

# ***CHARACTERIZATION AND FORMULATION OF SUNSCREEN FROM MARINE SEAWEED***

Submitted in partial fulfilment of the requirements for the award of  
Bachelor of Technology degree in Biotechnology

By

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**DEPARTMENT OF BIOTECHNOLOGY SCHOOL OF  
BIO AND CHEMICAL ENGINEERING**

**SATHYABAMA**

**INSTITUTE OF SCIENCE AND TECHNOLOGY  
(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade “A” by NAAC**

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**APRIL 2022**



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DEPARTMENT OF BIOTECHNOLOGY

## BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **M.Pirabanchana(38230024)** who carried out the project entitled “**CHARACTERIZATION AND FORMULATION OF SUNSCREEN FROM MARINE SEAWEED**” under our supervision from January 2022 to April 2022.

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## DECLARATION

I, **M.Pirabanchana (38230024)** hereby declare that the Project Report entitled “**CHARACTERIZATION AND FORMULATION OF SUNSCREEN FROM MARINE SEAWEED** ” was done by us under the guidance of **Dr. R. Thyagarajen** is submitted in partial fulfillment of the requirements for the award of a Bachelor of Technology degree in Biotechnology.

**DATE:**21 April 2022

**PLACE:** Chennai



**SIGNATURE OF THE CANDIDATE**

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**(M. PIRABANCHANA)**

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## **ABSTRACT**

Secondary metabolites such as mycosporine-amino acids (MAA) are produced by organisms that live in high-light environments, such as marine environments. They're often referred to as " Microbial sunscreen ". MAAs have a lot of potential in the cosmetics and biotechnological fields. Indeed, their UV-absorbing capabilities would enable the development of products derived from natural photoprotectors that are both environmentally friendly and effective against UV damage. The sunscreen will be formulated using marine seaweeds collected from Rameswaram, and mycosporine-like amino acid extracted from the seaweeds. The antibacterial and antifungal activities of the MAA will be observed, and the mycosporine process will be characterized using silica gel thin-layer chromatography and other methods. Here, commercial sunscreens contain an ingredient that can be harmful to the skin, and they come at a high cost to the local ecosystem and the natural world, and it also shows less effects of frequent and prolonged sun exposure over time increased risk of skin cancer, sunburn, and skin discoloration, and it also shows less effects of frequent and prolonged sun exposure over time increased risk of skin cancer, sunburn, and skin discoloration. Wrinkles and other signs of aging, leathery skin from reduced elasticity (Age spots, Sunspots, Hyperpigmentation, Freckles, etc.),

## LIST OF SYMBOLS AND ABBREVIATIONS

|       |                 |                                      |
|-------|-----------------|--------------------------------------|
| i.    | UV-VIS sepctrum | Ultraviolet visible septrum          |
| ii.   | TLC             | Thin layer chromatography            |
| iii.  | Nm              | Nanometer                            |
| iv.   | ml              | Milliliter                           |
| v.    | GCMS            | Gas chromatography–mass spectrometry |
| vi.   | MAA             | Mycrospine like amino acid           |
| vii.  | EAE             | Enzyme-assisted extraction           |
| viii. | UAE             | Ultrasound assisted extraction       |
| ix.   | MAE             | Microwave assisted extraction        |
| x.    | A.fragillissima | Amphiroa fragillissima               |
| xi.   | $\lambda$       | Wavelength                           |

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## 1. INTRODUCTION

The biggest organ in the human body is the skin. The skin serves as protection (barrier) against a variety of external and internal hazardous threats. UV light exposure is one of the most dangerous external risks to the skin. UV rays can cause skin irritation and rashes. As a result of the sunburn, the synthesis of melanin is stimulated. Long-term UV exposure can wreak havoc on skin cancer. Sunscreen is one approach to lessen the detrimental effects of UV exposure. (Suwandi *et al.*, 2020)

UV irradiation and its interaction with living systems have been a hot topic for several years. UV irradiation refers to the UV area (280–400 nm), which is split into three parts: UV-B (280–315 nm), UV-A (315–400 nm), and UV-C (200–280 nm) [1–5]. UV-C has no biological significance because it is completely absorbed by the atmosphere. UV-B (7-8 W mK<sup>2</sup>) irradiation has increased significantly as a result of global warming (ozone depletion). In some of the locations, a significant rise in UV-A (45-50 W mK<sup>2</sup>) was also found [6–9]. This is seen as a major global environmental issue that could exacerbate the harmful effects of UV radiation on human health. As a result, sunscreen agents are always advised over the world.

Bioactive chemicals found in marine species have a wide range of biological actions, including antibacterial, anti-inflammatory, antifungal, antioxidant, antiulcer, sun-protective, immunomodulatory, and anti-microbial properties. Algal resources, often known as seaweed, are a rich source of medicinal chemicals with a wide range of biological activity. These molecules can be considered acceptable candidates for formulation and development if they have been identified, isolated, and toxicologically confirmed using designed pharmacological models. According to recent findings, algae have a unique family of sun-protective chemicals known as mycosoorine amino acids (MAAs). Seaweeds, which might be regarded as a vital source of sun protective chemicals, have a higher concentration of MAAs ( Bhatia *et al.*,2019).

There are around 555 kinds of seaweed found in Indonesian waters. *Amphiroa fragilissima* seaweed has potential as cosmetic raw material and is readily available. According to the Food and Aquaculture Organization (FAO), Indonesia ranked second after China in seaweed cultivation production in 2013, accounting for 34 percent of the global total of 26,896,004 tonnes . The increased public awareness of the necessity of

skin health care is fueling the demand for skin care cosmetics. One of the methods to preserve the skin from the detrimental effects of weather conditions is to use skincare cosmetic items. With the right temperature, the air humidity in Indonesia can reach 80%. Black patches will appear as a result of continuous sun exposure. The red seaweed *Amphiroa fragilissima* contains phycocyanin molecules, which are imine derivatives comprising aminocycloheximine UV absorbent chromophore and contain mycosporine acid (MAAs). Antioxidant chemicals found in red seaweed can prevent intense UV radiation from penetrating tissues or cells. (Sipahutar, Y.H. *et al.*, 2019)

Marine algae are one of the most studied creatures in the ocean. Because they are good providers of nutrients and useful elements, these marine organisms have piqued people's interest. Biological effects such as antioxidant, anti-cancer, anti-hypertension, hepatoprotective, immunomodulatory, and neuroprotective activity have been identified in numerous research. Marine algae are already found in a variety of meals, vitamins, medications, and cosmetics, and are frequently touted as having health benefits. The abundance of photoprotective chemicals found in marine algae is an intriguing aspect. Marine algae present in intertidal coastlines to a depth of 150 metres are extremely vulnerable to UV exposure. Photoprotective chemicals such as mycosporine-like amino acids (MAAs), sulfated polysaccharides, carotenoids, and polyphenols are used to counteract and decrease photodamage caused by excessive UV radiation. The current methods for isolating and recovering photoprotective compounds from marine algae are rapidly evolving. Novel environmentally friendly extraction and separation techniques, such as enzyme-assisted extraction (EAE), ultrasound assisted extraction (UAE), microwave assisted extraction (MAE), supercritical carbon dioxide (SC-CO<sub>2</sub>), and subcritical water extraction (SWE), have recently been applied to the development of photoprotective substances derived from marine algae, and are not limited to organic solvent extraction. The quantity of photoprotective chemicals recovered from marine algae is determined by the method used and the species of marine algae. Furthermore, the isolation method used has an impact on photoprotective action. As a result, the focus of this work is on photoprotective compounds found in marine algae. The most up-to-date research on photoprotective compounds found in marine algae, as well as their biological functions (Pangestuti *et al.*, 2018)

To reduce the damage caused by UV radiation, red algae can manufacture UV-absorbing mycosporine-like amino acid (MAA) molecules. MAAs are low-molecular-weight compounds exhibiting absorption peaks in the UV range (310–360 nm). These characteristics, when combined with their antioxidant properties, imply that they could be used to prevent and treat diseases caused by free radicals and UV irradiation in humans. The use of MAAs in biotechnological products is limited, however, due to the low quantities of these chemicals in wild-harvested macroalgae. As a result, animals with high MAA levels are desired. MAAs are frequently found in low amounts in red algae from Patagonia. Under stressful situations, however, certain species have shown increased MAA or at least variations in individual MAA concentrations. Additionally, methanolic extracts show an interesting absorption in the UVB region in certain red algae species, such as *Lophurella hoockerian*. (Navarro *et al.*, 2015)

## 2. REVIEW OF LITERATURE

Bioactive chemicals found in marine species have a wide range of biological actions, including antibacterial, anti-inflammatory, antifungal, antioxidant, antiulcer, sun-protective, immunomodulatory, and anti-microbial properties. Algal resources, often known as seaweed, are a rich source of medicinal chemicals with a wide range of biological activity. These molecules can be considered acceptable candidates for formulation and development if they have been identified, isolated, and toxicologically confirmed using designed pharmacological models. According to recent findings, algae have a unique family of sun-protective chemicals known as mycosporine amino acids (MAAs). Seaweeds, which might be regarded as a vital source of sun protective chemicals, have a higher concentration of MAAs. ( Bhatia, S *et al.*, 2019)

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abundance of photoprotective chemicals found in marine algae is an intriguing aspect. Marine algae present in intertidal coastlines to a depth of 150 meters are extremely vulnerable to UV exposure. Photoprotective chemicals such as mycosporine-like amino acids (MAAs), sulfated polysaccharides, carotenoids, and polyphenols are used to counteract and decrease photodamage caused by excessive UV radiation. The current methods for isolating and recovering photoprotective compounds from marine algae are rapidly evolving. Novel environmentally friendly extraction and separation techniques, such as enzyme-assisted extraction (EAE), ultrasound assisted extraction (UAE), microwave assisted extraction (MAE), supercritical carbon dioxide (SC-CO<sub>2</sub>), and subcritical water extraction (SWE), have recently been applied to the development of photoprotective substances derived from marine algae, and are not limited to organic solvent extraction. The quantity of photoprotective chemicals recovered from marine algae is determined by the method used and the species of marine algae. Furthermore, the isolation method used has an impact on photoprotective action. As a result, the focus of this work is on photoprotective compounds found in marine algae. The most up-to-date research on photoprotective compounds found in marine algae, as well as their biological functions. (Pangestuti *et al.*, 2018)

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Cosmetics are widely used by many people around the world to protect their skin from stimuli. Consumers prefer natural cosmetic products because synthetic cosmetic

products are caused some side effects due the chemical molecular size. The cosmetic industry used the term “cosmeceutical” referring the cosmetics claimed to have the medicinal and drug benefits. Now a day’s marine algae have gained huge attention in cosmetically. Marine algae are rich in bioactive substance that are show strong benefit to skin and skin-based problems. The review showed the cosmeceutical potential and application of algae as skin whitening, anti-aging, anti-inflammation, antioxidant agents. The biological activities and underlying mechanism are also discussed and In addition, the challenges of using algae in cosmeceutical applications were also discussed (Krishnapriya *et al.*, 2020).

The term cosmeceutical is derived from combined by the cosmetic and pharmaceutical . these product have ingredients like medicinal and drug like benefits. They are prepsred to increase the physiological effects at the cellular level in addition to increasing the skin’s apperance . the algae in cosmetics are demand in consumers so the application of cosmeceutical growing rapidly .These compounds should have highly effective and stable properties for therapeutic use with low potential toxicity. There are many compounds have been cut off from marine organisms, and these compounds have various claimed cosmeceutical activities including antioxidant, anti-inflammatory, antiallergenic, antiaging and anti-wrinkling effects, and ultraviolet protection. Here this review studied on algal natural products and their potential for development of cosmeceuticals from novel and potent phytochemical compounds (Afroz jahan *et al.*, 2017).

Eventhough humans has been using the marine resource for food since time anicent . today the marine ecosystem contained largely undiscussed biodiversity it gives considerable potential for a variety of industrial sector, especially in cosmetic industries. The sea and ocean are capable to supplying new extracts and molecules for potential use as excipients or additives, but above all as active ingredients in the cosmetic formulation like the expectation of consumers called natural products and marketing said by the marine world . the product categorised most affected are moisturizer and antiaging products (Céline *et al.*, 2016)

Seaweeds based cosmetic are gradually used by consumers instead of synthetic products. These products are usually contained purified compounds or extracted with

some compounds. Some seaweeds' molecules already demonstrated a high potential as a cosmetic active ingredient (such as, mycosporine-like amino acids, fucoidan, pigments, phenolic compounds) or as a key element for the products consistency (agar, alginate, carrageenan). Furthermore the seaweed compounds contain important qualities for cosmetic application like cytotoxicity and low allergens content. Still seaweed profile can variable and the extraction method can affect loss of some biomolecules .this study says the general aspects of seaweed cosmetic and benefits in the cosmetic industry. And focused in ecological and sustainable scope of seaweed in safe source of ingredients for the cosmetic industry and consumers (Tiago Morais *et al.*,2021)

Marine organisms use mycosporine-like amino acids (MAAs) as biological sunscreens for the protection from damaging ultraviolet (UV) radiation and the prevention of oxidative stress. MAAs have been discovered in many different marine and freshwater species including cyanobacteria, fungi, and algae, but also in animals like cnidarian and fishes. Here, we describe a general method for the isolation and characterization of MAA compounds from red algae and symbiotic dinoflagellates isolated from coral hosts. This method is also suitable for the extraction and analyses of MAAs from a range of other algal and marine biota. (Rosic *et al* ., 2015)

## **Description Of Selected seaweed**

### ***Amphiroa fragilissima* (Linnaeus)**

- Class -Florideophyceae
- Order-Corallinophycidae
- Family-Lithophyllaceae
- Genus-Amphiroa
- Phylum- Rhodophyta

### **General information**

*Amphiroa* is a thalloid red algae genus that includes 55 species. Specimens can grow up to 30 cm in length. The thalli become crustose, and dichotomous branches appear. Secondary pit connections are present in the organisms.

### **Geographical distribution**

In terms of geographical distribution, *A. fragilissima* can be found in all of the oceans' tropical and subtropical zones. Many epiphytes and animals use the articulated coralline algae as a microhabitat. These plants are usually found in the seagrass beds and belong to the genera *Caulerpa*, *Halimeda*, and *Padina*. From September through March, reproductive structures are visible.

### **Applications**

Tetraspores are produced by *Amphiroa*, which reproduces by conceptacles. It has parallel filaments lining its pore canals; the shape of the pore canal is a significant characteristic used to distinguish species within the genus.

### **3.AIM**

Characterization and formulation of sunscreen from Marine seaweed

### **OBJECTIVES**

- ❖ Collection of Marine Seaweeds from Rameshwaram District, Tamil Nadu
- ❖ Extraction of Mycosporine - Like Amino Acid (MAA)
- ❖ Antibacterial activities of the MAA
- ❖ Separation of Compounds using Thine Layer chromatography
- ❖ Cytotoxicity analysis of the MAA
- ❖ Characterization of MAA by using UV-VIS analysis, GCMS

## 4. MATERIALS AND METHODS

### 4.1.SAMPLE COLLECTION

The sample was collected from the east coast of Rameswaram east coast of India. The seaweed was washed thoroughly with water and dried then crushed into powder.



**FIGURE 1: COLLECTION OF DRY SEAWEED (*Amphiroa fragillissima*)**

### 4.2. EXTRACTION OF MAAs

Five grams of dry powder were extracted with 100 ml of extraction solvent (methanol 25%) for 2h in a 500 ml conical flask and incubated in a water bath at 45°C. after pouring out the extracts, extraction solvent was again added to the conical flask, and the extraction process was repeated once again according to the above conditions. these extracts were combined, filtrated, and evaporated under reduced pressure to obtain the concentrate. 80% ethanol was added to the concentrate and keep it at -20°C for 6h then centrifugation at 4000 rpm for 10 mins at 4°C, the supernatants were poured out. the pellets were washed with distilled water 2~3 times. the washing solution and the previous supernatants were combined, and concentrated under reduced pressure at 45°C. In this way, MAA extracts were prepared. The calculation of the yield of MAAs was followed:

The yield of MAA extracts (%) =  $100\% \times \frac{\text{the quality of MAA extracts (DW,g)}}{\text{the quality of seaweed powder (DW,g)}}$ . (2) The solid-liquid ratio, the time of extraction, the

extraction degree, and the temperature. The extraction process was carried out according to the method described above. Table 1 shows the level of experimental factors. The time of extraction, extraction degree, and solid-liquid ratio was set to 2h, 2 times, and 1:20g/mL. The extraction temperature, period of extraction, and extraction degree were all fixed at 45 C twice in the tests to determine the solid-liquid ratio.



**Fig2: Dry seaweed in 25% methanol**

**Table 1. Factors and levels of single-factor experiments**

| <b>Factors</b>          | <b>Levels</b> |
|-------------------------|---------------|
| Temperature / °C        | 45            |
| Time of extraction/h    | 2             |
| Solid-liquid ratio/g/ml | 1:20          |

#### **4.3. ANTIBACTERIAL ACTIVITY**

Antibacterial activity was assayed by using the agar diffusion technique. The nutrient agent medium was prepared the pH was maintained and then it was sterilized by autoclaving at 121°C and 15 lbs pressure for 15 min. 20ml of the sterilized media was poured into sterilized Petri dishes and allowed to solidify at room temperature. A sterile cotton swab is used for spreading each microorganism from the 24 h inoculation broth evenly on the nutrient agar plates. Left for a few minutes to allow complete absorption of the inoculums. In each of these plates, 5-mm diameter wells were made at the center

using sterilized cork bories different concentrations of each algal extract were added to the respective wells on the nutrient agar plates. after incubation a clear inhibition zone around the well's incubation the presence of antibacterial activity.

#### **4.4 Thin Layer Chromatography**

The sample was dissolved in distilled water (0.5g/L), spotted on a silica gel plate, and developed, with a mixture of methanol, ethanol, and distilled water (8:10:5,v:v:v) used as the developing agent. after the silica gel plate was blown dry, the potassium iodide reagent (3.6 g bismuth potassium iodide,10ml glacial acetic acid, 60ml distilled water) was sprayed and left to stand for 15~20 min. the presence of red spots indicated that a positive MAA reaction had occurred

#### **4.6 Characterization of MAA**

##### **4.6.1 UV Vis spectrophotometer (UV -vis)**

A quantity of 0.05g of the sample (MAA extracts) was dissolved in 10ml of distilled water, and scanned at wavelengths ranging from 300 to 400 nm in a UV spectrophotometer to determine the characteristic absorption of the sample.

##### **4.6.2. Gas chromatography-mass spectrometry (GC-MS)**

During the run time of 20 minutes, 50 peaks were obtained. It is stated that algae produce secondary metabolites up to 7% of dry weight which shows antimicrobial activity. Among these about 60% are terpenes, and 20% are fatty acids along with nitrogenous compounds. In the present study as the methanolic extracts, *Amphiroa fragilissima* have An appreciable amount of antifungal activity. The composition of bioactive compounds in the GC-MS chromatogram of these seaweed extracts was analyzed and found that they contained a mixture of compounds. The retention time, peak area %, peak height % along with the compound name, formula, and molecular weight were fetched from the library data as given in Tables 2 & 3. Correlating the presence of certain MAA, fatty acids, and terpenes to the antifungal activity exhibited by seaweeds have been attempted. In this study, the MAA contributed a major portion among the various factions of the extract. The peaks for MAA were fetched at a retention time of 17.31 with an area % of 38.53 and height % of 28.58 for *A.fragilisima*.In this study, GC-MS chromatogram has shown that the methanolic extract of and in *Amphiroa fragilissima* Tridecanoic acid, Nonadecanoic acid, cyclopropane octanoic acid, Heneicosanoic acid. The compound

ethyl isoallocholate is present in the extract of *Amphiroa fragilissima*. 3,7,11,17-Tetramethyl-2-hexadecen-1-ol and 17 1,5-Dimethylhexyl)- 10,13-dimethyl-2,3,4 which are generally proved for antimicrobial activity. The presence of 3,7,11,17-Tetramethyl-2-hexadecen-1-ol, 17 1,5-Dimethylhexyl)-10,13 dimethyl-2,3,4, Di-n-decylsulfone, 1, 2-Bis (trimethylsilyl) benzene compounds in chromatogram of *Amphiroa fragilissima* with height % of 4.62, 6.0 and 3.8 respectively has been noted and in previous studies their antimicrobial activities have been proved.

#### **4.6.2 Cytotoxicity analysis and scratch assay**

An MTT assay was performed to determine the cytotoxicity of the various *Amphiroa fragilissima* sunscreen gel materials on HaCaT cells. Wound healing A wound healing test is a lab technique for studying cell migration and cell-cell interactions. This is also known as a scratch test since it involves scratching a cell monolayer and using a time-lapse microscope to capture photos at regular intervals. It's a 2D cell migration method for measuring cell migration in a sheet of cells semi-quantitatively. This scrape can be created in a variety of ways, including mechanical, thermal, and chemical damage. The goal of this scratch is to create a cell-free zone in order to get cells to move and close the gap. The scratch test is only appropriate for cell types that migrate as epithelial sheets and is ineffective for non-adherent cells.

#### **4.6.4 Physical Evaluation of MAA loaded gel :**

**Morphological characterization of gel:** Physical appearance and color was monitored by visual observations over a period of time from 1- 30 days.

**pH:** pH of the drug-loaded gel was determined by means of a pH meter (calibrated). This was done at various at different ten days time interval (1, 10, 20, 30 days) to further check any pH variation by the time.

**Odour:** the odour of the gel was checked by mixing the gel in water and smelling it.

**Consistency:** the consistency was checked by applying on the skin

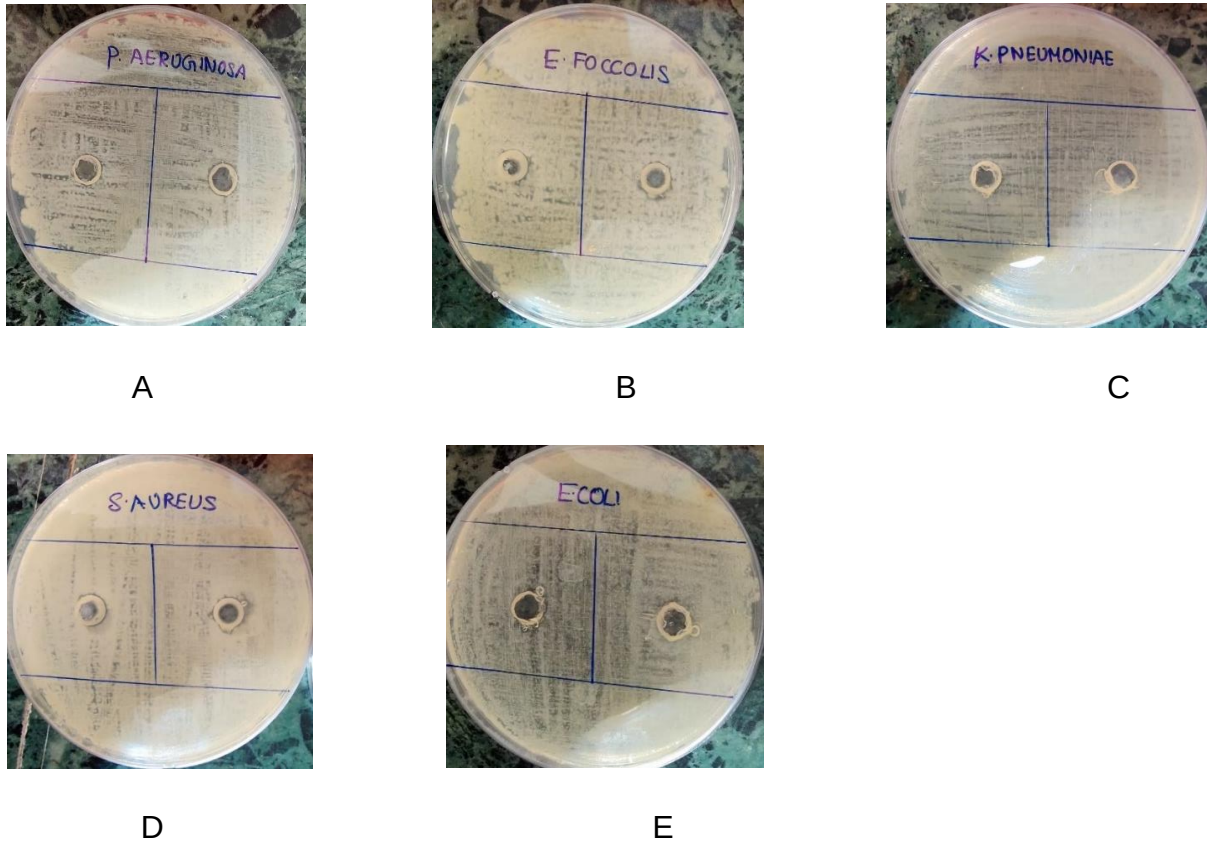
**Greasiness:** The greasiness was checked by applying on the skin

**Homogeneity:** Homogeneity was tested by visual inspection after allowing them set in a container

## 5.Results and Discussion

### 5.1 Antibacterial activities

*A.fragillissima* seaweed was taken for antibacterial activity. it showed different responses to the different human pathogens. In this experiment, the MAA extract of *A . fragillissima* has been well soaked in distilled water and then added to the well.



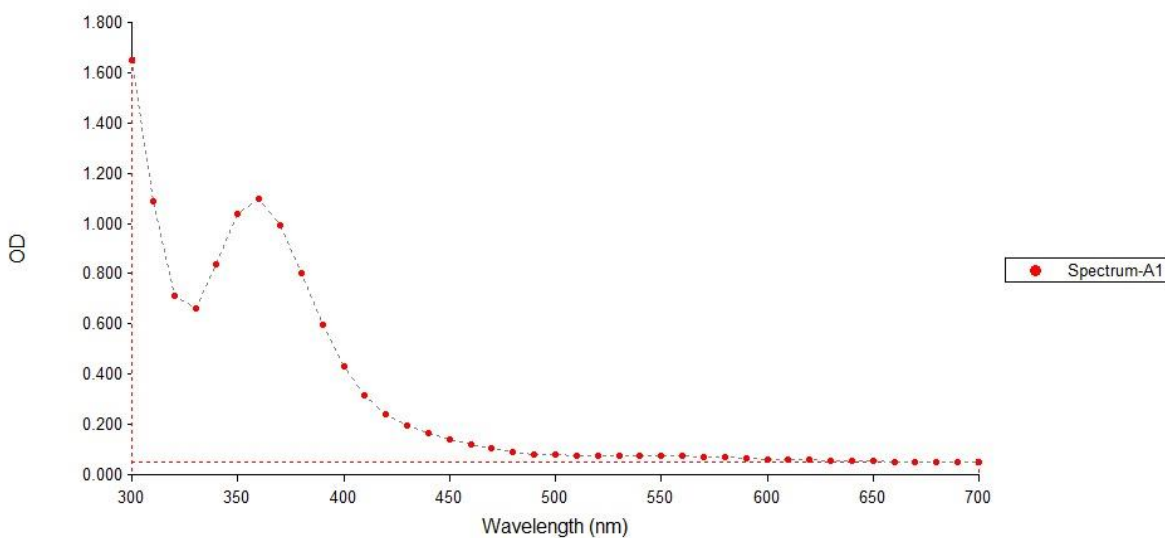
**FIGURE 3: Antibacterial activity zone of inhibition :** (A)*Pseudomonas Aeruginosa* (B)*Escherichia Foccous* (C)*Klebsiella Pneumoniae* (D)*Staphylococcus Aureus* (E)*Escherichia Coli*

Comparatively another human pathogen in *P. Aeruginosa* , *E.Foccous* , *S.Aureus* zone was formed .

**Table 2: Antibacterial activities**

| Bacteria Nam         | AMPHIROA FRAGILISSIMA |
|----------------------|-----------------------|
| <i>E.coli</i>        | –                     |
| <i>P. Aeruginosa</i> | 1mm                   |
| <i>S.aureus</i>      | 2mm                   |
| <i>E.faecalis</i>    | 1.5mm                 |
| <i>K.pneumoniae</i>  | –                     |

## 5.2 UV VISIBLE SPECTROPHOTOMETRY



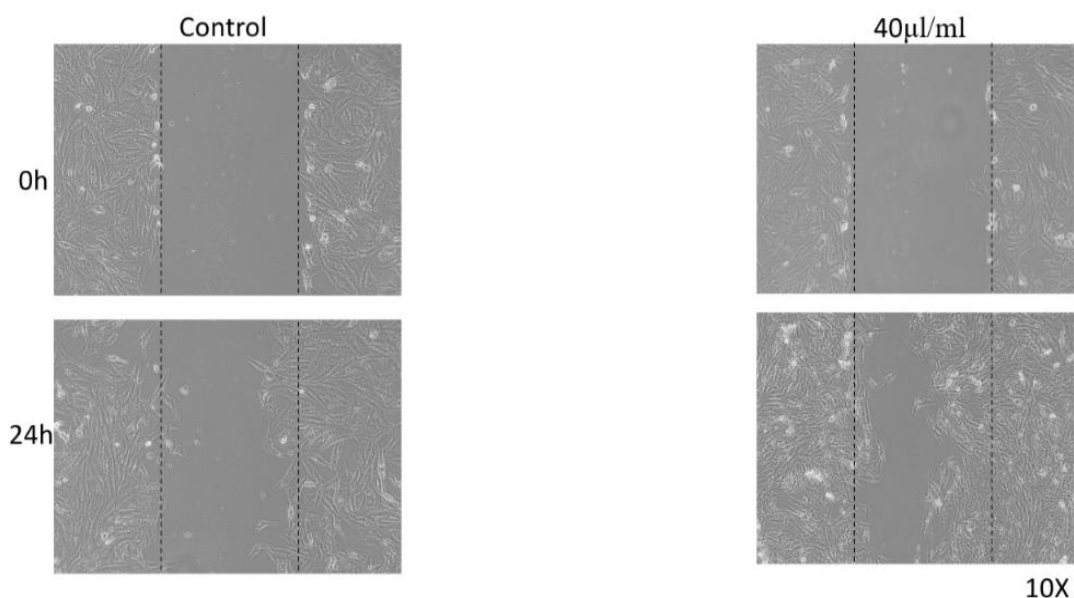
**Figure3: UV–visible spectrophotometry**

### **(UV-vis absorption spectra of absorbance versus wavelength from 320-400 nm)**

Figure shows typical plots of UV-vis absorption spectra of the *Amphiroa fragillissima* MAA extract sunscreen from 320 to 400 nm. The peak was centered around 300 nm (UVB region) for SPF 30. The UV-vis spectra of the *Amphiroa fragillissima* MAA extracted sunscreen indicate that its able to absorb UVB rays. This sunscreen only focused on the UVB radiation and only the absorption peak centered around 300 nm

was obtained. The wavelength at which absorbance is highest is called the maximum wavelength or  $\lambda_{\text{max}}$ , and the absorbance at the  $\lambda_{\text{max}}$  is used.

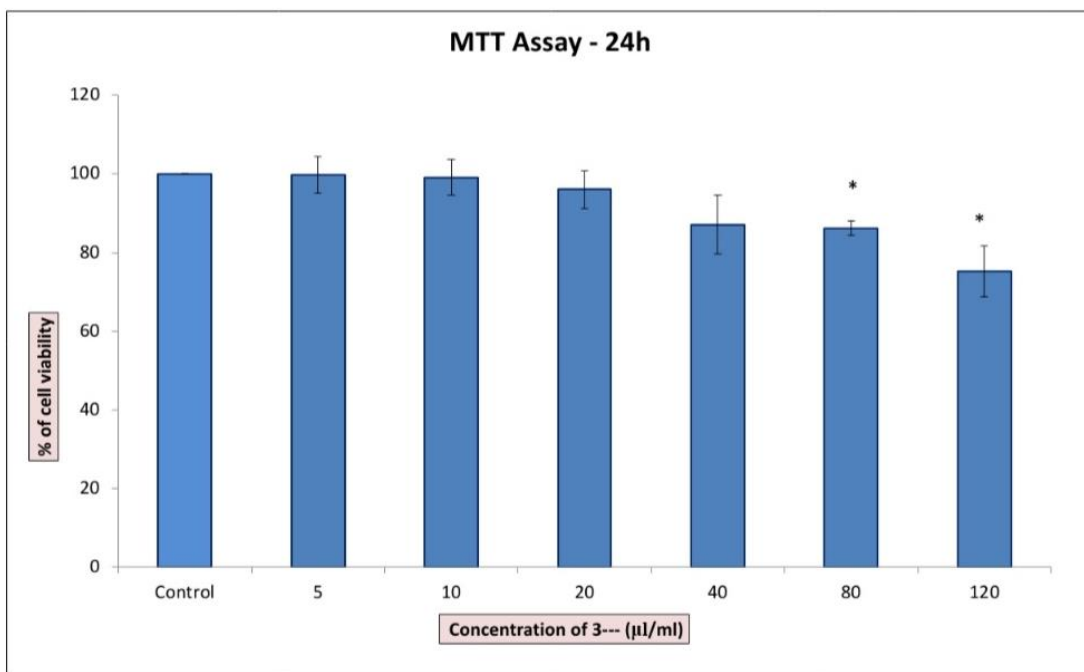
### 5.3 CYTOTOXICITY AND SCTRACH ASSAY



**Figure 4: Scratch assay**

The gels were evaluated for nauplii cytotoxicity and compatibility with human blood and skin cells. Attachment and proliferation of HaCaT and HFF1 cells were seen in media containing 400 µl/mL MAA sunscreen gel. MAA sunscreen gel dramatically accelerated wound closure in an in vitro scratch assay by causing HaCaT cells to migrate. Skin irritation trials revealed no erythema or edoema, proving the gels' applicability. With a P-value of 0.01 for rapid wound closure by re-epithelialization and wound contraction, the MAA sunscreen gel showed considerably faster wound closure through re-epithelialization and wound contraction. The wound healing rates for MAA sunscreen gel-treated wounds were 70 and 87 percent, respectively, with a P 0.05 histology analysis indicating substantial epithelization and angiogenesis (P 0.05). MAA sunscreen

gel-treated wounds showed a thicker regenerated epidermis and a higher number of new blood vessels.



**Figure 5: MTT Assay**

The % cell viability of IL 0 was found to be 99% for the lowest concentration of 1 µg/mL in HaCaT cells. In the case of the highest concentration of 120 µg/mL, the % cell viability was 20.3% in HaCaT cells. In the case of 5, 98% cell viability was observed for the lowest concentration of 5 µg/mL in HaCaT cells. In the case of a higher concentration (120 µg/mL), the % cell viability was estimated as 23.1% in HaCaT cells. The half-maximal inhibitory concentration (IC<sub>50</sub>) value was observed above 10 µg/mL for both cells. The gel sample 10 showed 95% cell viability for the minimum concentration of 10 µg/mL HaCaT cells. The cell viability was reduced to 13.9% in HaCaT cells, for the higher concentration of the 120 µg/mL sample. The 20 sample exhibited 90% viability cells at the minimum concentration of 20 µg/mL, whereas the higher dose (120 µg/mL) showed 27% viability types of cells. The MTT assay indicates that 97% viability

of cells was observed for 40 in cells with a dose of 10 µg/mL. The higher dose of 120 µg/mL relatively showed 20% and 16% in the tested cells. The 120 sample clearly exhibited 89% cell viability for the 20 µg/mL dose concentration in HaCaT cells. The cell viability was observed as 21.5% in the 120 µg/mL dose of the sample in both the cells. Overall, more than 50% cell viability (HaCaT cells) was observed for all the gel samples till the 120 µg/mL concentration. The micrographs of the HaCaT cell lines treated with various gel samples with a concentration 20 µg/mL are provided. It can be observed from Figure 5 that gel samples provided very good viability and proliferation to HaCaT cell lines for the different concentrations of ionic-liquid-loaded ion gel samples (>90%). The addition of ionic liquid greatly influenced the of the 120 sample (99.5%) compared with the gel without ionic liquid (5(76%)). After 5% IL content, the Swiss cell viability decreased to 88%. The MTT assay clearly indicates that the prepared gel samples exhibit very good biocompatibility, which helps us to encapsulate biomolecules and retain their stability over a period.

## **7. Summary and Conclusion**

Several studies have verified the occurrence of MAA in various marine sources, as well as its crucial role in protecting marine organisms from UV-induced stress. Organisms from the sea are more susceptible to UV-induced damage because seawater absorbs light far more effectively than air, thus the effects of coastal zone receives more UV radiation than the inland zone. Sunlight is reflected from the sand and the sea surface in these regions. As a result, these marine species have a variety of photo-adaptive mechanisms that help protect them from UV-induced stress. MAA is a non-profit organisation. A group of amino acids found in a wide range of organisms sent to aquatic organisms, particularly seaweeds, to protect them from predators UV irradiation causes photo-oxidative stress. As a result, in the present effort, we were able to isolate and formulate obtained from this work permit the conclusion that this sun-protective formulation constitutes the most prominent and potent amino acid which can in future become a promising molecule in UV-related dermatological ailments . In further studies the gel-based MAA sunscreen has to be

## 8. References

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