

# A Comprehensive Review on *Sargassum duplicatum*

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## ABSTRACT:

This comprehensive review delves into the intricate world of brown seaweeds, with a particular focus on *Sargassum duplicatum*. Brown seaweeds, a vital component of marine ecosystems, have gained increasing attention due to their ecological significance and diverse applications. *Sargassum duplicatum*, a recently identified species, holds promise for expanding our understanding of this taxonomic group. The review encompasses taxonomical

classification, synonyms, macroscopical and microscopical characters, habitat preferences, and ecological impacts. Additionally, it explores the phytochemical composition of *Sargassum duplicatum*. The review also outlines the diverse uses of *Sargassum duplicatum* across industries and concludes with an exploration of reported pharmacological activities. By synthesizing current scientific knowledge, this review provides a holistic perspective on the multifaceted aspects of *Sargassum duplicatum* offering insights into its ecological role, potential applications, and implications for future research.

## KEYWORDS:

Brown seaweeds, ecological, pharmacological, phytochemical, *Sargassum duplicatum*, thallus.

## I. INTRODUCTION

The marine environment, with its vast expanses and rich biodiversity, continues to be a frontier of discovery for scientists exploring the intricate tapestry of life<sup>1</sup>. Within this watery realm, the brown seaweed *Sargassum duplicatum* has emerged as a captivating subject of study, drawing attention due to its unique characteristics and

potential ecological significance<sup>2</sup>. This introduction serves as a gateway to understanding the key aspects of *Sargassum duplicatum*, encompassing its taxonomy, morphology, ecological roles, and the promise it holds for various scientific disciplines.

*Sargassum duplicatum*, a member of the brown seaweed family found its place in scientific discourse through dedicated exploration and taxonomic scrutiny<sup>3</sup>. Its discovery represents a valuable addition to the understanding of brown seaweeds, shedding light on the intricate diversity within the *Sargassum* genus. The taxonomy of *Sargassum duplicatum* unveils its systematic classification and its position within the broader context of marine flora. *Sargassum duplicatum* belongs to the family Sargassaceae<sup>4</sup>. A wide range of biological properties of this seaweed, including antidiabetic, anticancer, anticoagulant, antithrombotic and antihypertensive activities<sup>5</sup>.

The allure of *Sargassum duplicatum* lies not only in its taxonomic identity but also in its fascinating morphology<sup>6</sup>. From its macroscopic appearance, characterized by branching structures and unique reproductive organs, to microscopic features that reveal cellular intricacies, each aspect contributes to the seaweed's distinctive identity<sup>7</sup>. These morphological details provide insights into its adaptation strategies and ecological roles within coastal ecosystems<sup>8</sup>.

Coastal ecosystems, where *Sargassum duplicatum* finds its home, are dynamic and interconnected environments<sup>9</sup>. Investigating the ecological roles of this brown seaweed unveils its importance as a habitat provider, shelter for marine organisms, and contributor to nutrient cycling<sup>10</sup>. Understanding its habitat preferences allows us to

appreciate its adaptability and discern its influence on the biodiversity and health of coastal areas.

Beyond its ecological functions, *Sargassum duplicatum* holds promise for various applications across diverse fields<sup>11</sup>. The investigation into its phytochemical composition explores the rich array of compounds present within the seaweed. This includes not only primary metabolites crucial for its survival but also secondary phytoconstituents with potential applications in industries such as pharmaceuticals, agriculture, and environmental remediation<sup>12</sup>.

This exploration of *Sargassum duplicatum* sets the stage for a comprehensive review, aiming to synthesize current knowledge and delve into the intricacies of this brown seaweed<sup>13</sup>. By dissecting its taxonomy, morphology, ecological roles, and biochemical makeup, this study aims to contribute to a nuanced understanding of *Sargassum duplicatum* and inspire further research into the broader realm of marine biodiversity<sup>14</sup>.

## 1. BROWN SEAWEEDS

Brown seaweeds, scientifically classified within the phylum Ochrophyta, represent a diverse and ecologically significant group of marine macroalgae<sup>15</sup>. These algae are predominantly found in temperate and cold coastal waters, where they play vital roles in marine ecosystems. The southwest coast of India has a diverse marine habitat of seaweeds, with brown algae being the most prevalent<sup>16</sup>. The brown algae are differentiated by their colour which differs from olive green via light golden shades of brown. This is due to the occurrence of a golden-brown xanthophyll pigment fucoxanthin in their chromatophores<sup>17</sup>. The brown algae are brownish in colour because of the huge quantities of the carotenoid and fucoxanthin covering the residual pigment chlorophyll a and c, carotene, and other xanthophylls<sup>18</sup>. The cell walls are composed of alginic acid, which was extracted as alginate or agent for industrial use. Brown algae range from smaller cords to the largest seaweed, and the majority are found in the intertidal belt<sup>19</sup>. Brown seaweeds are mostly utilized to cure hypothyroidism, fatigue, cellulite, cough, asthma, stomach ailments, and headache<sup>20</sup>. Brown seaweeds are also utilized to encourage weight loss besides assistance in skincare<sup>21</sup>. The prospective antioxidant compounds in brown seaweeds were recognized as polyphenols and pigments mostly<sup>22</sup>. These compounds are dispersed in plants or algae and are widely known for displaying antioxidant

activities by reactive oxygen species (ROS) recovery activity and lipid peroxidation inhibition<sup>23</sup>.

## 1.1 TAXONOMICAL CLASSIFICATION<sup>24</sup>

Kingdom	: Chromista
Subkingdom	: Harosa
Infrakingdom	: Heterokonta
Phylum	: Ochrophyta
Class	: Phaeophyceae
Subclass	: Fucophycidae
Order	: Fucales
Family	: Sargassaceae
Genus	: <i>Sargassum</i>
Species	: <i>duplicatum</i>

## 1.2 SYNONYMS

- *Sargassum duplicatum* var. *duplicatum* J. Ag.
- *Sargassum duplicatum* var. *moumeensis* Grunow

## 1.3 DESCRIPTION

Stem terete<sup>25</sup>, up to 11 mm high. Primary branches up to 65 cm length, cylindrical at base, slightly compressed at lower to middle part, up to 3.0 mm in width, up to 2.5 mm in depth, with smooth surface<sup>26</sup>. Primary leaves broader elliptical to lanceolate up to 43 mm in length, up to 18 mm in width. Secondary leaves narrower elliptical to lanceolate, up to 40 mm in length, up to 14 mm in width, base cuneate, apex obtuse, margin entire to small dentate, midrib immersed, vanishing below the tip of the leaves, scattered small, conspicuous cryptostomata<sup>27</sup>. Vesicles compressed ellipsoid or obovoid, up to 10 mm in length, with sharp spines or appendages or crown leaves, stalks terete, up to 3 mm in length, shorter than the vesicles. Plant dioecious. Female receptacles slightly compressed, up to 7 mm in length, with spines on the distal part, simple or rarely once divided, racemosely arranged. Male receptacles unknown. Mostly brown or dark green in colour<sup>28</sup>.

## 1.4 DISTRIBUTION AND HABITAT

*Sargassum duplicatum* is commonly found in the coastal waters of the Atlantic Ocean, particularly in the western Atlantic region<sup>29</sup>. It is known to occur in areas such as the Gulf of Mexico, the Caribbean Sea, and the southeastern coast of the United States. *Sargassum duplicatum* thrives in warm, tropical and subtropical waters with temperatures ranging from 20 to 30 degrees Celsius. It is typically found in shallow, nearshore areas with rocky substrates or coral reefs. The

presence of nutrients and sunlight is also important for its growth and survival<sup>30</sup>.

### 1.5 ECOLOGY/IMPACT

*Sargassum duplicatum* plays an important ecological role in its habitat<sup>31</sup>. It provides shelter and habitat for a variety of marine organisms, including fish, invertebrates, and microorganisms. The complex structure of the algae provides hiding places and protection from predators. Additionally, *Sargassum duplicatum* contributes to nutrient cycling and provides a source of food for herbivorous species. It forms dense floating mats that serve as nursery grounds and shelter for various marine species, including fish, crustaceans, and turtles. The presence of *Sargassum duplicatum* supports biodiversity and promotes the overall health of the ecosystem. It also acts as a substrate for various organisms, allowing them to attach and grow, contributing to the overall productivity of the ecosystem. The pictorial representation of *Sargassum duplicatum* is shown in figure 1.



Figure 1: *Sargassum duplicatum*

### 1.6 BOTANICAL DESCRIPTION

*Sargassum duplicatum*, a distinguished member of the Sargassum genus, stands as a testament to the complexity and adaptability of marine algae<sup>32</sup>. This brown macroalgae is recognized for its robust presence in various coastal and oceanic environments, where its intricate structure and unique features set it apart. *Sargassum duplicatum* boasts a complex thallus structure characterized by branching patterns that form dense and bushy fronds<sup>33</sup>. The arrangement of these structures contributes to its overall resilience in turbulent marine environments. The size of individual *Sargassum duplicatum* specimens can vary, with mature individuals often reaching notable lengths<sup>34</sup>. The morphology of this species exhibits a striking balance between flexibility and durability, allowing it to withstand the dynamic forces of ocean currents. Typically displaying a rich brown hue, *Sargassum duplicatum* exhibits a

coloration that harmonizes with its marine surroundings. This pigmentation not only provides camouflage but also plays a role in the absorption of sunlight for photosynthesis<sup>35</sup>. One of the most distinctive features of *Sargassum duplicatum* is its incorporation of pneumatocysts, specialized gas-filled bladders. These structures provide buoyancy, enabling the algae to float on the ocean's surface. This adaptation is essential for optimizing sunlight exposure and nutrient absorption<sup>36</sup>. *Sargassum duplicatum* employs a range of reproductive strategies, including both sexual and asexual methods. The presence of reproductive structures such as receptacles and conceptacles is a notable feature, contributing to the algae's successful propagation. *Sargassum duplicatum* exhibits a remarkable ability to thrive in varying salinity conditions<sup>37</sup>. This adaptability is supported by efficient osmoregulation mechanisms that enable the algae to maintain cellular balance in environments with fluctuating salt concentration<sup>38</sup>. The species showcases eco-physiological adaptations that allow it to endure challenging environmental conditions, such as fluctuations in temperature and exposure to intense sunlight. These features contribute to its resilience and widespread distribution.

### 1.7 MACROSCOPICAL CHARACTERS

*Sargassum duplicatum* has a thallus<sup>39</sup>. Elaborate branching structure with a central stipe (stem), lateral branches, and numerous blade-like structures. The overall thallus is likely to exhibit a complex and bushy appearance. The size of *Sargassum duplicatum* can vary, with some individuals being relatively small, while others may form larger, more extensive structures. It is brown to olive-green coloration, typical of brown seaweeds. The color is attributed to the presence of chlorophylls a and c, along with the accessory pigment fucoxanthin<sup>40</sup>. Presence of characteristic air bladders at various points along the thallus. Air bladders contribute to buoyancy, allowing the seaweed to float in the water column. Blades may be broad and may exhibit variations in shape, such as lobed or serrated margins. Blade color may show some variation depending on environmental conditions. Presence of reproductive structures such as receptacles and conceptacles. These structures are essential for the seaweed's reproductive processes.

### 1.8 MICROSCOPICAL CHARACTERS

Thallus tough, up to a height of 1 m. cylindrical, warty, 3–20 mm high main axis with many main branches<sup>41</sup>. The main and minor branches are branched erratically or alternately, with a mild compression. Branchlets are 5-7 cm long, slender, and cylindrical. The primary and secondary branch phylloids are short-stalk, elliptic to lanceolate, with a rounded apex and asymmetric base. The margins are irregularly dentate-serrate, and the midrib is evident and disappears towards the tip. Small, obovate, 10-15 mm long, 3-6 mm wide, and lacking a prominent midrib are the phylloids of the branchlets. Vesicles: several, short stalks, spherical to obovate, occasionally slightly compressed, 3–5 mm; smooth, apiculate, or with one or two teeth at the apex, frequently with wings that resemble ears. There is cryptostomata. Grow dioecious plants. Phylloid’s axils are where the receptacles in racemose clusters grow. Male receptacles are up to 12 mm long and terete. Female receptacles are dentate, triquetrous above, and compressed at the base. Holdfast discoid.

### 1.9 REPRODUCTION

*Sargassum duplicatum* reproduces through both sexual and asexual reproduction.

#### Sexual Reproduction:

The reproductive structures of *Sargassum duplicatum* are specialized air-filled bladders called pneumatocysts that contain both male and female reproductive cells. These bladders are released from the main plant and float on the ocean's surface<sup>42</sup>. When the male reproductive cells are released, they are carried by water currents and may come into contact with the female reproductive cells, leading to fertilization and the

formation of zygotes. The zygotes then develop into new plants.

#### Asexual Reproduction:

*Sargassum duplicatum* can also reproduce asexually through fragmentation. When the main plant is damaged or broken, fragments of the plant can detach and float in the water<sup>43</sup>. These fragments can then develop into new individuals, creating a clone of the original plant. The air-filled bladders, or pneumatocysts, allow the reproductive structures to float on the ocean's surface. This enables the male and female reproductive cells to be dispersed over a wide area, increasing the chances of fertilization.

## II. PHYTOCHEMICAL CHARACTERIZATION OF THE MARINE BROWN ALGAE -

### *Sargassum duplicatum*

*Sargassum duplicatum* contains a diverse range of phytochemicals including polysaccharides, polyphenols, terpenoids, and flavonoids. The polysaccharides in *Sargassum duplicatum* have been found to possess various biological activities such as antioxidant, anti-inflammatory, and immunomodulatory properties. Polyphenols, such as phlorotannins, are abundant in *Sargassum duplicatum* and have demonstrated antioxidant, anticancer, and antimicrobial activities. Terpenoids present in *Sargassum duplicatum* have shown potential as antiviral, antifungal, and anti-inflammatory agents. Flavonoids, including quercetin and kaempferol, have been identified in *Sargassum duplicatum* and exhibit antioxidant and anti-inflammatory properties<sup>44</sup>.

**Table 1:** Phytochemical analysis of *Sargassum duplicatum* extract in different solvents.

Sl No	Phytochemicals	Petroleum Ether	Chloroform	Acetone	Methanol	Aqueous
1	Steroids	+	+	+	+	-
2	Alkaloids	-	-	-	-	-
3	Phenolic groups	+	+	+	+	-
4	Cardiac glycosides	-	-	-	-	-
5	Flavonoids	-	+	-	+	+
6	Saponins	-	+	+	+	-
7	Tannins	-	-	-	-	+
8	Anthraquinone	-	-	-	-	-
9	Terpenoids	-	-	-	-	-
10	Sterol	+	+	+	+	-

	Total	3	5	4	5	2
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+ ; presence - ;absence

## 2.1 QUALITATIVE ANALYSIS OF PHYTOCHEMICALS

Each solvent extract was subjected to primary phytochemical analysis such as presence of alkaloids, terpenoids, flavonoids, tannins, polyphenols, saponins, cardiac glycosides and quinones by adopting the standard qualitative procedures.

The methanolic and chloroform extracts of *S. duplicatum* showed the presence of maximum of five metabolites out of ten metabolites examined. Next to that acetone extract of *S. duplicatum* displayed four metabolites. Petroleum ether extract of *S. duplicatum* demonstrated the occurrence of three metabolites in the crude extracts. Aqueous extract of *S. duplicatum* displayed the presence of two metabolites.

Terpenoids are reported to be useful in the prevention and therapy of several diseases including cancer. Terpenoids are also known to possess antimicrobial, antifungal, antiparasitic, anti-viral, anti-allergenic, anti-spasmodic, antihyperglycemic, anti-inflammatory and immunomodulatory properties.

In the present study flavonoids was observed in chloroform, methanol and aqueous extract. Flavonoids are reported to possess antioxidant, free radical scavenger, antileukemic, vasodilator and antibacterial properties and are reported to be useful for improving blood circulation in brain of Alzheimeric patients<sup>45</sup>.

In the present study tannin was observed in aqueous extract of *Sargassum duplicatum*. Many tannin-containing drugs are used in medicine as astringent. They are used in the treatment of burns as they precipitate the proteins of exposed tissues to form a protective covering. They are also medicinally used as healing agents in inflammation, leucorrhoea, gonorrhoea, burns, piles and as antidote. Tannins has been found to have antiviral, antibacterial, antiparasitic effects, anti-inflammatory, anti ulcer and antioxidant property for possible therapeutic applications Tannins are used in medicine as mild antiseptics in treatment of diarrhea and to check small hemorrhages.

Phenolic compounds are important in plant defence mechanisms against invading

bacteria and other types of environmental stress, such as wounding and excessive light or ultraviolet (UV) radiation Phenolic compounds are commonly found in plants, including seaweeds and have been reported to have a wide range of biological activities including antioxidant properties. The Folin-Ciocalteu method was applied to study the total phenolic content of the seaweeds<sup>46</sup>. Phenols are structural and allelopathic components which are associated with diverse functions including activation of enzymes, nutrient uptake, protein synthesis and photosynthesis.

Saponins have a wide range of medicinal properties including hypo-cholesterolemic, anticarcinogenic, anti-inflammatory, antimicrobial, anti-feedent, antioxidant and hemolytic effects.

The cardiac glycosides are basically steroids with an inherent ability to afford a very specific and powerful action mainly on the cardiac muscle when administered through injection into man or animal. Cardiac glycosides and catecholamine are agents of choice in treatment of congestive cardiac failure (CCF).

Quinones are compounds very much used in pharmacopoeia in the treatment of malaria and more recently of tumours. They are having good source of anti-inflammatory, antibacterial and immunomodulating potentials.

*Sargassum duplicatum* is known to contain fucoidans, complex polysaccharides with demonstrated anti-inflammatory, antioxidant, and immunomodulatory properties. These bioactive compounds contribute to the alga's therapeutic potential. The presence of antioxidants, including polyphenols and carotenoids, equips *Sargassum duplicatum* to scavenge free radicals. This antioxidant activity holds promise in mitigating oxidative stress-related disorders and supporting overall health.

## III. USES OF *Sargassum duplicatum*

*Sargassum duplicatum* is used as a natural fertilizer and soil conditioner<sup>47</sup>. When incorporated into the soil, the algae release nutrients that enhance soil fertility and promote plant growth. *Sargassum duplicatum* has the potential to be used in bioremediation efforts, helping to absorb and remove pollutants from aquatic environments. The algae can absorb heavy metals

and other contaminants, contributing to environmental cleanup initiatives. *Sargassum duplicatum* are consumed as food in certain cultures. It contains various vitamins, minerals, and bioactive compounds that could be explored for dietary and nutritional purposes. Extracts from *Sargassum duplicatum* are used in the cosmetic industry for their moisturizing and skin-conditioning properties.

#### IV. PHARMACOLOGICAL ACTIVITIES OF *Sargassum duplicatum*

##### 4.1 Antimicrobial Activities

Su -Tuen Yeh et al;(2005) says that *L.vannamei* immersed in hot water extract of *Sargassum duplicatum* at 300mg/l or the shrimp that are injected with hot-water extract at 10µg/g enhances the immune resistance and resistance to *V.alginolyticus* infection<sup>48</sup>.

##### 4.2 Antioxidant Activities

Aisyah Tri Septiana et al;(2013) describes that antioxidant activity of *Sargassum duplicatum* extract was measured by analyzing the peroxide value, malonaldehyde (MDA) and 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity. Antioxidant activity on linoleic acid of methanol extract from one-step extraction method was the highest, whereas antioxidant activity of ethanol and ethyl acetate extracts was not significantly different.

##### 4.3 Anticancer Activities

Roza V. Usoltseva et al;(2017) study shown that laminaran SdL and fucoidan SdF were isolated from *Sargassum duplicatum* Structure of SdL was studied by NMR analysis, and laminaran was shown to be a glucan with a main chain of 1,3-linked β-d-glucose residues and single glucose residues as branches at C6. In vitro, the fucoidan SdF effectively inhibited colony formation of colon cancer cells.

##### 4.4 Antiarthritic Activities

Handajan et al;(2020) showed *Sargassum duplicatum* extract reduced arthritis severity score and inhibited the production of MMP-1 in the periarticular tissue of adjuvant-arthritis rats subjected to a cold stressor.

##### 4.5 Wound healing Activities

Fitria Nikmatul et al;(2022) carried out study on the topical administration effect of *Sargassum duplicatum* and *Garcinia mangostana* extracts combination on open wound healing process in diabetic mice. And it showed that topical administration of the combination of this extract

improved the open wound healing activity in diabetic mice.

#### V. THREATS FACED BY *Sargassum duplicatum*

Pollution, particularly from agricultural runoff and industrial waste, possess a significant threat to the survival of *Sargassum duplicatum*. Chemical pollutants can disrupt the growth and reproduction of the species, leading to population decline<sup>49</sup>. The increasing temperatures and changing ocean currents associated with climate change can negatively impact *Sargassum duplicatum*. These changes can disrupt the species habitat and alter the availability of nutrients, affecting its growth and reproduction. Overfishing can have indirect effects on *Sargassum duplicatum* by disrupting the balance of the marine ecosystem<sup>50</sup>. Removing large numbers of fish species that interact with the seaweed can lead to changes in nutrient cycling and availability, which can impact the growth and survival of the seaweed.

#### VI. CONCLUSION

*Sargassum duplicatum*, once primarily valued for its ecological contributions, now emerges as a potential source of medicinal wonders. From its traditional uses in coastal communities to the contemporary pharmacological explorations uncovering its bioactive compounds, this brown macroalga stands at the intersection of nature's pharmacy and human health. As research progresses, the medicinal potential of *Sargassum duplicatum* holds promise for novel therapeutic interventions, reminding us of the untapped wealth concealed beneath the waves and the importance of sustainable practices to preserve and harness these natural resources for the betterment of humanity. *Sargassum duplicatum*, with its intricate ecological roles, embodies the delicate interconnectedness of marine life. As we navigate the intricate dance between its ecological importance and the looming threats it faces, a call to action resonates. Conservation efforts, sustainable practices, and increased awareness are imperative to safeguarding the invaluable contributions of *Sargassum duplicatum* to coastal ecosystems. Only through collective commitment can we ensure the continued presence and prosperity of this marine marvel, preserving not just a species but the health and resilience of our oceans. The vast expanse of our oceans hides within its depths not only ecological wonders but also a treasure trove of potential medicinal marvels. Among these,

*Sargassum duplicatum*, a brown macroalgae, emerges as a noteworthy contender with a rich history of traditional medicinal use and an increasing focus in contemporary pharmacological research. This essay explores the medicinal applications of *Sargassum duplicatum*, unveiling its potential to contribute to human health and well-being. *Sargassum duplicatum* stands as a testament to the marvels of the underwater world, offering not only visual beauty but also a plethora of applications across various fields. From ecological contributions to agricultural benefits, bioremediation potential, and even culinary uses, the brown algae showcases the importance of sustainable exploration and utilization of marine resources. As research continues to unveil the mysteries of *Sargassum duplicatum*, its significance in shaping a more sustainable and interconnected world becomes increasingly evident.

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