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RESEARCH ARTICLE
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ASSESSMENT OF ANTI-INFLAMMATORY AND ANTIOXIDANT POTENTIALS OF METHANOLIC EXTRACT FROM TURBINARIA ORNATA

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Abstract:
Background: Turbinaria ornata, a marine brown alga widely distributed along the southeast coast of India, is known to contain various bioactive compounds with therapeutic potential. This study aims to evaluate the in vitro antioxidant and anti-inflammatory properties of the methanolic extract of T. ornata to assess its suitability for applications in wound healing.
Methods: A methanolic extract of T. ornata was prepared and subjected to preliminary phytochemical screening to identify the presence of secondary metabolites. The antioxidant potential was evaluated using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging assay. Simultaneously, the in vitro anti-inflammatory activity was assessed using a protein denaturation assay.
Results: Phytochemical analysis of the methanolic extract confirmed the presence of key bioactive constituents, including alkaloids, tannins, cardiac glycosides, flavonoids, and phenolic compounds. The DPPH assay revealed a significant, concentration-dependent increase in free radical scavenging activity. Furthermore, the protein denaturation assay demonstrated that the extract successfully inhibited protein denaturation in a dose-dependent manner.
Conclusion: The methanolic extract of Turbinaria ornata exhibits notable in vitro antioxidant and anti-inflammatory activities, largely attributed to its rich profile of phytochemicals such as tannins and phenolic compounds. These findings substantiate its potential as a natural therapeutic agent and support its prospective use in the treatment of wound healing.

INTRODUCTION

Antioxidants are free radical scavengers (FRS), delaying the oxidation and preventing the chain reaction started by high energy molecules and other subsequent processes. These FRS aid in the prevention of stress-related illnesses like melanoma, heart issues, diabetes mellitus, inflammatory,

and neurological diseases [1]. Although many synthetic antioxidants are effective in treating a variety of human diseases, their pro-oxidant or cytotoxic properties at greater concentrations preclude their long-term usage. Seaweeds or their extracts have been demonstrated to create a wide range of compounds during the past several decades, and some of them have been revealed to possess biological activity with potential therapeutic use [2]. As a result, new interest has emerged in the quest for natural remedies.A large species of marine green alga in the Phaeophyceae family, Turbinaria ornata is high in fucoids and sulphated polysaccharides. It is extensively dispersed in Tamil Nadu's (India's) southeast coast and is reportedly utilised as fertiliser, food, and animal feed [3]. The Indian Ocean, the central and western Pacific, and subtropical regions all have large populations of this alga. This seaweed has been found to have a wide range of biological activities, including antibacterial, anticoagulant, anti-inflammatory, and antioxidant effects. Furthermore, research on fucoidan, an extract of Turbinaria species, has demonstrated therapeutic advantages, including the protection of cardiac injury, hepatoprotective, anticancer, and neuroprotective properties [4]. As a result, there is increased interest in finding natural and secure antioxidative compounds from marine sources. More recent studies have shown that marine algae, like Acanthophora spicifera and Halimeda tuna , are abundant sources of antioxidant chemicals with potential free radical scavenging action [5]. A type of brown algae called Turbinaria ornata is seen in large numbers along India's south-east coast. It is most frequently connected to the biopolymer and aagroindustrial communities [6]. Previous reports imply that T. According to Asari et al. (1989), ornata is a suitable biosor- bent to be used for the continuous removal of copper(II) ions from aqueous solution and has cytotoxic effect on murine melanoma and colon cancer cells.

MATERIALS AND METHOD

Preparation of Extract

The marine brown alga, Turbinaria ornata, was processed to prepare a methanolic extract for biological evaluation. The plant material was immersed in methanol and placed in an orbital shaker to facilitate the extraction of its bioactive constituents. Following an adequate extraction period, the residue was allowed to settle, and the clear supernatant was carefully decanted. This methanolic extract was utilized for all subsequent phytochemical and biological assays.

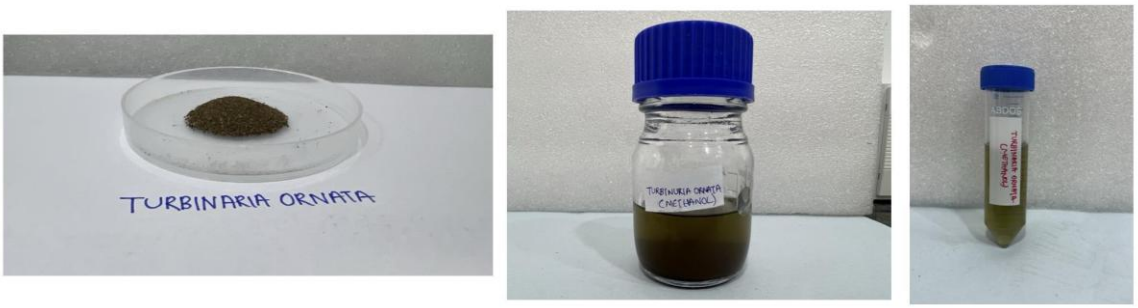


Figure 1: Preparation of Turbinaria ornata methanolic extract. Left: Powdered T. ornata biomass. Middle and Right: The resulting methanolic extract stored in glass and plastic vessels.

Phytochemical Screening

The clear methanolic extract of T. ornata was subjected to standard qualitative phytochemical screening to identify the presence of various secondary metabolites. The extract was systematically tested for alkaloids using Hager's test, cardiac glycosides utilizing the Keller-Kiliani test, and flavonoids via the alkaline reagent test. Additionally, the presence of phenolic compounds and tannins was evaluated using the gelatin test and the ferric chloride ($FeCl_3$) test, respectively.

In vitro Biological Assays

To determine the therapeutic potential of the extract, in vitro antioxidant and anti-inflammatory analyses were conducted. The antioxidant capacity was evaluated utilizing the 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging assay, which measures the extract's ability to reduce the stable DPPH radical. Concurrently, the anti-inflammatory activity was assessed using a protein denaturation assay, which determines the extract's efficacy in inhibiting heat-induced protein denaturation.

RESULTS

Phytochemical Analysis

The preliminary qualitative phytochemical screening of the Turbinaria ornata methanolic extract revealed a rich and diverse profile of secondary metabolites. As detailed in Table 1, the extract tested positive for all evaluated phytochemicals. A notably strong presence (++) was observed for alkaloids and tannins. Furthermore, the analysis indicated a moderate presence (+) of cardiac glycosides, flavonoids, and phenolic compounds. The visual color changes confirming these constituents are illustrated in Figure 2.

CONSTITUENTS	(Methanol Extract)	METHOD
Alkaloids	++	Hager's test
Cardiac glycosides	+	Keller kelliani’s test
Flavonoids	+	Alkaline reagent test
Phenolic compound	+	Gelatin test
Tannins	++	Fecl3 test

Table 1: Preliminary qualitative phytochemical screening of the methanolic extract of Turbinaria ornata.
(+) indicates a moderate presence of the constituent; (++) indicates a strong presence of the constituent.

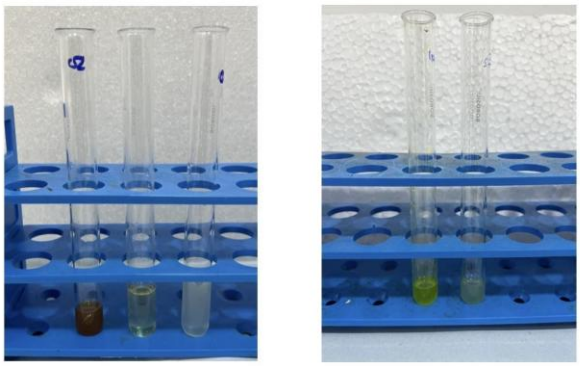


Figure 2: Qualitative phytochemical screening of the Turbinaria ornata methanolic extract, demonstrating positive colorimetric reactions for the presence of secondary metabolites.

Antioxidant Analysis (DPPH Assay)

The free radical scavenging potential of the methanolic extract was quantitatively assessed using the DPPH assay. The extract exhibited potent antioxidant activity, demonstrating a clear, concentration-

dependent increase in radical scavenging across the tested concentrations of 25, 50, and 100 µg. Notably, the antioxidant activity of the extract at 50 µg and 100 µg was highly comparable to, and slightly exceeded, the efficacy of the standard reference drug, Ascorbic Acid, at 50 µg. The progression of this scavenging activity is depicted in Figure 3.

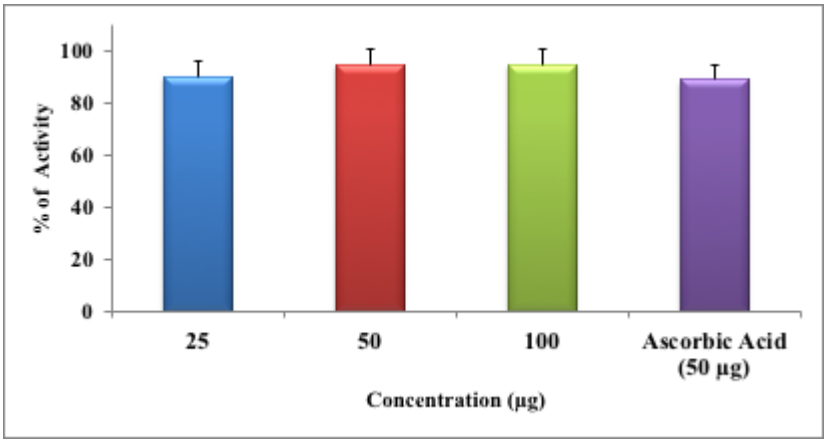


Figure 3: DPPH free radical scavenging activity of the methanolic extract of Turbinaria ornata at concentrations of 25, 50, and 100 µg, compared against Ascorbic Acid (50 µg). Data are expressed as mean ± standard deviation. The graph illustrates a significant, dose-dependent increase in the percentage of radical inhibition.

Anti-Inflammatory Analysis (Protein Denaturation Assay)

The in vitro anti-inflammatory activity was evaluated by measuring the extract's capacity to prevent heat-induced denaturation of proteins. The results mirrored the antioxidant findings, with the extract displaying a robust, dose-dependent inhibitory effect at concentrations of 250, 500, and 1000 µg. At a peak concentration of 1000 µg, the maximum percentage of inhibition was achieved, demonstrating a strong stabilizing effect on tissue proteins that surpassed the standard reference drug, Diclofenac, tested at 500 µg (Figure 4).

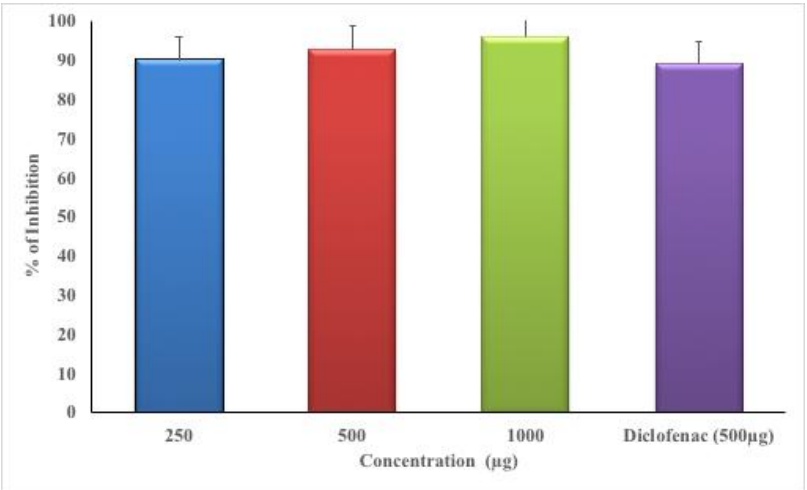


Figure 4: Inhibitory effect of Turbinaria ornata methanolic extract on heat-induced protein denaturation at concentrations of 250, 500, and 1000 µg, compared against Diclofenac (500 µg). Data are represented as mean ± standard deviation. The graph demonstrates a concentration-dependent stabilization of proteins, highlighting the extract's anti-inflammatory efficacy.

DISCUSSION

The present study was designed to evaluate the in vitro anti-inflammatory and antioxidant potentials of the methanolic extract of Turbinaria ornata, a brown seaweed abundant along the southeastern coast

of India [7]. The preliminary phytochemical screening of the extract revealed the presence of alkaloids, cardiac glycosides, flavonoids, phenolic compounds, and tannins. The presence of these bioactive secondary metabolites provides a scientific basis for the observed biological activities. Flavonoids and phenolic compounds, in particular, are well-documented for their potent antioxidant properties, as they can donate hydrogen ions to neutralize free radicals and chelate metal ions that catalyze oxidative reactions [8]. Tannins and alkaloids also contribute to anti-inflammatory mechanisms by modulating various cellular pathways [9].The antioxidant potential of the T. ornata extract was assessed using the DPPH (2,2-diphenyl-1-picrylhydrazyl) assay. This assay is based on the principle that antioxidants reduce the stable, purple-coloured DPPH radical to a yellow-coloured compound, diphenylpicrylhydrazine. The results demonstrated a concentration-dependent increase in the percentage of inhibition, indicating that the extract possesses significant free radical scavenging activity. This effect is likely attributed to the high concentration of phenolic compounds and tannins detected in the phytochemical analysis, which act as primary antioxidants [10]. This finding aligns with previous research on brown seaweeds, which have been recognized as rich sources of natural antioxidants like phlorotannins and fucoidans that can combat oxidative stress [11].The anti-inflammatory activity was evaluated using the protein denaturation assay. Denaturation of tissue proteins is a well-established cause of inflammation, as it can lead to the production of auto-antigens and the subsequent activation of the inflammatory response. The ability of the T. ornata extract to inhibit protein denaturation in a dose-dependent manner suggests its potential to stabilize proteins and prevent inflammatory processes [12]. The presence of bioactive compounds such as flavonoids and alkaloids in the extract could be responsible for this inhibitory effect, as these compounds are known to interfere with the inflammatory cascade, possibly by inhibiting the release of mediators like histamines and prostaglandins [13]. This result corroborates earlier studies that have reported the anti-inflammatory properties of Turbinaria species, often linked to its sulphated polysaccharides and fucoidan content [14]. In conclusion, the findings of this study confirm that the methanolic extract of Turbinaria ornata possesses notable antioxidant and anti-inflammatory properties in vitro. These effects are mediated by the rich profile of phytochemicals present in the seaweed. The results support the ethnopharmacological use of T. ornata and suggest its potential as a source of bioactive compounds for the development of natural therapeutic agents, particularly for applications in wound healing where both oxidative stress and inflammation play crucial roles [15]. Further studies are recommended to isolate the specific active compounds and to validate these effects through in vivo models.

CONCLUSION

Turbinaria Ornata has antioxidant and anti-inflammatory properties so it can be used in the treatment of wound healing.

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Conflict of interest

All the authors declare that there was no conflict of interest in the present study.

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