Review Article

# Chemical Investigation and Pharmacological Review of Seaweed *Turbinaria conoides*

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**ABSTRACT**

*Turbinaria conoides* is a brown-algae found in marine habitats, it possesses significant therapeutic properties. massive investigative studies on this seaweed have highlighted the information regarding its medicinal applications and chemical compounds of extracts and isolated biomolecules. The biologically active compounds shown to have potential pharmacological effects through research. Seaweeds are known to have rich nutrient values and traditionally consumed, they are utilized as thickeners, stabilizing agents, as gelling agents and used as natural fertilizers. *Turbinaria conoides* locally used to treat fevers in children have anti-cancer, antibacterial, antioxidant, antifungal, antipyretic, anti-inflammatory, immune stimulatory and anti-diabetic activities. This review provides summary of state of our understanding of pharmacological and phytochemical profile of *Turbinaria conoides* underscores its significance in drug discovery and nutraceutical development. Further investigation into its specific compounds and mechanisms of action holds promise for future therapeutic interventions.

**Keywords:** *Turbinaria conoides*, biomolecules, therapeutic properties, phytochemicals.

## INTRODUCTION

The water of the ocean are thought to have a unique variety of rich bioactive compounds, with macroalgae being the top producers of diverse secondary metabolites that have bioactive properties with potential medical applications. Marine secondary metabolites that are bioactive have received a lot of attention lately due to their unique chemistry and diverse biological characteristics.[1]

Seaweeds are traditionally consumed as food and medicine in many Asian countries and reported before 10,000 years [2]. Now a days Countries like Europe and USA are widely utilizing as food because of their nutritional values. Due to the functional properties, they became popular and used in preparations as ingredient in food industries in beverages, ice creams and also as fertilizers in agriculture and feed in aqua cultures, fuels applications[3]. Even though modern medicine has high availability in many countries, herbal medicines have significant cultural and historical importance, and in modern days numerous people are turning towards effective alternative therapies such as herbal medicines [4].

The brown marine macroalga *Turbinaria conoides* is a member of the Phaeophyceae family. In large wave act zones, it is often found in tiny clusters attached to the fissures of basalt rocks aside from the fissures of coral heads at a depth of 20 to 30 meters. This alga's physical characteristics enable it to survive in extremely challenging ecological conditions.[5] Particularly seaweed emerged as valuable resources in field of pharmacology to their diverse bioactive compounds among vast marine algae has attracted attention for its intriguing pharmacological and phytochemical properties. Over the years, scientific interest in *Turbinaria conoides* has grown, driven by its potential applications

*Turbinaria conoides* has demonstrated promising pharmacological properties, including antimicrobial, antioxidant, anti-inflammatory, antidiabetic, and anticoagulant activities[6,7]. The pharmacological significance of *Turbinaria conoides* is closely tied to its rich phytochemical composition. Chemical analyses have revealed the presence of an array of bioactive compounds, including flavonoids, phenolics, terpenoids, polysaccharides, chlorophylls, and carotenoids[8]. Compounds contribute to the diverse range of biological activities exhibited by *Turbinaria conoides*

This comprehensive review, we aim to provide the current state of knowledge regarding the phytochemical composition, and pharmacological activities of *Turbinaria conoides*.

### *Turbinaria conoides* profile:

*Turbinaria conoides* is a brown macro algae belongs to the family **Sargassaceae,** widely distributed in tropical and subtropical marine ecosystems, exhibits distinct morphological characteristics. [9]

**Biological Description:** *Turbinaria conoides* is a Brown algae belonging to the **Sargassaceae** family.

They are primarily found in tropical marine source (sea or ocean waters), generally grown on hard substrates. It is often preferentially consumed by herbivorous fishes.

**Geographical Description**: Found in Indian Ocean Coastal Regions from Iran to Madagascar and Pseychelles, Aldabra, Mauritius Persian Gulf, Reunion East, India and Indonesia.

**Figure 1:** *Turbinaria conoides*

**Morphology**

**1. Thallus Structure**: *Turbinaria conoides* thalli are usually thick and dichotomously branching, creating dense mats or clusters. They are made up of ribbon-like, flattened structures that might have a wide, blade-like look or a more cylindrical one.

**2. Color:** *Turbinaria conoides* ranges in color from olive-brown to golden brown, frequently showing deeper tones at the base of the branches and lighter tones at their tips.

**3. Growth Form:** The flattened, disc- or cup-shaped structures that algae frequently produces at the tips of its branches give it a unique look. These structures resemble cups and are made of segments or plates that overlap.

**4. Dimensions:** *Turbinaria conoides* come in a broad range of sizes. Larger thalli can form on some specimens, whereas smaller, more compact development may occur on others.

**5. Attachment:** In shallow and tropical marine environments, *Turbinaria conoides* normally binds itself to stony materials or coral substrates via a holdfast.

**6. Reproduction:** *Turbinaria conoides* replicates both sexually and asexually, like a lot of brown algae. Spores are produced during sexual reproduction, whereas new thalli are formed by fragmentation or the creation of new reproductive structures during asexual reproduction.

**Applications**

- Locally, *Turbinaria conoides* has been consumed occasionally and treats fevers in children.
- It is also used as a natural **fertilizer** and **insect repellent.**
- Additionally, *Turbinaria conoides* serves as a source of **algin**, **tannins**, and **phenols**.
- *Turbinaria conoides* has been traditionally recognized for its antibacterial properties.
- **Alginate Extracts**: *Turbinaria* is utilized for its alginate extracts, which serve as thickening, gelling, and stabilizing agents in **food**, **beverages**, **cosmetics**, and **pharmaceutical products**.
- **Environmental Applications**: The genus has shown promise in removing lead from aqueous solutions.

**Chemical characterization *Turbinaria conoides:***

*Turbinaria conoides* crude extraction was done using water, methanol, petroleum ether and acetone, sulphuric acid, HCl based on targeted biomolecule to be isolated. The petroleum ether and acetone extracts of *Turbinaria conoides* used to isolate polysaccharide-fucoidan, laminaran and algin that are reported to have antioxidant activity [10] and sulphuric acid and hydrochloric acid extracts of *Turbinaria conoides* used in purification and characterisation of polysaccharides carrageenan, ulvan, agar, and furcellaran along with fucoidans, alginate, laminaran. The potential use of polysaccharides in tissue engineering, drug delivery systems, wound healing and other in biomedical engineering applications are investigated [11].

The alginates are extracted by soaking in formaldehyde and then treating with sodium carbonate the precipitation was formed in ethanol as sodium salts redissolved with water and neutralised with NaOH and then with HCl [12].

The fractionation of *Turbinaria conoides* organic extract yielded three 2H pyranoids they are 1)methyl-21-yl-[5′, 6′-dihydro-5′-yl-{54-(4-hydroxybenzoyl)-oxy-(52-methylbutyl)}-3′-methyl-2H-pyran]-21-methyl butanoate 2) 11-[(3′, 6′-dihydro-4′-methyl-2′-oxo-2H-pyran-3′-yl)methyl]-10-methylhexyl benzoate and 3)[6-ethyl-3,4-dimethyl-(tetrahydro-2′, 2 6′-trimethyl-2H-pyran-3′-yl)-2,5-cycloheptadiene]-1-propanoate [13].

The macrocyclic lactones known as conoidecyclics A-C are resulted when organic extract was fractionated. Where conoidecyclic A has potential anti-inflammatory activity when ibuprofen is a standard drug against cyclo oxygenase -2 and 5- lipoxygenase [14].

Fucoidan extracted from brown algae *Turbinaria conoides* is compared with the fucoidan extracted from green algae *Padina tetrastromatica* using water and HCl extracts revealed that water extracts yield 30% more fucoidan compared to organic extract [15]. When organic extract of *Turbinaria conoides* was fractioned chromatographically the isochromanyl metabolite called turbine chromanone was isolated which was characterized as methyl 4-[(3S)-8-{[(3R)-4-ethyl-2,3-dihydrofuran-3-yl] methyl}-1-oxo-3,4-dihydro-1H-2-benzopyran-3-yl] butanoate which have anti-inflammatory activity effectively [15].

The sodium alginate is found in cell-walls of brown seaweed (Phaeophyceae)[16]. The sodium alginate is extracted from the brown seaweed and protein content analysed by using lowry method[17], carbohydrates estimated by dubois method[18], uronic acid content estimated using Bitter and muir[19] method. The phytochemical qualitative analysis was carried out by FT-IR analysis and functional groups analysed by Kbr pellet

method found that only saponins are present in the alginate. Swelling behaviour of alginate provides scope in new drug delivery systems [20].

The ethanolic extract spectrophotometrically analysed for chemical constituents belonging to the classes such as alkaloids, saponins, tannins, terpenoids, phenols, flavonoids, glycosides, steroids, reducing sugars, coumarins and found absence of alkaloids, steroids and resins. [21]

From the aqueous extract of *Turbinaria conoides* collected from Tamil Nadu, Mandapam region was prepared by boiling the deionised water for 15 mins and strained the treated with silver and gold and incubated to synthesize nanoparticles they are characterized using UV spectrophotometer, fourier transform infrared (FTIR) in the range of 4000 and 400cm$^{-1}$. The nanoparticles showed high inhibition of bacterial biofilm formation effectively. The silver nanoparticles studied to have potent anti microfouling and can be resolve biofouling issues in aquacultures [23].

Unknown steroids 14,15,18,20-diepoxyturbinarin and 3,6,17-trihydroxy-stigmasta-4,7,24(28)-triene and a known fucosterol are isolated from cyclohexane extract and based on spectroscopic evidences structures are elucidate [24].

The fractionated polysaccharides from the *Turbinaria conoides* isolated was structurally elucidated using Uv-visible and FT-IR spectroscopy techniques and reported to have radical scavenging and anti-oxidant activity. [27]

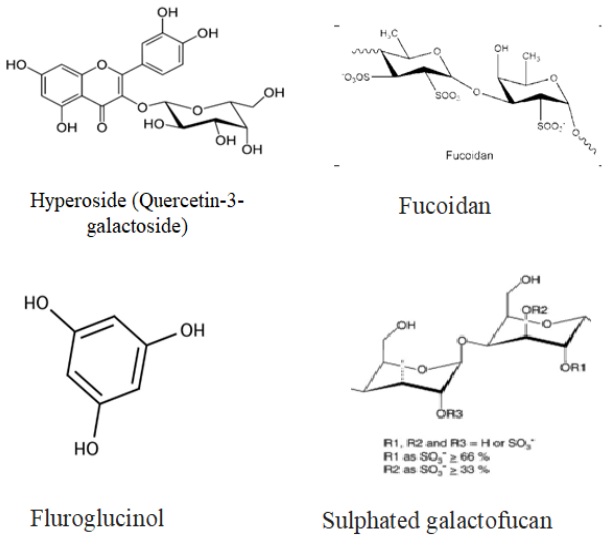


**Figure 2:** Some of isolated compounds from *T. conoides*

**Pharmacological activities of *Turbinaria conoides:***

**Anti-oxidant activity:**

Invitro Anti-oxidant activity is performed using Ferric reducing Anti-oxidant power (FRAP),1,1-diphenyl-2-picryl hydrazyl (DPPH), Cupric reducing Anti-oxidant capacity (CUPRAC), Hydrogen peroxide assay and ABTS methods.

The polysaccharide fucoidan isolated from the petroleum ether and acetone extract have shown potential anti-oxidant activity with ferric reducing antioxidant power (FRAP) and 1,1-diphenyl-2-picrylhydrazyl (DPPH) assays [10].

Hexane, dichloromethane and ethyl acetate extracts and aqueous extracts has highest antioxidant activity was examined by ABTS radical assay. superoxide radical assay generated by xanthine oxidase system found to have radical scavenging activity in ethyl acetate fraction of brown seaweed. Ethyl acetate fraction found to show anti-oxidant activity when iron chelation and uric acid formation inhibitory assay compared to standards L-ascorbic and β-carotene[21].

The ethanolic extract of *Turbinaria conoides* functional salt preparations can be used as alternative for hypertensive patients because of sodium potassium ratio while using completely randomized design it is found to have moderate antioxidant activity using (FRAP) method and very potent anti-oxidant activity using CURPAC method [22].

Fractionated polysaccharides from the extract were evaluated for anti-oxidant activity by hydrogen peroxide radical scavenging assay and DPPH assay also reported to have potential activity [27].

**Anti-inflammatory**

The 2H pyranoids yielded from organic extract of *Turbinaria conoides* exhibited potent antioxidant and anti-inflammatory by inhibiting COX-1 IC 50 and COX -2 IC 50 applications [13] .

The biomolecule turbine chromanone isolated from organic extract have shown potent anti- inflammatory activity when displayed with standard diclofenac. It also has anti-oxidant 5-lipoxygenase and cyclooxygenase-2 inhibition property and have pharmaceutical and biotechnological applications [15].

The sodium alginate extracted for the *Turbinaria conoides* when used in preparations of hydrogels, microfilms and encapsulation were discussed and stated when alginate is formulated with collagen shows anti-inflammatory property in rats, if it is encapsulated tamoxifen shown sustained anti-cancer activity [20].

**Anti-bacterial activity:**

The ethanolic extract, hexane, dichloromethane and ethyl acetate extracts of *Turbinaria conoides* reported to have antibacterial activity expressed in milli meter diameter of zone of inhibition when examined by disc diffusion method[21].

The nanoparticles synthesized from aqueous extract investigated for the antibacterial activity against 4 marine biofilm forming strains they are *E. coli, Salmonella sp. , S. liquefaciens and A. hydrophila* were inoculated and incubated for 12hrs in zobell marine broth, then on to mueller hinton agar with 50% seawater using sterile cotton swab experimental wells are prepared and zone of inhibition is calculated and reported silver nanoparticles

synthesised from extract have anti-bacterial antifouling activity [23]. The steroids isolated from the cyclohexane extracts are having moderate inhibition activity on the bacteria [24].

**Anti-cancer activity:**

The ethanolic extract of *T. conoides* shown anticancer activity when evaluated by analyzing cytotoxicity by MTT assay, cell cycle arrest by flow cytometer that examines morphological changes of cells through mitochondrial membrane capacity and nuclear contents and apoptosis in HepG2 cell lines under fluorescence microscopy showed increased synergistic effects over quercetin standard compound [21].

The cytotoxicity effect of nanoparticles synthesized from the aqueous extract to *T. conoides* was shown when performed using the *Artemia salina (*brine shrimps) and mortality was observed to be proportionate directly to concentration of the silver nanoparticles [23].

Sulphated polymers of brown seaweed -fucoidan from brown seaweed have mainly fucose, galactose, xylose and glucuronic acid recorded to have anti-cancer activity when examined for cell viability, nuclear morphology and mitochondria assay on cancer cell lines such as hepatoblastoma – (hepG2) and MTT assay comparing with quercetin and concluded that fucoidan can be used in chemo therapy and radiation treatments [26].

The fucoidans effectively examined on human lung adenocarcinoma epithelial cell line A549 which are cultured in fatal bovine serum and reported growth inhibition, apoptosis detected by ethidium bromide straining. The study stated fucoidan from extract showed effective cell cycle arrest, apoptosis, inhibition of proliferation of A549 cells invitro and can be further used as anticancer agent [28].

**Anti-fungal activity:**

The unknown compound 14,15,18,20-diepoxyturbinarin isolated from cyclohexane extract have potent anti-fungal activity on *Aspergillus niger*, thus can be developed as new antifungal drug in future [24].

**Anti histaminic activity:**

14,15,18,20-diepoxyturbinarin is unknown steroid isolated from the cyclohexane reported to have effective antihistaminic activity whereas 3,6,17-trihydroxy-stigmasta-4,7,24(28)-triene from same extract shows moderate activity when compared with control chlorpheniramine maleate. They also investigated for the antiviral and cytotoxicity by colorimetric formazan-based MTS assay in Crandell-Rees feline kidney cells (CRFK) but no effective results were reported [25].

**Anticoagulant activity:**

*Turbinaria conoides* fractionated polysaccharides pronounced highly to have invitro anticoagulant activity of human plasma (APTT, PT), confirmed in prolongation time of intrinsic coagulant pathway. It also showed mosquito larvicidal activity on *Aedes aegypti* and *Eteromorpha compressa* on *Culex quinquefasciatus* [27].

## CONCLUSION

*Turbinaria conoides,*a brown seaweed, displays promise owing to its rich chemical composition comprising polysaccharides, macrocyclic lactones and various bioactive compounds. Studies suggest potential pharmacological properties, including antioxidant, anti-inflammatory, antifungal, anti-bacterial, anti-histaminic, and possibly anticancer effects. While these findings are encouraging for medicinal and nutritional applications, further research is necessary to comprehend its mechanisms fully and address challenges like bioavailability.

*Turbinaria conoides* holds potential for future pharmaceutical and biomedical exploration, yet comprehensive investigations are crucial to harness its benefits effectively.

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