EXTRACTION AND CHARACTERISATION OF ACTIVE COMPOUNDS FROM SEAWEEDS AND THEIR APPLICATION IN TEXTILES

A THESIS

Submitted by

JANARTHANAN M

in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

FACULTY OF TECHNOLOGY

ANNA UNIVERSITY

CHENNAI 600 025

SEPTEMBER 2018

ANNA UNIVERSITY
CHENNAI 600 025

CERTIFICATE

The research work embodied in the present thesis entitled "**EXTRACTION AND CHARACTERISATION OF ACTIVE COMPOUNDS FROM SEAWEEDS AND THEIR APPLICATION IN TEXTILES**" has been carried out in the Department of Textile Technology, PSG College of Technology, Coimbatore. The work reported herein is original and does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion or to any other scholar.

I understand the University's policy on plagiarism and declare that the thesis and publications are my own work, except where specifically acknowledged and has not been copied from other sources or been previously submitted for award or assessment.

JANARTHANAN M
RESEARCH SCHOLAR

Dr. M. SENTHILKUMAR
SUPERVISOR
Associate Professor
Department of Textile Technology
PSG College of Technology
Coimbatore 641 004

ABSTRACT

Medical textile is the significant developing area pertained to technical textiles. The disease transmissions are caused by the textile materials due to environmental pollution and biological infections. Medical industries produce different hygiene and healthcare products with special and functional properties such as antimicrobial, antiviral and anti-allergic activities based on need and requirements of consumers. Although abundant synthetic agents are used to treat the textile materials to attain antimicrobial activity but it creates few regular negative impacts such as toxic, allergic to the users etc. The diverse safe and durable natural based antimicrobial finishing agents are gradually gaining attention in current years to conquer the negative impacts caused by synthetic agents in antimicrobial textiles.

Most of the natural fibres are ecological friendly in character and used to make hygienic products after treating with natural biodegradable agents. In recent years, seaweeds acquired from the aquatic habitat have increased much importance for its different pharmacological properties. Seaweed holds excellent bioactive substances, antioxidant compounds, antimicrobial agents, antiviral agents and anti-cancer compounds.

In this research, six species from green algae, brown algae and red algae were collected and studied their antibacterial, bioactive and antioxidant properties under the standard conditions. The two green algae species namely *Ulva Reticulata* and *Ulva Lactuca*, two red algae species namely *Kappaphycus Alvarezii* and *Acanthophora Spicifera*, two brown algae species namely *Padina Tetrastromatica* and *Sargassum Wightii* were freshly collected from Thonidurai coast in Mandapam region, Tamil Nadu, India were selected for the study.

The preliminary bioactive screening of 15 different bioactive compounds of six seaweeds was analysed using methanol extracts under the standard conditions. During the analysis, it was found that all the six seaweeds exhibited the presence of moisture, dried matter, total ash, acidic insoluble ash and sulphated ash to a measurable level. All the six seaweeds are capable to absorb moisture up to 99.5%. The presence of three biochemical constituents like protein, carbohydrates and lipid were evaluated from six seaweed species. The protein, carbohydrate and lipid constituents of seaweeds varied from 0.13g/100g to1.2g/100g.

The minimum inhibitory, fungicidal and bactericidal concentration of six seaweed extracts were tested under *In vitro* conditions.The MIC against *Klebsiella pneumoniae* bacteria of six seaweed species exhibited 250mg/ml.The MIC against *Candida albicans* fungi of six seaweed species ranged from 62.5mg/ml to 250mg/ml. The MBC of six seaweed species ranged from 250mg/ml to 1000mg/ml. The MFC of six seaweed species ranged from 250mg/ml to 1000mg/ml. Total antioxidant activity and DPPH radical scavenging assay for six seaweed extracts were analyzed. Among the five divergent concentrations of six seaweed extracts, 250µg/ml showed more total antioxidant activity than all other concentrations. During this analysis, the *Acanthophora Spicifera* extract showed remarkably higher scavenging activity of 77 ± 0.17% inhibition.

Microcapsules were synthesized using seaweed extracts under controlled aseptic conditions and applied on cotton fabric using pad-dry-cure method and their antibacterial, antioxidant and physical properties were studied. The bioactive compounds available in six seaweed extracts and the treated fabrics were analysed using GC-MS analysis. The qualitative and quantitative antibacterial activity were tested for microcapsules treated fabrics using AATCC-147 and AATCC-100 methods. The treated fabrics revealed the bactericidal inhibition zones ranging from 30mm to 38mm and bacterial reduction percentage ranging from 92% to 98% against test pathogens. Among the six species, *Padina Tetrastromatica* treated fabric exhibited maximum inhibition zone

of 38mm and *Ulva Lactuca* treated fabric exhibited 98% of maximum bacterial reduction percentage against test pathogens (*Staphylococcus aureus* and *Escherichia coli*).

The surface appearance of microcapsules treated fabric was assessed using SEM images with 3000× and 6000× magnifications clearly showed the microcapsules of six seaweed extracts adhered evenly spread on the treated fabric surface attained uniform distribution on finishing layer of the fabric. The UPF results of each seaweed treated cotton fabrics proved excellent UV protection compared with untreated fabric. All six seaweed treated fabrics proved slightly lesser water vapour and air permeability compared with untreated fabric. The capability of each seaweed microcapsules provides a strong fixation on fabric surface results in good rubbing fastness of treated fabrics.

The good washing fastness result clearly proved that even absorption of extracts takes place in between the pores of fabric after subsequent washing up to 20 washes. The tensile strength decreases with increases in elongation of six seaweed treated fabrics were observed due to citric acid makes cross-links with chains of cellulose polymer during finishing in comparison with untreated fabric. The wicking test results revealed that the capability of the liquid absorbed by the treated fabrics and observed significantly lower than the untreated fabric.

The six seaweed treated fabrics were used to develop hygienic textile products like surgical face mask, bed covers, sun protective gloves, wound dressing materials, surgical gown and anti-wrinkle textile face mask and their performance was evaluated in this study.

The skin irritation test for bed cover, sun protective gloves, face mask and surgical gown are performed using contact allergy test method. The test results showed no irritation endpoints for all the products obtained from the seaweed treated cotton fabrics. The alginate film coated cotton fabrics showed potent antibacterial activities, good wound healing and excellent biocompatible properties. The coated cotton fabrics

were used for making wound dressing materials. The anti-wrinkle textile face mask fabrics showed good biostability and biocompatible properties. It also proved the growth of cell tissues as skin equivalent fibroblasts in a particular culture medium was similar to *In vivo* skin layers. Such skin equivalent fibroblasts were also used for tentative and skin equivalent in *In vitro* condition for healthcare textiles.

The abundant synthetic agents are used to treat the textile materials to obtain antimicrobial activity to produce various medical products. These synthetic agents are capable to develop some unwanted negative impacts to the users. In recent years, natural agents are widely preferred to make hygienic products. Such treated cotton fabrics can also be widely preferred for non-implantable materials like gauzes, sterilisation wraps, bandages and compression garments in hygienic and healthcare textiles.