International Journal of Research and Development in Pharmacy & Life Science
An International Open access peer reviewed journal
ISSN (P): 2393-932X, ISSN (E): 2278-0238
Journal homepage: http://ijrdpl.com

Review Article

Pharmacological aspects of *Turbinaria*

Alka*, Nidhi Tyagi and S. Sadish Kumar

Department of Pharmacology, I.T.S. College of Pharmacy, Murad- Nagar, Uttar Pradesh, India

Keywords: Seaweeds, Phaeophyceae, *Turbinaria*, antifungal, terpenoid, alkaloids

Article Information:

Received: March 31, 2017;
Revised: April 20, 2017;
Accepted: May 07, 2017

Available online on:
15.06.2017@http://ijrdpl.com

http://dx.doi.org/10.21276/IJRDPL.2278-0238.2017.6(4). 2648-2653

ABSTRACT: Seaweeds, are plant-like organisms that generally live attached to rock or other hard substrata in coastal areas. The brown color of these algae results from the dominance of the xanthophyll pigment fucoxanthin. Brown algae (Phaeophyceae) is a genus of *Turbinaria* found in tropical marine waters, which grows on rocky substrates. *Turbinaria* species are consumed by herbivorous fishes and echinoids in tropical areas, it has a low level of phenolics and tannins. It is widely distributed in tropical and subtropical areas of central, western Pacific and Indian Ocean. *Turbinaria* belongs to the class- Anthozoa, Order-Scleractinia, family-Dendrophylliidae, Genus-*Turbinaria*. Different extracts of the *Turbinaria* shows the presence of phytoconstituents like alkaloids, terpenes, phenols, tannins, saponins, flavonoids, quinones, proteins, sugars, carbohydrates, alkaloids, coumarins, steroids, terpenoids and cardiac glycosides, they exhibit pharmacological activities like antipyretic, antimicrobial, antidiabetic, antioxidant, hepatoprotective, antifungal, antiulcer, antitumor, anticoagulant, antibacterial.

⇑ Corresponding author at:
Alka, Department of Pharmacology, I.T.S. College of Pharmacy, Murad- Nagar, Uttar Pradesh, India
E-mail address: alka2660@gmail.com

INTRODUCTION

Brown algae (Phaeophyceae) is a genus of *Turbinaria* found in tropical marine waters, which grows on rocky substrates. *Turbinaria* species are consumed by herbivorous fishes and echinoids in tropical areas, it has a low level of phenolics and tannins [1]. It survived very well, species fragments were slower growing of all the animals. Estimated time of regeneration is to be 24-36 months. Cut areas were quickly healed and rounded out, species is abundantly found in Pohnpei lagoon but regeneration time is longer. This species collected locally, it grows slowly and rounded out well after fragmentation and it start curling attractively at the edges after 5-6 months of growth. It turns brown in low light conditions [2].

MORPHOLOGY

The height of bushy corallum is 20 cm, branches are erect, base is encrusting, on opposite sides twisted and flattened branches develop irregular corallites.

In the plane of the branches between the previously formed and the next previously formed corallites new extra-tenracular buds appears. Length of cylindrical coralliti is more than 10 mm. long without buds and have an average of 4 mm in diameter, spongy wall calices are circular and have an average internal diameter of 3 mm. Septa is peripherally thick in the wall and thin axially, upper margins drop to the level of columella 36 to 40 in number, irregularly arranged, the fusing to the lower cycles of septa.

Columella is deep, chicoraceous, trabecular column about half the internal diameter of the corallites. Exterior free parts of the corallites are very compact but porous, the surface appears smooth but have vernicule-echinulate. The growth form in *Turbinaria* is characteristically foliate with barely protuberant corallites. The calice are smaller 2.5- 3 mm,14 to 16 mm thick slightly taper towards corallites, septa are wedge-shaped and the sublamellar columella. The loose ramose form grows in relatively sheltered sites.

Table 1: Current species of *Turbinaria* [3]

S. No.	Name of algae	Discovered by	Year
1.	*Turbinaria condensate*	Sonder	1860
2.	*Turbinaria conoides*	Kutzing	1860
3.	*Turbinaria crateriformis*	W.R. Taylor	1966
4.	*Turbinaria decurrens*	Bory de Saint-Vincent	1828
5.	*Turbinaria denudate*	Bory de Saint-Vincent	1828
6.	*Turbinaria elatensis*	W.R. Taylor	1965
7.	*Turbinaria filamentosa*	Yamada	1925
8.	*Turbinaria foliosa*	M.J. Wayne	2002
9.	*Turbinaria gracilis*	Sonder	1845
10	*Turbinaria indica*	Gopalkrishnan	1974
11.	*Turbinaria kenyaensis*	W.R. Taylor	1966
12.	*Turbinaria luzonensis*	W.R. Taylor	1964
13.	*Turbinaria murrayana*	E.S. Barton	1891
14.	*Turbinaria ornate*	J. Agardh	1848
15.	*Turbinaria papenfussil*	W.R. Taylor	1964
16.	*Turbinaria parvifolia*	C.K. Tseng & Lu	1983
17.	*Turbinaria tanzaniensis*	Jassund	1976
18.	*Turbinaria triquetra*	Kutzing	1849
19.	*Turbinaria turbinate*	Kutzing	1898
20.	*Turbinaria vulgaris*	J. Agardh	1848

Rough-water environments form stunted, compact, fasciculate colonies. The polyps have unpleasant Sulphur odor, yellow in color [4].

HIERARCHY

CLASS : Anthozoa

ORDER : Scleractinia

FAMILY : Dendrophylliidae

GENUS : *Turbinaria*

Sensitivity of these corals are generally tolerant, forgiving and do not need any specialized care. Polyps are medium sized feed on variety of foods including cyclopeeze, mysis and brine shrimp and other meaty aquarium foods. When healthy polyps of many species fully expanded, the coral will look bushy with tentacles. *Turbinaria* can adapt to a wide range of lighting conditions, to acclimate to new lighting prevents bleaching. These corals can be particularly vulnerable to sediment damage. The corals minimize collection of debris and place in areas of moderate to high water flow [5].

DISTRIBUTION & HABITAT

It is widely distributed in tropical and subtropical areas of Central, Western Pacific and Indian Ocean. *Turbinaria* very commonly found in mid intertidal to at least 30 m deep. It grows on variety of habitats including tide pools, rocky intertidal, intertidal benches, reef flats and deeper water. Brown alga *turbinaria* are very common it also found intertidally on Hawaiian reefs throughout the Indian and Pacific Ocean.

The crevices of basalt rocks in high wave action areas as well as in the crevices of coral heads at 20-30 meters deep attached to the small clusters form of this algae, due morphological characteristics of this alga enable it to survive in extreme environmental conditions and this alga is capable of recolonization if the thallus removed. It exhibited seasonal changes [6].

Optimal initial fragment size: 70-80 mm square

Best growing conditions: eutrophic or fast flowing with oceanic water exchange.

Preferred substrate: live rock disk

Time to harvest: 6-8 months

Optimal harvest size: 90-100 mm

Aquarium hardiness: high [7]

The habitat of the most species is stiff, cone and compact. The leaf-vesicles are stipulating, turbinate or pyramidal and crowned with a peltate lamina. All the lateral species of *Turbinaria* is terminated by triangular or rectangular with one or two edges of teeth, flat or concave outer face, it will depend upon the species. In most of the species proximal art of the leaf is terete, but it is ridged or winged in some species.

In most of the species of *Turbinaria* the leaves have an air vesicle embedded within the peltate enlargement. Thalli are attached by a well-developed system of spreading hapterous branches emanating from the main axes [8].

PHYTOCHEMICAL CONSTITUENTS

Different extracts of the *Turbinaria* shows the presence of alkaloids, terpenes, phenols, tannins, saponins, flavonoids, quinones, proteins, sugars, carbohydrates, alkaloids, coumarins, steroids terpenoids and cardiac glycosides [9].

REPORTED PHARMACOLOGICAL ACTIVITIES

Kandasamy Kathiresan *et al*., (2014), have investigated the synthesis of silver and gold nanoparticles by different extract of brown seaweeds (*Turbinaria ornata*) through analytical techniques. The size of the nanoparticles was determined by scanning electron microscopy and dynamic light scattering and result shows the appearance of brown and ruby red color which indicate the presence of silver and gold nanoparticles which was confirmed by UV-Vis spectrophotometer, scanning electron microscopy and dynamic light scattering and concluded that silver and gold nanoparticles shows antimicrobial activity against human pathogens [10].

K. S. Khalifa *et al*., (2016), have evaluated the aqueous extracts of *Turbinaria tubinita* for antitumor efficiency of different concentrations of silver nanoparticles. Silver nanoparticles were synthesized by the reduction of silver nitrate in the algal aqueous extracts. The most cytotoxic silver nanoparticles were examined by TEM, SEM, EDAX, X-ray and FT-IR and result indicated that trypan blue exclusion test shows a decrease in EAC cells viability by increasing AgNPs concentration in tested algae and concluded that Silver nanoparticles biosynthesized by *Turbinaria turbinata* were the most cytotoxic against EAC *in vitro* [11].

S. Sadish Kumar *et al*., (2009), Brown alga, *Turbinaria conoides* have evaluated with n-hexane, cyclohexane, methanol and ethanol-water for acute antipyretic activity study reveals that n-hexane, cyclohexane and ethanol-water extracts caused increase in serum cholesterol, protein and alkaline phosphatase levels and concluded that Cyclohexane extract exhibited more significant antipyretic activity than the other extracts [12].

Poonam Sethi *et al*., (2014), have investigated the water, methanol: toluene extracts of *Turbinaria* for activity against Tobacco necrotic virus (TNV) and bacteria. Local lesion method was adopted and the result reveled that toluene: methanol extract of *Turbinaria* exhibited good activity. The study concluded clearly that *turbinaria* had a profound antimicrobial activity and it may be useful in the treatment of various infectious bacterial diseases [13].

Seniwati Dali *et al*., (2012), have evaluated the protein fraction from chocolate algae *Turbinaria decurrens* to inhibit the growth of *Salmonella typhi* and *Staphylococcus aureus*, the highest protein concentration was found in the 0-20% fraction of the chocolate algae, using a layered jelly diffusion method on MHA medium antibacterial activity was performed. The study concluded that the highest antibacterial activity to *Staphylococcus aureus* was found in whole extracts [14].

Hardoko *et al*., (2014), the whole brown seaweed has investigated for the ability of laminaran, fucoidan and alginic fractions from *Turbinaria decurens*.

In vitro antidiabetic activity was performed by using α-glucosidase enzyme. The results show the inhibition activity toward α-glucosidase enzyme, laminaran fraction of brown seaweed showed higher activity compared to fucoidan fraction, whereas the alginic fraction showed no inhibition activity and concluded that the brown algae show the antidiabetic property [15].

Anong Chirapart *et al*., (2010), have evaluated polysaccharides extracted by boiling the dried seaweed samples in water .The total polysaccharide yield, total carbohydrate, sulfate content and sugar components were determined, result reveled fucose and mannose as a main component in all extracts and the antimicrobial activity determined at 2 mg/ml, in most of the extracts were not only inactive against the microorganisms that were tested but actually promoted microbial growth study concluded that the extracts have antimicrobial activity [16].

Walailuck Boonchum *et al*., (2011), have evaluated the extract of *Turbinaria conoides* with water or ethanol and they are examined for phenolic compounds and antioxidant activities, the result revealed that the aqueous extracts (AE) showed higher antioxidant activities and phenolic contents than ethanolic extracts and concluded that the dried *T. conoides* had a potential to antioxidative agent in nutraceutical products [17].

P.S. Unnikrishnan *et al*., (2014), have evaluated the methanol and acetone extract of, *Turbinaria ornata* for their antidiabetic potential using enzyme inhibitory assays (α-amylase, α-glucosidase, and dipeptidyl peptidase-IV) result reveled that significant inhibitory effects on α-amylase, α-glucosidase and dipeptidyl peptidase. Study concluded that *Turbinaria ornata* can be used as a potential source for further *in vivo* studies in controlling hyperglycemia [18].

J. John Peter Paul *et al*., (2014), have determined the histochemical and fluorescence analysis of *Turbinaria ornata* and result showed positive reaction to phenol compounds, polyphenol and tannin extracts of *Turbinaria ornata* and concluded that the histochemical and the fluorescence analysis could be used for rapid identification of potential medicinal plants and bioactive compounds [19].

K. Preethi *et al*., (2010), have evaluated the methanolic extract of *Turbinaria ornata* for anti -oxidant activity, result shows the presence of antioxidants and concluded the presence of anti-oxidant activity in *Turbinaria ornate* [20].

C. Parthiban *et al*., (2011), have evaluated the acetone and ethanolic extract of *Turbinaria ornata* for antioxidant activity result shows the presence of antioxidants and concluded the presence of antioxidant property [21].

Vijayabaskar *et al*., (2011), have evaluated the methanolic extracts of *Turbinaria ornata* against various Gram positive and Gram negative human pathogenic microbes for antimicrobial activity, result shows the presence of antimicrobial agent and

concluded that methanol extracts of *T. ornata* serve as a good source of antimicrobial agents in pharmaceutical industry [22].

Annappan Murugan *et al*., (2013), have evaluated acetone extract of *Turbinaria ornata* for antiulcer, wound healing and hepatoprotective activities and result showed marked wound-healing activity and effect on the serum marker enzymes indicating prominent hepato-protective activity and concluded the presence of wound healing activity [23].

Vijayabaskar P. *et al*., (2012), have evaluated the polyphenol extract of *Turbinaria ornata* for antioxidant activity and result shows the better scavenging activity of DPPH and concluded the presence of phenolic compounds which revealed the antioxidant activity [24].

Nirmal kumar *et al*., (2014), have evaluated the carbohydrate extract of *Turbinaria ornata* in acetone, ethanol and chloroform for antifungal activity and result deals with the assessment of the chemical composition of carbohydrate, protein, phenol, flavanoid, chlorophyll and carotenoid and concluded the presence of antifungal activity [25].

Soottawat Benjakul *et al*., (2015), have evaluated the methanolic and ethanolic extracts of *Turbinaria ornata* for antioxidant activity and result shows the presence of phenolic content and concluded that methanolic extract contained the highest total phenolic content and exhibited the highest antioxidant activity [26].

D. Vijayraja *et al*., (2015), have evaluated the presence of free radicals and imbalance in oxidant and antioxidant in *Turbinaria ornata* for antioxidant, antiulcer, hepatoprotective activities, result shows the presence of free radicals in *Turbinaria ornata* and concluded the presence of antioxidant, antiulcer, wound healing and hepatoprotective activities [27].

Mohammed A. *et al*., (2012), have evaluated the boiled water extract of the brown algae *Turbinaria ornata*, the oleic acid and palmitic acid were extracted by organic solvents for antitumor activity result shows the presence of oleic acid and palmitic acid in *Turbinaria ornata* and concluded that antitumor activity of palmitic acid was higher than the oleic acid [28].

Shyamali S. *et al*., (1998), have evaluated the acetone extract of *Turbinaria ornata* for antioxidant activity and result shows the presence of carbohydrate from the brown seaweeds *Turbinaria ornata* and concluded the presence of the antioxidant activity [29].

M. Manoj Saravana *et al*., (2015), have evaluated the methanolic extract of *Turbinaria ornata* for the antioxidant activity result shows the free-radical scavenging capacity of crude sulphated polysaccharides (CSP) from *Turbinaria ornata* and concluded that *Turbinaria ornata* possess antioxidant and free-radical scavenging capacity [30].

Ayman M. Mahmoud *et al*., (2009), have evaluated the acetone extract of *Turbinaria ornata* for protective effects of the brown seaweed *Turbinaria ornata*, against cyclophosphamide (CP), result shows the presence of polysaccharide, galactans and concluded that *Turbinaria ornata* extract showed a marked hepatoprotective effect against CP induced hepatotoxicity [31].

Sarah Joy Bittick *et al*., (2009), have studied that one organism lives close association with another result shows the effect of close association and concluded that when *Turbinaria ornata* aggregations were removed experimentally, there was a Significant increase in the number of associate algal species, local increase in algal richness [32].

Sradhasini Rout *et al*., (2015), have determine that *Turbinaria ornata* contains chemical component like agar, gelatin carrageenan or alginate, carbohydrates, proteins dietary minerals particularly iodine, polyphenols, carotenoids, flavonoids, dietary fibers, vitamins and iron result shows the presence of different chemical compound shows different activity and concluded that seaweeds possess anti-oxidant, antimicrobial, antifungal, anti-inflammatory and antidiabetic properties could be used in the form of food, energy, medicine and pharmaceutical industries [33].

Sridharan, M.C. *et al*., (2012), have evaluated chloroform, methanol, chloroform: methanol and petroleum ether extracts of *Turbinaria conoides* for in vitro for their antibacterial activities against *Escherichia coli, Salmonella typhi, Staphylococcus aureus, Pseudomonas aeruginosa* and *Proteus mirabilis* with the disc diffusion method**.** The study shows the importance of *Turbinaria conoides* to produce new compounds having antibacterial activity and concluded the presence of antioxidant activity [34].

Kala K. J*et al*., (2015), have investigated the cytotoxic activity of fucosterol isolated from *Turbinaria conoides*,**.** Trypan blue viability assay was performed on Dalton's lymphoma ascites **(**DLA cell lines) to evaluate the cytotoxic potential of the compound. Result reveled that fucosterol proved to be effective against these malignant cells and inhibit cell proliferation against *in vitro* DLA cells, and concluded the potential role of fucosterol in developing safe medicines against malignant lymphoma [35].

D. Sekar *et al*., (2015), have evaluated the extract of *Turbinaria conoides* using five different solvents (methanol, ethanol, acetone, ethyl acetate, and chloroform). The extracts were tested against Gram positive and Gram negative human pathogenic bacteria by Disc diffusion method. and result reveled that minimum activity was observed in ethyl acetate extract of *Turbinaria conoides* against *Escherichia coli*. Study concluded that the extract *Turbinaria conoides is* a rich source of potential bioactive molecules which can be isolated and further screened for various biological activities [36].

N. Shanthi, *et al*., (2014), extracts of the *Turbinaria decurrens* were evaluated for anticoagulant activity. Two fractions of fucoidan one with low molecular weight and another with high molecular weight showed anticoagulation activity under *in vitro* APTT assay. Fucoidan isolated using DEAE Cellulose column was characterized by FTIR and concluded that the anticoagulation activity was an increased with increase in the sulphate content in the fucoidan [37].

Ameer Junaithal Begum M. *et al*., (2016), have evaluated the extract of Turbinaria *conoides* against root rot pathogen *Fusarium oxysporum* for their antifungal activity, result revealed that the no mycelial growth in 15 % and 20 % sea weed extract weed extract treated plates, visible inhibition of mycelial growth was noticed in all the concentrations, the increased concentration of 15 and 20 % had shown 100 % inhibition, and concluded the presence of antifungal activity [38].

P. Senthilkumar *et al* (2012), have evaluated the chloroform, methanol, ethanol and water extracts of marine algae *Turbinaria conoides* against Gram-positive strains and Gram-negative strains. Results demonstrated that methanolic extract of *Turbinaria conoides* exhibited antibacterial activity against both Gram-positive and Gram-negative bacteria and concluded that Turbinaria *conoides* extracts recorded maximum activity against *Streptococcus pyogenes* **and** show antifungal activity [39].

M. Vanaja *et al*., (2013), have investigated biomedically valid gold nanoparticle were synthesized by using marine brown algae *Turbinaria conoides*. The colour changes from brown to pinkish red confirmed the gold nanoparticles synthesis. The nature of elemental gold was analyzed by using Energy dispersive analysis (EDS), result reveled the antibacterial activity of gold nanoparticles, it shows *Streptococcus* sp., having the maximum inhibition and medium range of inhibition was examined against *Bacillus subtilis* and *Klebsiella pneumonia* and concluded the presence of antibacterial activity [40].

USES

It is used as antipyretic [12], Antimicrobial [13], Antidiabetic [15], Antioxidant [17], Hepatoprotective [23], Antifungal [25], antiulcer [27], Antitumor [28], Anticoagulant [37], Antibacterial [40].

CONCLUSION

Different extracts of the *turbinaria* shows the presence of phytoconstituent like alkaloids, terpenes, phenols, tannins, saponins, flavonoids, quinones, proteins, sugars, carbohydrates, alkaloids, coumarins, steroids terpenoids and cardiac glycosides, different extracts will exhibit pharmacological activities like antipyretic, antimicrobial, antidiabetic, antioxidant, hepatoprotective, antifungal, antiulcer, antitumor, anticoagulant, antibacterial, further *Turbinaria* possess phytoconstituent like phenols and flavonoids which possess pharmacological activity like antiobesity, antidiabetic, antiviral, cytotoxicity.

REFERENCES

1. Peter D. Steinberg: Chemical defenses and the susceptibility of tropical marine brown algae to herbivores. *Oecologia journal* 1986; 69: 628-630. [View in PubMed]
2. Simon Ellis, Eileen Ellis: Recent Advances in Lagoon-based Farming Practices for Eight Species of Commercially Valuable Hard and Center for Tropical and Subtropical Aquaculture Soft Corals. Publication No. 147 March 2000.
3. Guiry M.D. & Guiry G.M.: www.algaebase.org; Algae Base version 4.2. *World-wide electronic publication*; 2007; *National University of Ireland*, Galway; *www.algaebase.org/search/species/detail/?species_id=4130;* accessed on feb 15, 2017.
4. John W. Wells, Duncan: Notes on Indo-Pacific Scleractinian Corals. PACIFIC SCIENCE; Vol. XIII, July 1959; Department of *Geology, Cornell University Ithaca*, N. Y. Manuscript received February 17, 1958.
5. Charlie Ehlers: www.richmond aquarium.com; accessed on March 20, 2017.
6. Russell, D. J: *Turbinaria ornate* Identification manual for dietary vegetation of the Hawaiian green turtle; (2000); *https://www.hawaii.edu/reefalgae/invasive_algae/phaeo/turbinaria_ornata.htm* ; accessed on march 10,2017.
7. Simon Ellis. Eileen Ellis: Recent Advances in Lagoon-based Farming Practices for Eight Species of Commercially Valuable Hard and Center for Tropical and Subtropical Aquaculture, Soft Corals Publication No. 147, March 2000.
8. Michael J. Wynne: *Turbinaria foliosa* sp. nov. (Fucales, Phaeophyceae) from the Sultanate of Oman, with a census of currently recognized species in the genus *Turbinaria*, *Phycological Research*, 2002*; 283*–293.
9. Neelamathi E. and Kannan R.: Screening and Characterization of Bioactive Compounds of *Turbinaria ornata* from the Gulf of Mannar, India. *American-Eurasian J. Agric. & Environ. Sci*., 2016; 243-251.
10. Kasinathan Kayalvizhi, Nabikhan Asmathunisha, Vasuki Subramanian and Kandasamy: Purification of silver and gold nanoparticles from two species of brown seaweeds (*Padina tetrastromatica* and *Turbinaria ornata*). *Kathiresan Journal of Medicinal Plants Studies*, 2014; 32-37.
11. Khalifa K. S., Hamouda R. A., Hanafy D., Hamza A. *In vitro* antitumor activity of silver nanoparticles biosynthesized by marine algae; *Digest Journal of Nanomaterials and Biostructures*, January - March 2016; 11; 213 – 221.
12. Sadish Kumar S., Y. Kumar, M. S. Y. Khan, J. Anbu, K. G. Sam. Acute toxicity study and antipyretic effect of the brown alga *Turbinaria conoides* (j. Agardh) kuetz; *African journal Trad. Cam*, 2009; 233 – 240.
13. Poonam Sethi: Antimicrobial activities of *Turbinaria conoides* (J. Agardh) Kutzing; Pelagia Research Library; *Asian Journal of Plant Science and Research*, 2014; 36-40.
14. Seniwati Dali, Hasnah Natsir, Hanapi Usman, and Ahyar Ahmad: bioactivity of protein fraction in brown algae, *Turbinaria decurrens*, as antibacterial agent", Department of Chemistry, Hasanuddin University.
15. Hardoko, Titri, Siratantri, Evelili, Mario Yogabuana Stella, Olivia: *In Vitro* study of antidiabetic activity of *Sargassum duplicatum* and *Turbinaria decurens* seaweed; *International Journal of Pharmaceutical Science*, February 2014; 3: 13-18.
16. Attachai Kantachumpoo and Anong Chirapart, Kasetsart: Components and Antimicrobial Activity of

Polysaccharides Extracted from Thai Brown Seaweed; *Journal of National. Sci*. 2010; 220 – 233.
17. Walailuck Boonchum, Yuwadee Peerapornpisal, Duangta Kanjanapothi, Jeereporn Pekkoh, Chayakorn Pumas, Utan Jamjai, Doungporn Amornlerdpison, Thidarat Noiraksar and Panmukvacharapiyasophon: Antioxidant Activity of some Seaweed from the Gulf of Thailand; *International Journal of Agriculture & Biology*, 2011; 410–429.
18. Unnikrishnan P. S., K. Suthindhiran, and M. A. Jayasri: Inhibitory Potential of *Turbinaria ornata* against Key Metabolic Enzymes Linked to Diabetes; *BioMed Research International* Volume; 2014.
19. John J. Peter Paul: histochemistry and fluorescence analysis of *Turbinaria ornata* (turner) an important brown seaweed (phaeophyceae); *Indian Journal of Plant Sciences*; 2014; 3: 40-44.
20. Preethi K. and Shunmuga Piramu T. Phytochemical analysis and antioxidant activity of *Turbinaria ornata* seaweeds from thoothukudi coastal area; *International Journal of Bioscience Research* 2013; 2.
21. C. Parthiban, C. Saranya, K. Girija, A. Hemalatha, M. Suresh and P. Acantharean: Evaluation of *in vitro* antioxidant properties of some selected seaweeds from Tuticorin coast; *International Journal of Current Microbiology and Applied Sciences*, 2013; 2: 64-73.
22. Kulandhaisamy Arul Senthil, Annappan Murugan: Antiulcer, wound healing and hepatoprotective activities of the seaweeds *Turbinaria ornata* P. Vijayabaskar and V. Shiyamala: Antibacterial Activities of Brown Marine Algae *Turbinaria ornata* from the Gulf of Mannar Biosphere Reserve; *Advances in Biological Research, Publications*; 99-102; (2011).
23. Kulandhaisamy Arul Senthil, Annappan Murugan: Antiulcer, wound healing and hepatoprotective activities of the seaweeds *Turbinaria ornata* from the southeast coast of India; *Brazilian Journal of Pharmaceutical Sciences*, 2013; 49.
24. Vijayabaskar. P, Shiyamala. V: Antioxidant properties of seaweed polyphenol from *Turbinaria ornata* (Turner) J. Agardh; 1848, *Asian Pacific Journal of Tropical Biomedicine*; 2012.
25. Nirmal Kumar, J. I., Megha Barot And Rita N. Kumar: phytochemical analysis and antifungal activity of selected seaweeds from okha coast, Gujarat, India; *Life Sciences Leaflets*, 2014; 52.
26. Saowapa Rattaya, Soottawat Benjakul, Thummanoon Prodpran: Extraction, antioxidative and antimicrobial activities of brown seaweed extracts, *Turbinaria ornata* and *Sargassum polycystum*, grown in Thailand; *International Aquatic Research*, 2015; 7: 1-16.
27. D. Vijayraja and Dr K. Jeyaprakash: Phytochemical Analysis, *In-vitro* Antioxidant and Anti-Hemolysis Activity of *Turbinaria ornata* (turner) J. Agardh; *International Advanced Research Journal in Science*, 2015; 2.
28. Mohammed A. Deyab Lotfy Z. Habbak Fatma M. Ward: Extraction and antitumour activities of *Turbinaria ornate*; *The Egyptian Journal of Experimental Biology* (Botany), 2016; 12.
29. Shyamali S. and Silva De M.: *Turbinaria ornata*; Carbohydrates constituents of the marine algae of Sri Lanka, 1998; 16: 201 -208.
30. Manoj M., Saravana Guru, Mani Vasanthi & Anant Acharya: Antioxidant and free radical scavenging potential of crude sulphated polysaccharides from *Turbinaria ornate*; *Biologia Section Cellular and Molecular Biology*, 2015; 27-33.
31. Ayman M. Mahmoud, Omnia E. Hussein and Shymaa A. Ramadan: A melioration of Cyclophosphamide-Induced Hepatotoxicity by the Brown Seaweed *Turbinaria ornate; International Journal of Clinical Toxicology*, 2013; 9-17.
32. Sarah Joy Bittick, Nicholas D. Bilotti, Heather A. Peterson, Hannah L. Stewart: *Turbinaria ornata* as an herbivory refuge for associate algae; M*ar Biol Springer-Verlag*, 2010; 317–323.
33. Sradhasini Rout and Anjan Kumar: a review on the potentiality of marine seaweeds as a medicinal source; *World journal of pharmacy and pharmaceutical science*, 2015; 4.
34. Sridharan, M. C and Dhamotharan: Antibacterial activity of marine brown alga *Turbinaria conoides*; *Journal of Chemical and Pharmaceutical Research*, 2012.
35. Kala K J, Prashob Peter K J, Chandramohanakumar N: Cyto-Toxic Potential of Fucosterol Isolated from *Turbinaria Conoides* Against Dalton's Lymphoma Ascites; *International Journal of Pharmacognosy and Phytochemical Research*, 2015; 1217-1221.
36. Sekar D. and Kolanjinathan K. Antibacterial activity of marine macroalgae *Padina gymnospora* and *Turbinaria conoides* collected from Mandapam Coast of Tamil Nadu, India; *International Journal of Advanced Research in Biological Sciences*.
37. Shanthi N., T. Eluvakkal and K.Arunkumar : Characterization of galactose rich fucoidan with anticoagulation potential isolated from *Turbinaria decurrens*; *Journal of Pharmacognosy and Phytochemistry*, 2014; 132-137.
38. Ameer Junaithal Begum M. P. Selvaraju and A. Vijayakumar: Evaluation of antifungal activity of seaweed extract (*Turbinaria conoides*) against *Fusarium oxysporum*; *Journal of Applied and Natural Science*, 2016; 60 – 62.
39. Senthilkumar, S. Sudha: antibacterial properties of *Turbinaria conoides; Journal of Pharmaceutical Sciences Review and Research*, 2012; 74.
40. Rajeshkumar, C Malarkodi, M Vanaja, G Gnanajobithan, K Paulkumar, C Kannanand G Annadurai: Antibacterial activity of algae mediated synthesis of gold nanoparticles from *Turbinaria conoides*; *Scholars Research Library Der Pharma Chemica*, 2013; 224-229.

How to cite this article
Alka, Tyagi N and Kumar SS. Pharmacological aspects of *Turbinaria*. *Int. J. Res. Dev. Pharm. L. Sci. 2017; 6(4)*: 2648-2653.
doi: 10.13040/IJRDPL.2278-0238.2017.6(4).2648-2653.