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REVIEW ARTICLE

Antifungal efficacy of marine seaweed extracts against *Alternaria sesami* and *Macrophomina phaseolina* in sesame (*Sesamum indicum* L.)

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Abstract

In Tamil Nadu sesame is cultivated in an area of 74376 ha with average productivity of 433 kg / ha. Productivity has remained stagnant over recent decades because of its susceptibility to biotic and abiotic stresses. Root-rot and leaf spot disease of sesame caused by *Macrophomina phaseolina* is most serious disease-causing losses in seed yield in sesame. Diseases caused by fungi *Alternaria sesami* and *Macrophomina phaseolina*, which cause diseases with leaf spot and root rot, respectively, usually reduce its production.The antifungal effectiveness of methanolic seaweed extracts, namely from *Sargassum myricocystum*, which was collected from the Gulf of Mannar in Tamil Nadu, against various infections was assessed in this study. Soxhlet extraction was used to produce the extracts, which were then examined utilizing Gas Chromatography- Mass Spectrometry (GC-MS) analysis, poisoned food techniques and field and pot experiments. The growth of *A. sesami* (65.33 %) and *M. phaseolina* (24.44 %) was strongly suppressed by *S. myricocystum* extract at a 3 % concentration, according to *in vitro* screening. GC-MS profiling revealed important antifungal substances, such as phytol and squalene. Investigations in the field revealed that treated plants had a reduced incidence of disease and a higher yield, with significant defense against Alternaria leaf spot, powdery mildew and root rot. The structural damage to fungal mycelia and the preservation of plant tissue integrity were confirmed by histopathological and Scanning Electron Microscopy (SEM) investigations. According to these results, *S. myricocystum* has strong antifungal and biostimulant characteristics and can be used as a sustainable bioinoculant for integrated control of diseases in sesame cultivation.

Keywords: disease control; leaf-spot; root-rot; seaweed extract; *sesame*

Introduction

Sesamum (*Sesamum indicum* L.) is a widely produced oilseed crop belonging to the Pedaliaceae family (1). It is referred to as the "Queen of oilseed crops". Sesame (*Sesamum indicum* L.) is one of the major oilseed crops cultivated in India, occupying the fourth position (FAO). It is rich in vitamin E, iron, copper, magnesium, zinc and potassium and contains 50-62 % oil, 18-25 % protein, 9.8 % digestible fiber, 1 % calcium and 0.7 % phosphorus. India is the largest producer of sesame, yielding 0.82 million tons from an area of 1.81 million hectares (2). India's major sesame-growing regions include Gujarat, Madhya Pradesh, Rajasthan, Uttar Pradesh, Orissa, Maharashtra, Tamil Nadu, Andhra Pradesh and West Bengal. In India, the average production is low (391 kg/ha) when in comparison with other countries (3, 4). The crop suffers from several attacks of many pathogens such as fungi, bacteria and phytoplasma diseases (5). Among the fungal diseases leaf spots, phyllody, root rot and stem rot are the most devasting disease that causes a significant reduction in the yield. Among all these diseases, Alternaria leaf spot and root rot is one of the most serious diseases cause yield losses up to 80 % (6). Fungal diseases are often controlled with chemical fungicides, but these chemicals are bad for the environment, damage plants and make plants resistant to the fungicide. The development of alternative control strategies, such as the application of bio-stimulants like seaweed extracts, is increasingly essential for the efficient management of diseases. Recent years have observed an increase in interest in the biological activities of macroalgae due to their antifungal, antibacterial, antiviral, antioxidant, anti-inflammatory, cytotoxic and antimitotic properties. Seaweeds are rich in antifungal compounds such phenolic compounds and terpenes, that promote plant growth and productivity by inhibiting the growth of diseases (7). Therefore, investigating into the use of seaweed products as a natural and eco-friendly way of combating the fungal diseases and make sesame crops healthier and more productive.

Materials and Methods

Isolation and maintenance of *Macrophomina phaseolina* and *Alternaria sesami*

The affected specimens were used to isolate the pathogen. A sterile scalpel will be used to cut the diseased tissue from the infected plant, along with some healthy tissue, into small pieces (5 mm diameter). The plant exhibiting typical symptoms will then be rinsed three times with sterilized water and disinfected with 1 % sodium hypochlorite solution for a minute. The infected samples will be placed aseptically on potato dextrose agar (PDA) medium and the plates will be incubated at room temperature in the inverted position. After seven days of incubation, the fungal growth transferred aseptically to PDA slants and purified following single spore technique (Fig. 1a). The pathogen's identity as *A. sesami and M. phaseolina* were validated using the accession number PV960986 and PV960827 obtained from the National Center for Biotechnology Information (NCBI). For further study, the isolates pure cultures were kept on PDA agar slants (Fig. 1b).

Collection of seaweeds

In Tamil Nadu, several seaweeds were manually collected from the deep-water regions close to Rameswaram. The seaweeds have been collected in Tamil Nadu's Gulf of Mannar geographic region. The phenotypic traits of the brown algae varied, ranging from dark brown to yellow/brown. The red algae had a spiral shape and were pale yellow and grey in color (Table 1; Fig. 2).

Preparation of different solvent extracts of promising seaweeds

The seaweed samples that had been collected were carefully washed with clean fresh water and then clean distilled water to get rid of any dirt or trash. Subsequently, the seaweed samples were gently blotted to remove extra wetness and then exposed to shade drying for a period of 2 to 3 weeks at room temperature. After the drying process, the seaweed samples were stored under dry conditions in an environmental room at an average temperature range from 28 °C to 37 °C and they were subsequently powdered (8). Different solvents such as methanol, ethyl acetate and hexane were used to prepare extracts from the powdered seaweeds to test their antifungal activity.

To prepare the seaweed extract, 20 g of partially blended seaweed powder were placed into a Soxhlet apparatus. The seaweed powder was enclosed in a cellulose thimble paper and subjected to reflux for a duration of 12 hrs using methanol solvent measuring 150 mL. Following the reflux process, the extracted solvent was filtered through Whatman No. 1 filter paper to eliminate any impurities. The resulting solution was then concentrated through evaporation using a rotary evaporator operating at a temperature of 40 °C and a speed of 45 rpm, continuing until the solvent was completely evaporated, following the procedure as described. The final extract was diluted with the respective solvents and stored at -4 °C for future use (9).

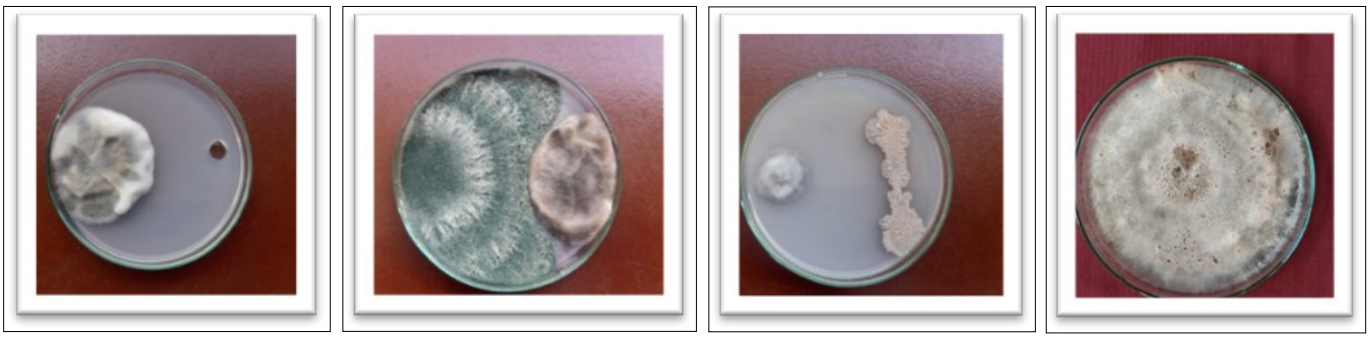

Fig. 1. *In vitro* screening of methanol extract of seaweeds (3 %) against *Alternaria sesame.*

Table 1. Phenotypic character of seaweeds collected from the Gulf of Mannar region in Tamil Nadu

S. No	Seaweeds	Type	Phenotypic characters	Structure of the seaweeds
1	*Sargassum myricocystum*	Brown	Dark brown	Smooth
2	*Kappaphycus alvarezii*	Red	Yellow to brown	Hardy structure
3	*Gracilaria edulis*	Red	Light yellow & grey	Small spiral
5	*Ulva lactuca*	Green	Green	Leafy
6	*Caulerpa racemosa*	Green	Yellow to green	Small leaves

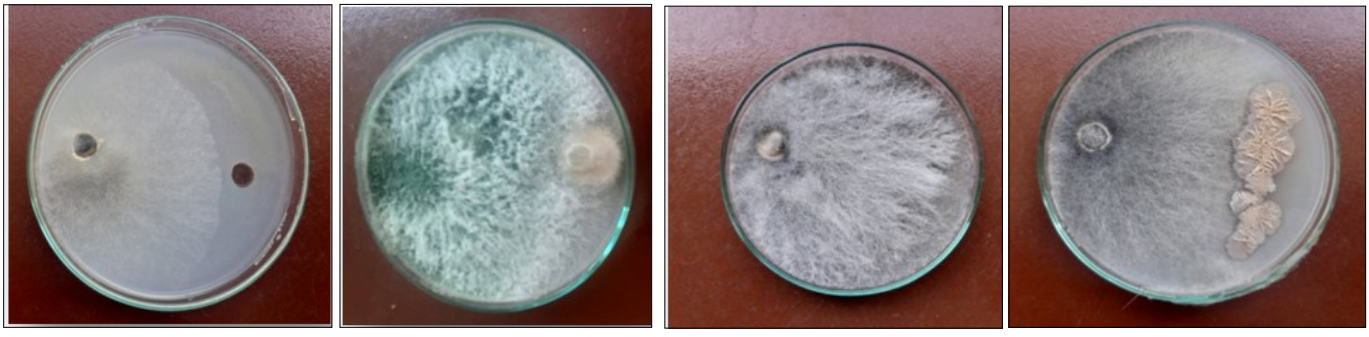

Fig. 2. *In vitro* screening of methanol extract of seaweeds (3 %) against *Macrophomina phaseolina.*

Screening of antifungal activity of seaweeds against the growth of pathogen causing root rot, *Alternaria* leaf spot and powdery mildew in sesame (Poisoned food technique)

The primary objective of this study was to evaluate the effectiveness of seaweed extracts, namely bio-stimulants, in reducing, Alternaria leaf spot and root rot in sesame. In this study, methanol was used to obtain extracts from five distinct seaweeds: *Ulva lactuca, Gracilaria edulis, Sargassum myricocystum, Kappaphycus alvarezii* and *Caulerpa racemosa* (10). Seaweed extracts' antifungal qualities were tested using the poisoned food approach. After adding 1 %, 3 % and 5 % seaweed extracts to potato dextrose agar medium, the mixture was autoclaved and put into sterile petriplates. A sterile cork borer was used to cut 5 mm-diameter discs off the edge of a 5-day-old culture. After that, the discs were aseptically put onto PDA plates that had been poisoned with seaweed extracts. The medium was utilized as a control, but the extract was not added. The colony diameter of the infected plates was measured and recorded at 25 °C after 48, 72 and 96 hrs of incubation. Three plates per replication were kept for each treatment. The growing culture was observed visually and microscopically for evidence of a reduction of mycelial growth. After four days of incubation, mycelial growth of the pathogen and inhibition zone were measured in the solvent extract/bio-inoculants plates, as well as in control plates and percent inhibition (PI) of mycelial growth was calculated using the formula (11).

$$PI = \frac{Dc - Dt}{Dc} \times 100$$

Where,

PI = percent inhibition

C= Average diameter of fungal growth (cm) in control

T= Average diameter of fungal growth (cm) in treatment

GC-MS analysis of methanol extract of *S. myricocystum*

GC-MS analysis was carried out utilizing an Agilent GC-MC-5975C instrument equipped with a triple-axis detector and an auto sampler. The GC column utilized was a fused silica capillary column measuring 30 m in length, 0.25 mm in diameter, with a film thickness of 0.25 mm. Helium served as the carrier gas at a flow rate of 1.51 mL per minute for the initial minute. The mass spectrometer operated in electron ionization (EI) mode at 70 eV and scanned a range from 40 to 700 mass-to-charge ratio (m/z). The sample underwent injection with a split ratio of 1:10 and an injected volume of 1 µL. The injector T1 temperature was maintained at 250 °C, while the oven temperature began at 70 °C for 3 min before ramping up to 250 °C at a rate of 14 °C per min, resulting in a total run time of 41 min. Peak identification of crude seaweed extracts was conducted by comparing retention times with standards. The obtained mass spectra were compared with those available in NIST libraries (NIST 11-Mass Spectral Library, 2011 version) with an acceptance criterion of a match above a critical factor of 80 %, as per the criteria (12).

Evaluating the efficacy of promising seaweed extract against sesame root rot and Alternaria leaf spot under controlled and open field conditions

An experimental trial was performed at the Department of Plant Pathology, Agricultural College and Research Institute, Madurai, to assess the effectiveness of seaweed extracts against the pathogen *Machrophomina* and *Alternaria* in potted and field condition at orchard. The growth medium used consisted of a sterilized mixture of sand, red soil and farmyard manure (FYM) in a 1:1:1 ratio. The pathogen was cultivated in a sand maize medium and subsequently introduced into the earthen pots at a ratio of 1:20 (w/w), with some pots serving as controls without pathogen inoculation. To test the impact of biostimulants; namely, *S. myricocystum* and *K. alvarezii*, onion bulbs were treated and spray was performed at 25, 40 and 60 days after sowing (DAS). The recommended commercial biocontrol formulation, viz., *Trichoderma asperellum* TV1, *Bacillus subtilis* Bbv 57 and the recommended chemicals fungicide Mancozeb also compared with the seaweeds. Each treatment was replicated three times using a completely randomized design (CRD) for pot culture and randomized block design (RBD) for open field condition (13) (Fig. 3).

Histopathological studies and microscopic examination

For histology, three onion leaf samples from infected, infected treated and control plants were collected and the experiment was carried out at the Central Aquaculture Pathology Laboratory in Mayiladuthurai, Tamil Nadu, India (14).

Results and Discussion

In vitro screening of methanol extract of seaweeds (3 %) against *Alternaria sesami* and *M. phaseolina*

The seaweed extracts were screened against the *Alternaria sesami* and *Macrophomina phaseolina* by poissoned food technique (15). The effect of different seaweed extracts screened against the growth of *A.sesami* and *M. phaseolina*. The result showed that, the inhibition of mycelial growth was noticed in all the treatments. Among the seaweeds, *S. myricocystum* showed the higher antifungal activity which was significantly inhibited the growth of *A. sesami* (3.1cm) were found to maximum reduction over control (65.33 %) (Table 2; Fig. 4) whereas in mycelial growth of *M. phaseolina* was 6.8 cm and percent inhibition was recorded 24.44 over control (Table 3; Fig. 5). The percentage of mycelial reduction which emphasizes that the presence of bioactive metabolites in marine algae, which can be soluble in solvents, could be related to the high and low effect of organic extracts against microorganisms.

Table 2. *In vitro* screening of methanol extract of seaweeds (3 %) against *A. sesami*

Sl. No	Treatments	Mycelial growth (cm)	Per cent inhibition over control
1.	*G. edulis*	7.2	19.33
2.	*S. myricocystum*	3.1	65.33
3.	*C. racemosa*	7.4	17.33
4.	*U. lactuca*	6.2	31.11
5.	*K. alvarezii*	4.5	50.00
6.	*T.richoderma asperellum*	3.0	66.22
7.	*Bacillus subtilis*	1.9	75.88
8.	Control	9.0	-
	CD(p=0.05)	1.21	3.89
	SE(d)	0.57	1.81

Fig. 3. Bio-efficacy of promising seaweeds on sesame Alternaria leaf spot under pot condition.

Fig. 4. Bio-efficacy of promising seaweeds on sesame Macrophomina root rot under pot condition.

Table 3. *In vitro* screening of methanol extract of seaweeds (3 %) against *M. phaseolina*

Sl. No	Treatments	Mycelial growth (cm)	Per cent inhibition over control
1.	*G. edulis*	8.2	8.88
2.	*S. myricocystum*	6.8	24.44
3.	*C. racemosa*	8.5	5.55
4.	*U. lactuca*	7.9	12.22
5.	*K. alvarezii*	7.1	21.11
6.	*T. asperellum*	1.9	78.88
7.	*B. subtilis*	6.2	31.11
8.	Control	9.0	-
	CD(p=0.05)	1.04	2.08
	SE(d)	0.49	0.97

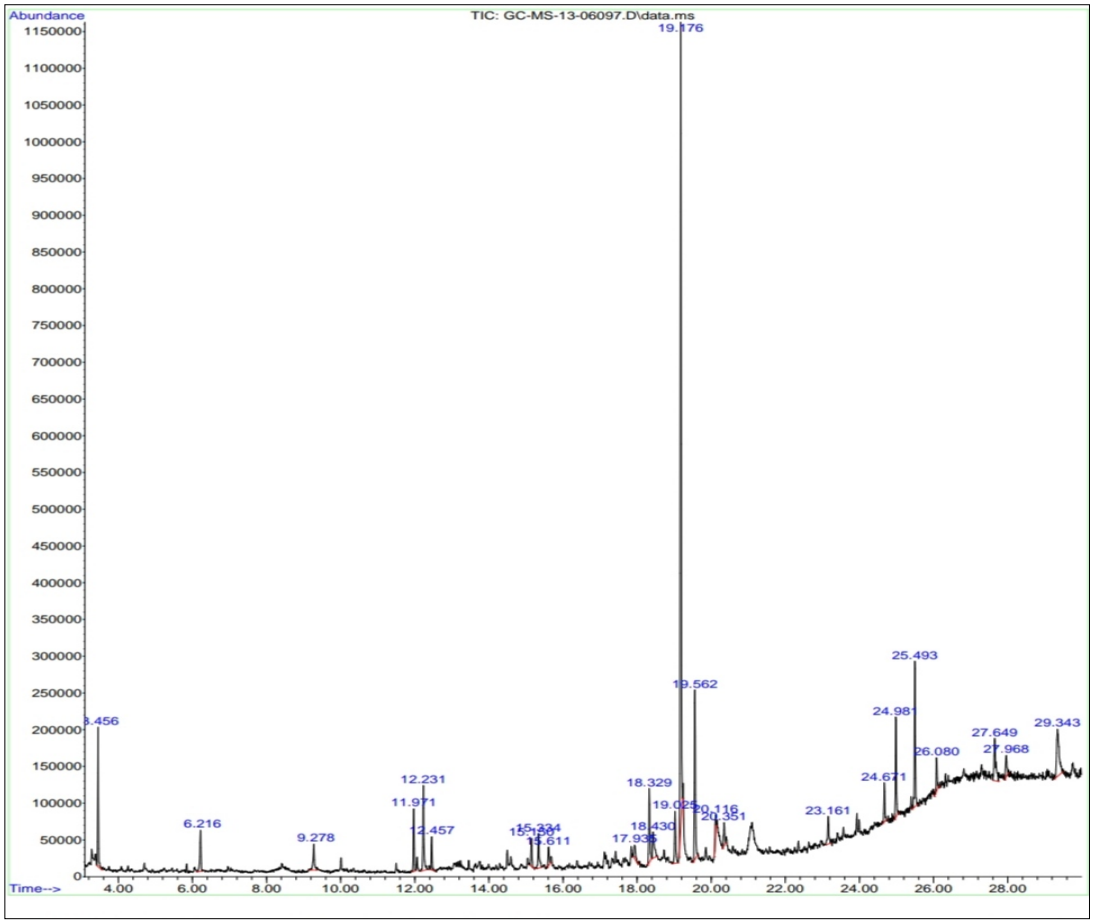

Fig. 5. GC-MS Chromatogram of *Sargassum myricocystum* secondary metabolites.

GC-MS analysis of *Sargassum myricocystum* secondary metabolites

The GC-MS examination of the crude extract from *S. cristaefolium* gave us useful information about its chemical composition. There were 25 chemicals found, showing a significant number of volatile compounds and secondary metabolites in the extract (Fig. 1; Table 4). Important chemicals like squalene, ethanone and phytol all served a part in the antifungal effects that were seen. It was interesting to see that squalene had a peak area of 6.43 % at a holding time of 25.39 min and that ethanone had a peak area of 4.91 % at 19.219 min. On the other hand, phytol, which was seen with a retention time of 17.81 min and a peak area of 0.53 %, added to the extract's complex chemical profile.

Evaluation of bio efficacy of seaweed extracts on Alternaria leaf spot and powdery mildew of sesame (pot culture)

The pot culture experiment was conducted with nine treatments with application different seaweeds and bio control agent in three replicates for managing foliar diseases of sesame. The result showed that foliar spray of Propiconazole (25 EC) 30 and 45 days after sowing (chemical check) found effective against Alternaria leaf spot and powdery mildew which recorded 7.18 and 9.78 PDI. Among the seaweeds, the minimum disease severity of *Alternaria* leaf spot (22.04 PDI) and powdery mildew (51.34 PDI) were recorded in foliar spray of *S. myricocystum* (3 %) 30 and 45 days after sowing followed by foliar spray of *S. myricocystum* (2 %) 30 and 45 days after sowing which recorded *Alternaria* leaf spot (23.75 PDI) and powdery mildew (55.16 PDI) (Table 5; Fig. 6).

Evaluation of bio efficacy of seaweed extracts on root rot of sesame (pot culture)

A pot culture experiment was conducted to assess the bio-efficacy of seaweeds and bio control agents against root rot in sesame and the results were depicted in Table 6 and Fig. 7. Soil drenching with Carbendazim 1g/L of water at 30 and 45 days after sowing significantly reduced the incidence of root rot which recorded 15.26 %. Among the different seaweeds, soil drenching of *S. myricocystum* @ 3 % at 30 and 45 days after sowing recorded lowest disease incidence of 41.17 %. This was followed by soil drenching of *S. myricocystum* @ 2 % at 30 and 45 days after sowing which recorded of 43.25 % root rot incidence.

Evaluation of seaweed and bio agents as integrated biocide treatments for controlling root rot, *Alternaria* leaf spot and powdery mildew in sesame under field condition

The experimental trial was laid out in farmers field at Korkai, Kumbakonam, Thanjavur district. A trail was taken in a randomized block design (RBD) with seven treatments with application of seaweeds and replicated thrice. The treatments were imposed as per the programme schedule.

The result showed that SD of Carbendazim (1 %) and FS of Propiconazole (25 EC) 30 and 45 DAS (chemical check) found effective against Alternaria leaf spot, powdery mildew and root rot which recorded 9.56 PDI, 11.25 PDI and 12.86 % with yield of 651 kg/ha and CB ratio of 1:2.62. Among the seaweeds, SD and FS of *S. myricocystum* @ 3 % at 30 and 45 days after sowing showed minimum incidences of *Alternaria* leaf spot (20.12 PDI), powdery mildew (24.27 PDI) and root incidence (30.45) with yield of 621 kg/ha and 1:2.00 C:B ratio (Table 7).

Table 4. GC-MS analysis for secondary metabolites produced by *S. myricocystum*

S. No	Name of the compound	Peak area (%)	Retention time	MW (g/mole)	Molecular formula	Specific role	References
1	Methanamine	4.30	3.446	31.05	CH_3NH_2	Antibacterial activity	Spinu *et al*. (2016)
2	Dodecane	1.37	9.218	170.33	$C_{12}H_{26}$	Antimicrobial activity	Ortansa *et al*. (2020)
3	2-Naphthalenemethanol	1.81	15.344	158.20	$C_{11}H_{10}O$	Antifungal activity	Carrillo *et al*. (2023)
4	Silane	3.46	18.319	32.11	H_4Si	Antifungal activity	Oldertrøen *et al*. (2017)
5	Tridecanoic acid	1.97	18.450	214.34	$C_{13}H_{26}O$	Antimicrobial activity	Chowdhury *et al*. (2021)
6	Methaqualone	2.73	19.055	250.30	$C_{16}H_{14}N_2O$.	Antibacterial activity	Du *et al*. (2021)
7	6-Octadecenoic acid	1.17	20.251	282.46	$C_{18}H_{34}O$	Antimicrobial properties	Chelliah *et al*. (2017)
8	Eicosane	1.60	23.561	282	$C_{20}H_{42}$	Antifungal, antibacterial, antitumor and cytotoxic effects	Hsouna *et al.* (2011)
9	1,4-Benzenedicarboxylic acid	4.51	24.881	166.02	$C_8H_6O_4$	Antibacterial and Antifungal activities	Guo *et al*. (2022)
10	Squalene	6.43	25.393	410.71	$C_{30}H_{50}$	Antimicrobial, antioxidant, antistatic and anti-carcinogenic.	Chenniappan *et al*. (2020)
11	hexamethyl-Cyclotrisiloxane	1.76	26.180	222.46	$C_6H_{18}O_3Si_3$	Antibacterial activity	Bhuyar *et al*. (2020)
12	2,4-dimethyl- Benzo[h] quinolone	3.47	27.549	207.27	$C_{15}H_{13}N$	Antibacterial activity	Sánchez*et al*. (2022)
13	Silicic acid	1.31	26.968	96.113	H_4O_4Si	Antibacterial activity	Kalaivani *et al*. (2023)
14	Phenol	1.28	17.918	94.113	C_6H_6O	Antibacterial activity	Maddox *et al*. (2010)
15	n-Hexadecanoic acid	2.71	16.472	256.424	$C_{16}H32O$	Antibacterial, antifungal and anti-inflammatory	Krishnaveni *et al*. (2014)
16	Ethanone	4.91	19.219	196.24	$C_{14}H_{12}O$	Antibacterial activity	Ferdosi *et al*. (2021)
17	Phytol	0.53	17.818	296.53	$C_{20}H_{40}O$	Antibacterial	Pejin *et al.* (2014)
18	Octadecanoic acid	1.25	20.634	284.47	$C_{18}H_{36}O_2$	Antibacterial activity	Pejin *et al*. (2014)
19	3-Cyclopenten-1-one	2.10	21.172	82.10	C_5H_6O	Antifungal activity	Soliman *et al*. (2022)
20	Stigmasterol	1.83	29.243	412.69	$C_{29}H_{48}O$	Antimicrobial activity	Mailafiya *et al*. (2018)

Table 5. Evaluation of seaweed extracts on Alternaria leaf spot and powdery mildew of sesame (pot culture)

Tr. No	Treatments	*Alternaria* leaf spot (PDI)	Powdery mildew (PDI)
T_1	Foliar spray of *K. alvarezii* (1 %) 30 and 45 days after sowing	51.81 (46.03)	75.14 (60.09)
T_2	Foliar spray of *K. alvarezii* (2 %) 30 and 45 days after sowing	34.67 (36.09)	68.79 (56.03)
T_3	Foliar spray of *K. alvarezii* (3 %) 30 and 45 days after sowing	32.13 (31.39)	67.14 (55.02)
T_4	Foliar spray of *S. myricocystum* (1 %) 30 and 45 days after sowing	48.10 (43.91)	74.23 (59.49)
T_5	Foliar spray of *S. myricocystum* (2 %) 30 and 45 days after sowing	23.75 (29.16)	55.16 (47.96)
T_6	Foliar spray of *S. myricocystum* (3 %) 30 and 45 days after sowing	22.04 (28.00)	51.34 (45.76)
T_7	Foliar spray of Propiconazole 0.1 % (25EC) 30 and 45 days after sowing (chemical check)	7.18 (15.47)	9.78 (8.22)
T_8	Foliar spray of *Bacillus subtilis* (0.2 %) 30 and 45 days after sowing (bio control check)	13.89 (21.88)	65.15 (54.14)
T_9	Control (untreated)	84.5 (66.81)	87.35 (69.15)
CD(p=0.05)		2.80	2.84
SEd		1.36	1.38

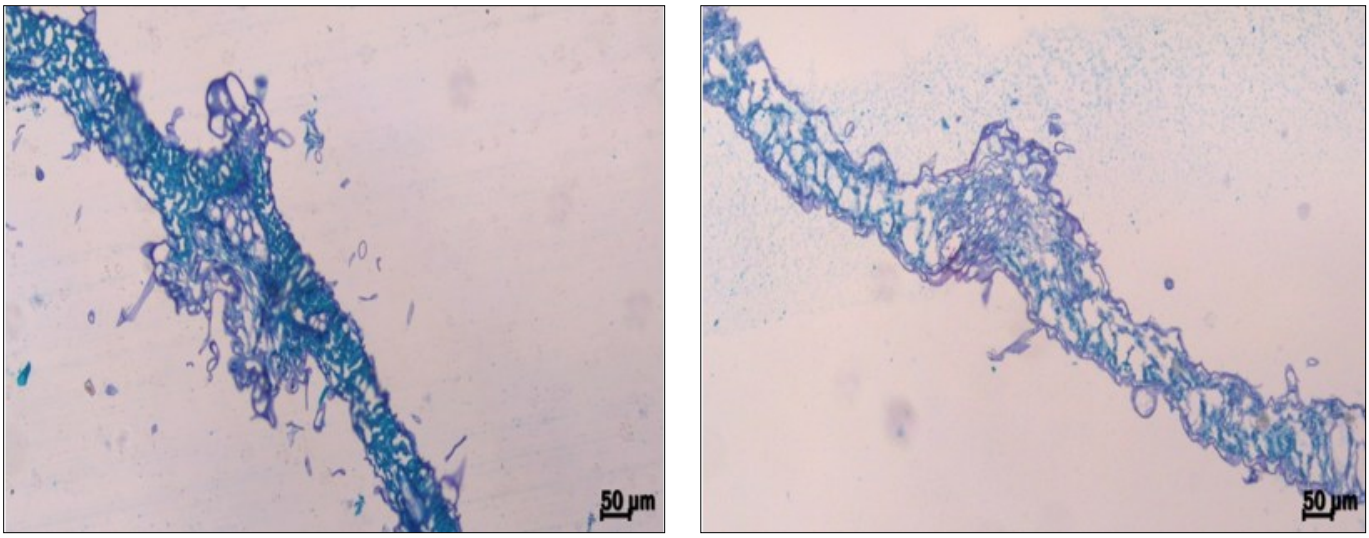

Fig. 6. Histology of control and infected specimen.

Table 6. Effect of seaweed extracts on root rot of sesame (pot culture)

Tr.No	Treatments	Root rot (%)
T_1	SD of *Kappaphycus alvarezii* (1 %) 30 and 45 days after sowing	57.34
T_2	SD of *Kappaphycus alvarezii* (2 %) 30 and 45 days after sowing	53.12
T_3	SD of *Kappaphycus alvarezii* (3 %) 30 and 45 days after sowing	51.76
T_4	SD of *Sargassum myricocystum* (1 %) 30 and 45 days after sowing	48.36
T_5	SD of *Sargassum myricocystum* (2 %) 30 and 45 days after sowing	43.25
T_6	SD of *Sargassum myricocystum* (3 %) 30 and 45 days after sowing	41.17
T_7	Soil application of *Trichoderma asperellum* 2.5 Kg/ha combined with 100 Kg of FYM at sowing and 30 and 45 days after sowing	21.12
T_8	Soil drenching with Carbendazim 1g/L of water at 30 and 45 days after sowing	15.26
T_9	Untreated check	94.35
CD(p=0.05)		1.63
SEd		3.35

Fig. 7. Bio-efficacy of promising seaweeds on controlling root rot, *Alternaria* leaf spot and powdery mildew of sesame under field conditions.

Table 7. Evaluation of promising seaweeds and bio agents for controlling root rot, *Alternaria* leaf spot and powdery mildew in sesame (Field condition)

Treatments		leaf spot (PDI)	Powdery mildew (PDI)	Root rot (%)	Yield (Kg/ha)	C:B ratio
T_1	SD and FS of *S. myricocystum* @ 2 % at 30 and 45 DAS	25.28	25.64	32.08	578	1.29
T_2	SD and FS of *Sargassum myricocystum* @ 3 % at 30 and 45 DAS	20.12	24.27	30.45	621	2.00
T_3	SD and FS of *Kappaphycus alvarezii* @ 2 % at 30 and 45 DAS	29.65	27.57	27.86	561	1.48
T_4	SD and FS of *Kappaphycus alvarezii* @ 3 % at 30 and 45 DAS	27.34	26.45	29.72	615	1.68
T_5	SA of *T. asperellum* 2.5 Kg/ha combined with 50 Kg of FYM at 30 and 45 DAS	30.13	28.12	14.28	648	2.60
T_6	SD of Carbendazim (1 %) and FS of Propiconazole (25 EC) 30 and 45 DAS (chemical check)	9.56	11.25	12.86	651	2.62
T_7	Untreated check	38.42	29.23	45.42	454	
	CD(p=0.05)	2.21	1.86	2.67	17.40	
	SEd	1.06	0.62	1.35	7.98	

Histopathological studies and microscopic examination

Histopathological analysis demonstrated that *S. myricosystum* extracts protected plant tissues from *Alternaria sesami* and *Macrophomina phaseolina* infections. Seaweed extracts can strengthen plants against fungal infections, as shown by the preservation of tissue integrity and the lack of pathological damage in treated tissues. These results highlight the potential of seaweed extract as a long-term disease control method by providing insightful evidence of the beneficial effects of seaweed extract treatments on plant health.

The structural modifications that *S. myricosystum* treatment caused in *Alternaria sesami* and *Macrophomina phaseolina* were better understood due to the SEM study. A significant antagonistic effect of the seaweed extract against the pathogen is suggested by the observed collapse of mycelial development and the lack of conidia generation. These results demonstrate the potential of *S. myricocystum* as an effective treatment for managing fungal infections in plants and underscore its exciting position in integrated disease management approach. Further research into the underlying processes of action and improvement of treatment methods could make seaweed based treatment more useful for managing diseases in agriculture.

Conclusion

This study illustrates the antifungal properties of *S. myricocystum*, a brown seaweed that was obtained from Mandabam in Tamil Nadu's Ramanathapuram area. At a concentration of 3 %, the methanol extract of *S. myricocystum* exhibited remarkable efficacy against the foliar and soil-borne pathogen responsible for sesame leaf spot and rot root. Furthermore, *in vivo* treatment of *S. myricocystum* in a pot culture experiment dramatically reduced the disease incidence of leaf spot. The significant antibacterial and biostimulant properties of *S. myricocystum* may be primarily attributed to its distinct phytochemical makeup, which includes fatty acids, saccharides and phenolic chemicals. Because of these features, *S. myricocystum* could be a useful brown macroalga for combating diseases and developing safe multifaced bioinoculants for sustainable farming.

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Authors' contributions

All authors contributed their valuable visions for this manuscript. MP[1] have done the research, EA carried out the writing process (methodology, conceptualization, molecular characterisation) and MP[2] drafted the manuscript. SRT supervised and corrected data analysis. All authors read and approved the final manuscript. [MP[1]: Mahalakshmi Palani & MP[2]: Mareeswari Pechimuthu]

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During the preparation of this manuscript, EA used Grammarly for grammar correction and fluency for improving the writing skill.

References

1. El Khier MK, Ishag KE, Yagoub AA. Chemical composition and oil characteristics of sesame seed cultivars grown in Sudan. Res J Agric Biol Sci. 2008;4(6):761-6. https://doi.org/10.1080/03235400903187279
2. FAO. World food and agriculture: statistical handbook 2010. Rome: FAO; 2021.
3. Elewa I, Mostafa M, Sahab A, Ziedan E. Direct effect of biocontrol agents on wilt and root-rot diseases of sesame. Arch Phytopathol Plant Prot. 2011;44(5):493-504. https://doi.org/10.1080/03235400903187279
4. Ziedan ES, Sadek Elewa I, Mostafa HM, Sahab AF. Application of mycorrhizae for controlling root diseases of sesame. J Plant Prot Res. 2011.
5. Tripathy SK, Kar J, Sahu D. Advances in sesame (*Sesamum indicum* L.) breeding. In: Advances in plant breeding strategies: industrial and food crops. Vol 6. 2019. p.577-635.
6. Pawar DV. Studies on sesamum leaf blight caused by *Alternaria sesami* (Kawamura) Mohanty and Behera [dissertation]. Parbhani: Vasantrao Naik Marathwada Krishi Vidyapeeth; 2017.
7. Rathore SS, Chaudhary DR, Boricha GN, Ghosh A, Bhatt BP, Zodape ST, et al. Effect of seaweed extract on the growth, yield and nutrient uptake of soybean (*Glycine max*) under rainfed conditions. S Afr J Bot. 2009;75(2):351-5.

8. Kannan R, Bharathkumar R. Bio-efficacy of two seaweeds methanol extract on growth and development of *Spodoptera litura* Fabricius. Ann Plant Prot Sci. 2016;24(1):1-5. https://doi.org/10.14719/pst.5395

9. Kombiah P, Sahayaraj K. Repellent activity of *Caulerpa scalpelliformis* extracts and its formulations against *Spodoptera litura* and *Dysdercus cingulatus* (Fab.). J Biopestic. 2012;5:145-50. https://doi.org/10.57182/jbiopestic.5.0.145-150

10. Baloch GN, Tariq S, Ehteshamul-Haque S, Athar M, Sultana V, Ara J. Management of root diseases of eggplant and watermelon with the application of asafoetida and seaweeds. J Appl Bot Food Qual. 2013;86(1):125-9. https://doi.org/10.5073/JABFQ.2013.086.019

11. Pandey KK, Pandey PK, Upadhyay JP. Selection of potential isolate of biocontrol agents based on biomass production, growth rate and antagonistic capability.

12. Musharraf SG, Ahmed MA, Zehra N, Kabir N, Choudhary MI, Rahman AU. Biodiesel production from microalgal isolates of southern Pakistan and quantification of FAMEs by GC-MS/MS analysis. Chem Cent J. 2012;6:149. https://doi.org/10.1186/1752-153X-6-149

13. Kunwar IK, Singh T, Machado CC, Sinclair JB. Histopathology of soybean seed and seedling infection by *Macrophomina phaseolina*. Phytopathology. 1986;76(5):532-5.

14. Mahalakshmi P, Jeevitha K, Sujatha M, Ayyandurai T, Suthin Raj T, Karthikeyan M. Exploring the antifungal potential of seaweed extract from *Sargassum cristaefolium* for twister blight management in onion. Ann Phytomed. 2024;13(1):1111-23. https://doi.org/10.54085/ap.2024.13.1.119

15. Dennis C, Webster J. Antagonistic properties of species-groups of *Trichoderma*: I. Production of non-volatile antibiotics. Trans Br Mycol Soc. 1971;57(1):25-39. https://doi.org/10.1016/S0007-1536(71)80077-3

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