossain et al. (63) likewise detailed the antioxidative property, alongside the antiallergic property of various dissolvable concentrates from the bark of the types of Bangladeshi beginning. It was seen that the water and the ethanol part displayed the greatest cancer prevention agent and histamine discharge inhibitory movement contrasted with different portions. Kumar et al. (64) performed starter gas chromatography – mass spectrometry (GC-MS) examination of the mixtures present in the root exudates of the species from Indian Sundarbans. It is the main report on the presence of aminopyrine and palmitic corrosive in the root exudates of this species. A new report by Rahman et al. (65) on the methanolic concentrate of come from the types of Bangladeshi beginning exhibited more intense antihyperglycemic action when contrasted with a standard antihyperglycemic drug, glibenclamide in this way showing the species as an expected hotspot for antidiabetic drugs. Another investigation by Chaudhuri and Guha (46) showed that the water concentrate of bark of this species had antifungal action against a pathogenic growth, *F. oxysporum*. Regardless of these expected bioactivities, generally little examinations on the synthetic substance or mixtures answerable for these exercises of the types of Sundarban beginning have been done. A few examinations on the science uncovering the presence of phorbol ester, flavanone glycoside, different di- and triterpenoids in the *E. agallocha* from different pieces of India and abroad have effectively been reported (66-76). A new report by Mun et al. (77) uncovered the substance qualities of *E. agallocha* alongside not many other mangrove species from Bangladeshi Sundarban exhibiting the dichloromethane, lignin, pentosan, α -cellulose and so forth, content in them.

3.3.5 *Sarcolobus globosus*

S. globosus Wall. (Asclepiadaceae), known as Caw Phal in Bengali, is a prostrate or climbing bush filling in the mangrove backwoods of Sundarban estuary (2). Traditionally, the plant is utilized as an alleviation for stiffness, dengue and fever (78). In an investigation did on the species from Bangladeshi Sundarban, Wangensteen et al. (78) interestingly revealed the presence of another

rotenoid [Figure 3] sarcolobin (20) and another isoflavone sarcolobone (21). The examination likewise revealed a couple referred to rotenoids [Figure 3], for example, tephrosin (22), 12 α -hydroxyrotenone (23), 12 α -hydroxydeguelin (24), 11-hydroxytephrosin (25), 12 α -hydroxyrotenone (26), 6 α , 12 α -12 α -hydroxyelliptone (27), 6 α , 12 α -dehydrodeguelin (28), 13-homo-13-oxa - 6 α , 12 α - dehydrodeguelin (29), the isoflavone barbigerone (30) and a chromone 6,7-dimethoxy-2,3-dihydrochromone (31). The gathering interestingly revealed 6,7 dimethoxy 2,3 dihydrochromone (31) as a characteristic item. Later on, Wangensteen et al. (79) distinguished two rotenoids, villosinol (32) and 6 oxo 6 α , 12 α dehydrodeguelin (33), one isoflavone called genistin (34) and four phenolic glycosides named vanillic corrosive 4-O- β -D-glucoside (35), glucosyringic corrosive (36), tachioside (37) and isotachioside (38) interestingly from the species [Figure 3].

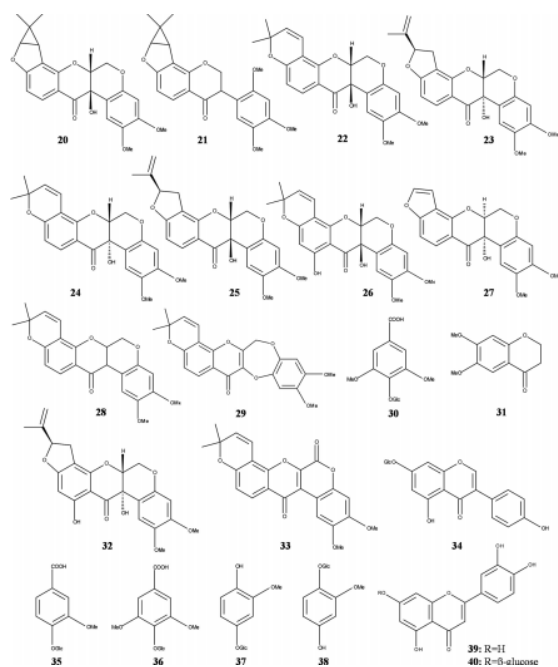


Figure 3 (52): Structures of compounds isolated from *Sarcolobus globosus* (20-38) and *Sonneratia caseolaris* (39,40)

In this investigation, the rotenoids were found to repress 15-LO yet needed DPPH rummaging movement along these lines recommending that the noticed 15-LO inhibitory impact may be because of other component than antioxidative action [Table 1]. The outcomes were discovered to be in accordance with a different report by Wangensteen et al. (3) The last investigation likewise uncovered the intense cytotoxic impact and brackish water shrimp lethality of the lipophilic

concentrates, which could be ascribed to the high measure of tephrosin and other rotenoids [Table 1]. No action was seen by Alamgir et al. (49) when *S. globosus* was tried for neuropharmacological impact on the mice. In a new report by Kuddus et al. ,(80) the bark concentrate of the types of Bangladeshi beginning showed critical cytotoxic impact in the salt water shrimp lethality bioassay, alongside the film settling movement utilizing the murine erythrocyte in the hypotonic arrangement and huge thrombolytic action in human blood example.

3.3.6 *Sonneratia caseolaris*

S. caseolaris (L.) Engl. (Sonneratiaceae), privately known as Chak Keora in Bengali, is an evergreen, medium to tall tree developing upto a stature of 10 m (2). Fruits from the species are utilized to treat dying, hemorrhages, heaps, sprain poultices. Study by Sadhu et al. (81) uncovered the presence of two flavonoids [Figure 3], luteolin (39) and luteolin 7-O- β -glucoside (40) having cancer prevention agent action (DPPH extremist searching action on TLC) [Table 1] from the dried powdered leaf of the species from Sundarban mangroves of Bangladesh. Ahmed et al. (82) noticed critical portion subordinate impact on the serum glucose and lipid profiles in rodents when regulated with the dried leaf powder from this species to their eating routine. The organization had prompted the critical abatement in serum glucose, serum fatty oil, serum absolute cholesterol and serum low thickness lipoprotein cholesterol levels when contrasted with controls. The utilization of leaf powder in the weight control plans had likewise brought about critical expansions in the serum high thickness lipoprotein cholesterol levels. The investigation recommends *S. caseolaris* leaf as a likely hotspot for antidiabetic specialists and solution for coronary sicknesses. An examination by Chaudhuri and Guha (46) uncovered the ethanolic concentrate of the leaf of *S. caseolaris* to have antifungal movement against *F. oxysporum*. In a new report on the species from Bangladeshi Sundarban, Mubassara et al.,(83) showed the species to have solid antioxidative action and diminishing force. The examination additionally showed restraint of both histamine and leukotriene B4 proposing the species to be a decent hotspot for the advancement of against hypersensitive specialists.

3.3.7 *Acanthus ilicifolius*

A. ilicifolius L.(Acanthaceae), privately called Horkoch Kanta or Horgoja in Bengali, is a hardly woody, rugged, thick plant bush of stature upto 2.5 m (2). Parts of the species are utilized as

Spanish fly and help for asthma, diabetes, diuretic, dyspepsia, hepatitis, uncleanliness, stiffness and various ailments (7). Chakraborty et al. (84) showed the chemopreventive capability of the watery leaf concentrate of the species in transplantable Ehrlich ascites carcinoma-bearing murine model showed in restricting metallothionein protein articulation and in forestalling DNA rotations in the creature liver. The examination showed diminishes in tumor cell tally, expansion in mean endurance span of the creatures, reclamation in hematological and hepatic histological profiles. Banerjee et al. (85) detailed the cell reinforcement action of the species from Indian Sundarbans. Senthil Kumar et al. (86) showed the calming movement of the leaves of the species from Indian Sundarbans utilizing the murine model. The examination showed an impressive decline of rodent paw edema. The negligible portion of the concentrate was additionally discovered to be a free extreme forager and is in accordance with another examination by Banerjee et al. (85) Leaf and bark concentrate of the species have been accounted for to have action against a pathogenic organism, *F. oxysporum* (87). A new report by Islam et al. (88) on the methanolic concentrate of *A. ilicifolius* leaves showed portion subordinate antinociceptive action against acidic corrosive instigated squirming, formalin and hot plate incited murine models. In another report by Senthil Kumar et al.,(89) the gastroprotective capability of the methanolic concentrate of the leaves from the species was exhibited utilizing various models of gastric ulceration in rodents. The concentrate displayed defensive action against the anti-inflammatory medicine, indomethacin, stress, ethanol and pylorus ligation actuated gastric ulcerations.

CHAPTER 4

Conclusion

The information presented in this review clearly show that the talked about mangrove species from the Sundarban estuary have maximum capacity for extraction of pharmacologically essential mixtures. Different classes of phytochemicals like flavonoids, limonoids, rotenoids, phenolic glycosides and so forth, have been disconnected and described from these species, various which have been accounted for to have various kinds of natural exercises. These mixtures and their subordinates may be valuable in more current medication revelation measure. In spite of the recognizable organic exercises, in any case, least drives have been taken for the ethnobotanical and ethnopharmacological contemplates, search of normal items and foundation of action structure relationship. In our writing study it was seen that however the species like *C. decandra*, *E. agallocha*, *A. ilicifolius* displayed various natural exercises there's solid lacuna in the quest for the dynamic mixtures mindful behind these exercises. From the Sundarban estuary, among the species talked about, it was tracked down that most of the works have been accounted for on *X. granatum* while *S. caseolaris* was discovered to be least detailed. Endeavor to build up movement structure relationship may likewise uncover a variety of mixtures answerable for single or various exercises, which may be of synergistic nature. For example, in an examination on *C. decandra*, two of the concentrates, which showed critical antimicrobial action during the circle dissemination test neglected to display any movement during bioautography after the detachment of the mixtures utilizing TLC.[21] This may be because of the partition of the constituents, which were showing action at the synergistic level. Action directed seclusion of bioactive mixtures have powerful application to build up the movement structure relationship. The data accessible likewise obviously expresses the absence of extreme exploration with respect to the natural action and the compound examination of the previously mentioned mangrove species from Indian Sundarban mangrove backwoods. Greater part of the investigations on the plants have been accounted for from

Bangladeshi Sundarban estuary. Extreme pursuit ought to be done to dig further into this inadequately investigated promising region from where new bioactive mixtures can be detached at last aiding in the medication disclosure measure.

The capability of bioactive plants or their concentrates to give new and novel items to infection treatment and anticipation is as yet tremendous. Medicinal plants of various beginning have been utilized since the Ayurveda

period to treat wounds, consumes and furthermore other genuine wellbeing issues. Phytochemical assessment has been gaining fast headway and home grown items are getting well known as wellsprings of conceivable anticancer mixtures. Albeit the substance constituents of the majority of the mangrove plants are as yet not been concentrated widely, examinations identified with revelation of a few novel mixtures with imminent therapeutic qualities for the disclosure of new chemotherapeutic specialists have been embraced all through the world. In any case, appropriate comprehension of the complex synergistic collaboration of different constituents of hostile to malignant growth spices in defining the plan to assault the destructive cells without making any mischief or harm the typical cells is as yet required. There is likewise colossal prerequisite for the improvement of new anticancer medications and chemotherapy systems, by the logical and efficient investigation of a pool of manufactured, organic and regular items from mangrove plants.

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