

Ethnobotanical Study of Seaweed Utilization Among Local Communities in Muar, Johor

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Abstract

This ethnobotanical study delves into the diverse utilization of seaweeds among the local community of Parit Jawa, Muar, Johor. The research aimed to identify and document the different categories of seaweeds utilized by the community, focusing on their applications in food, medicine, and other purposes. The objectives further included measuring the significance level of these seaweed groups and their utilization within the local context. The study involves online questionnaire interviews with respondents from Parit Jawa to gather comprehensive data. Results demographic profile uncovered three primary categories of seaweeds: green, red, and brown. Notably, the green seaweed emerged as the most prominently cited among the locals. The blade part of the seaweed stood out as the most utilized component, primarily for culinary purposes. Utilizing Relative Frequency of Citation (RFC) and Cultural Significance Index (CSI) for analysis, the study highlighted the importance of green seaweed in the daily activities of the Parit Jawa community. Locals acknowledged its abundant presence and frequent use for both sustenance and medicinal applications. This research highlights the uses and significance of seaweeds in the daily lives of Parit Jawa's community.

1. Introduction

Seaweeds are diverse and abundant aquatic plants that have a wide range of uses, including food, cosmetics, and pharmaceuticals. Ethnobotanical studies have shown that seaweeds have long been used by various coastal communities for food, medicine, and other cultural practices. So, with that the objective of this research are to identify the different seaweed categories that are utilized by the local communities, document the utilization pattern of local communities in the use of seaweeds for food, medicine, and other purposes, and also to measure the level of significance of seaweed species and its utilization in local communities by using ethnobotany indices. An ethnobotanical use of seaweeds was investigated by previous research (De Souza *et al.* 2015) that showed that seaweeds were used for various purposes, including as food for humans and livestock, fertilizer, and medicine for the treatment of various illnesses. The study also revealed that seaweed harvesting and processing are important economic activities for local communities, with women playing a prominent role in the processing of seaweed. The findings of this study highlight the significance of seaweed utilization in local communities and provide insights into the potential economic and ecological benefits of sustainable seaweed harvesting and processing practices [1].

In another research by Pandey *et al.* (2023) [2], seaweeds were traditionally utilised by the local population as a treatment for conditions like arthritis, digestive issues, and skin issues. Seaweeds was employed as both animal feed and a flavouring in regional cuisine. The study also emphasised the need to retain local populations' traditional knowledge and methods for using seaweed. There are diverse classifications of seaweed, that were primarily used by these local communities. They are broadly categorized into three primary groups—Chlorophyta (green), Rhodophyta (red), and Phaeophyta (brown) that can be distinguished among each other [3].

There is a profound cultural significance that seaweed holds within coastal communities. Beyond its ecological importance, seaweed serves as a cultural keystone, deeply interwoven into the fabric of local traditions, practices, and identities [4]. So, to state the objective of this research, it is to discover the group of seaweed being used by the local communities. Then, I was also intended to explore the variety of utilization these marine resources have to offer to the world. Last but not least, the significance of these seaweed has to the community whether it is in reality or spirituality, is of crucial thing that this research wanted to take note too.

2. Materials and Methods

2.1 Study Site

The site of the study that has been chosen is an area in Muar, which is Parit Jawa. While this study is being carried out at the designated location, several people from the local community participated in an interview related to the utilization of seaweed in their daily life that cover aspects that could be done with seaweed varieties.

2.2 Data Collection

During data collection, the respondents that were being interviewed are among them. All the informants chosen are from the group of fishermen, local vendor and local people living around the area. The respondents from each study area in Parit Jawa, were given an online questionnaire about the information of seaweed that they have been using.

The questionnaire session was divided into three parts, i) demographic profile of the informants such as gender, age, occupation and race, ii) the information of the seaweed species they use for various purposes, the use of seaweed, part of the seaweed being used, and also source of the seaweed either wild or cultivated, iii) the significance of seaweed in their daily life.

2.3 Measurement of Cultural Significance

The methodological approach to measure cultural significance is through ethnobotany indices. By employing a structured ethnobotanical survey design involving participant observations and semi-structured interviews, the engagement with knowledgeable informants or traditional healers have been a lot of help to compile a comprehensive list of locally significant seaweeds [4]. With quantitative ethnobotanical indices, such as use value, informant consensus factor, and cultural importance index, were then computed based on reported seaweeds uses, frequency, and consensus among informants. The methodological rigor included statistical analyses to determine the reliability and significance of cultural knowledge concerning plant use [5]. For this study, the indices that were being utilized are Relative Frequency of Citation (RFC) and Cultural Significance Index (CSI).

2.3.1 Relative Frequency of Citation (RFC)

According to a study [6], the relative frequency of citation (RFC) was used to further quantify the significance of particular species to the local communities. The RFC was performed to quantify the use frequency of certain species, which was determined using the following formula:

$$RFC = \frac{U}{N} \times 100 \quad (1)$$

2.3.2 Cultural Significance Index (CSI)

The Cultural Significance Index (CSI), suggested by Reyes-Garca *et al.* (2016), was one index that was used in the technique that was also based on indices suggested by other studies [7]. This index made it possible to determine the Cultural Importance Index by taking into account a number of variables, including usage frequency, cultural relevance, and traditional knowledge about seaweed use. But, before you can get the Cultural Significance Index (CSI), you need to calculate the Cultural Importance Index (CII) and Relative Frequency of Citation (RFC). Only then, you can compute the Cultural Significance Index (CSI) by multiplying CII and RFC. To interpret it, higher scores indicate greater cultural impact, and the range typically extends from 0 to 100, with higher values signifying increased significance. The formula that is being use in the process are:

$$CII = \sum \frac{U_i}{N} \quad (2)$$

$$CSI = CII \times RFC \quad (3)$$

2.4 Data Analysis

All measurements and analyses were carried out by the ethnobotany indices itself and all values were presented by using Microsoft Excel for Microsoft 365.

3. Results and Discussion

3.1 Demographic Profile

In this study, the google form questionnaire was used during data collection to obtain more information. The questionnaire that had been provided focused on the seaweed species that they used for daily life activities. The areas that had been selected for the Muar community is Parit Jawa. The total respondents for this study are 110 people that are dominated by 65 males and 45 females. Table 1-4 shows the demographic profile of informants. These respondents were among the local people, vendor and fisherman living there. The age of respondents was ranging from over 21 years old.

Table 1 Age Structure of Respondents

| Age | Count |
|--------------|-------|
| 21-25 | 11 |
| 26-30 | 46 |
| 31-35 | 17 |
| 36-40 | 20 |
| 41 and above | 16 |
| | 110 |

Table 2 Gender Structure of Respondents

| Gender | Count |
|-------------|-------|
| Male | 65 |
| Female | 45 |
| Grand Total | 110 |

Table 3 Ethnic Structure of Respondents

| Gender | Count |
|--------------------|------------|
| Cina | 12 |
| India | 36 |
| Melayu | 62 |
| Grand Total | 110 |

Table 4 Career Structure of Respondents

| Row Labels | Count of Pekerjaan |
|--------------------|--------------------|
| Government | 28 |
| Self-work | 18 |
| Private | 64 |
| Grand Total | 110 |

In my study about how people use seaweed in Muar, Johor, Parit Jawa is a lively community with 110 residents, including 65 men and 45 women. They are closely connected to the sea, and the fishermen are important for collecting seaweed, while local sellers make sure it reaches more people. The villagers, who have a strong cultural background, share their knowledge about collecting and using seaweed, passing it on to future generations. This interaction between fishermen, sellers, and villagers shows the special connection between the local people and the plentiful seaweed in Parit Jawa.

3.2 Ethnobotanical Information

There were 3 categories of seaweed that used by the Parit Jawa community throughout their daily activities. Based on Table 5, the highest group of seaweed that used by the Parit Jawa community in Muar is ‘green seaweed’ (Chlorophyta) with 46 (41.8%) people indicating it as the most used seaweed in daily activities around the area. Based on a study, it stated various potential uses of green seaweed, including its utilization in industries such as food, pharmaceuticals, biotechnology, and environmental applications [8]. This followed by ‘red seaweed’ (Rhodophyta) as the second highest used seaweed in Parit Jawa community with 44 (40%) respondents. There are potential uses of red seaweed (*Kappaphycus alvarezii*) and green seaweed (*Ulva lactuca*) biomass in Malaysia, including their applications in various sectors such as agriculture, food, pharmaceuticals, and environmental remediation [9]. For ‘brown seaweed’ (Phaeophyta) it falls on the least used seaweed in Parit Jawa community by only 20 (18.2%) respondents.

Table 5 Seaweed families that used by Parit Jawa Community

| No. | Group |
|-----|---------------|
| 1 | Green Seaweed |
| 2 | Red Seaweed |
| 3 | Brown Seaweed |

The potential uses of these seaweeds are vast and varied across industries, as highlighted in the study references [10] and [11]. Green seaweed, such as *Ulva lactuca*, has been recognized for its multifaceted applications. Industries like food, pharmaceuticals, biotechnology, and environmental applications have shown interest in utilizing green seaweed due to its rich composition and potential benefits. This could include its use in food products, as a source of nutrients or additives, and in pharmaceuticals for its medicinal properties. Additionally, its environmental applications might involve its use in processes like bioremediation or as a sustainable alternative in various industries to reduce environmental impact.

Similarly, red seaweed, exemplified by *Kappaphycus alvarezii*, possesses properties that make it valuable across multiple sectors in Malaysia. Its potential uses span agriculture, food, pharmaceuticals, and environmental

remediation. For instance, in agriculture, red seaweed might be explored for its fertilizer properties or as an organic soil conditioner. In food, it could serve as a source of food additives or ingredients due to its nutritional content. Its pharmaceutical applications might include medicinal extracts or compounds beneficial for health. Moreover, the potential for environmental remediation could involve its use in purification processes or waste management due to its bioactive compounds.

Contrastingly, brown seaweed appears to be the least utilized among the Parit Jawa community. However, brown seaweed still holds promise in various applications despite its lower usage rate. It might be less popular due to specific cultural practices or local preferences within the community.

The discernible usage patterns of green, red, and brown seaweed within the Parit Jawa community underscore a complex interplay between cultural practices and environmental resources. With green seaweed prominently preferred followed closely by red seaweed and a lesser inclination toward brown seaweed, these findings align with a study [12]. This research sheds light on the cultural significance and utilization of seaweed within Malaysian coastal communities, potentially hinting at regional variations in preferences and practices. Understanding these dynamics not only enriches our comprehension of local traditions but also underscores the need for sustainable management strategies, ensuring the preservation of these marine resources for the Parit Jawa community's cultural heritage and the ecological integrity of their surroundings.

3.3 Parts of Seaweed Used for Various Purposes

The recorded data in Table 6 shows that the Parit Jawa community utilizes different parts of seaweed for daily activities, each serving specific purposes in daily life. They target specific sections of seaweed believed to hold beneficial properties for food, medicine, or traditional practices. For instance, within the Red Seaweed group, like *Porphyra tenera* and *Porphyra umbilicalis* from the Porphyraceae family, the blade part is extensively used in Japanese cuisine, particularly in wrapping sushi, as well as in Korean and other Asian culinary traditions [13].

Table 6 Seaweeds Part Used

| No. | Group | Seaweed Parts |
|-----|---------------|------------------|
| 1 | Green Seaweed | |
| 2 | Red Seaweed | Stipes Blades |
| 3 | Brown Seaweed | |

The result shows the stipes and blades part of the seaweed are the parts that are mostly used by Parit Jawa community. There is one species of seaweed named *Caulerpa lentillifera* or commonly known as sea grapes, green caviar or Black Durian. This species belongs to the family Caulerpaceae within the green algae group. While it's often referred to as "black durian seaweed" due to its appearance resembling tiny grapes, it belongs to the green seaweed family Caulerpaceae. It is the most well-known species from the Caulerpaceae family utilized in food. By utilizing the blades and stipes part of the seaweed, it is often consumed as delicacy in various Asian cuisines. Usually, they eat it raw in salads or as a side dish due to their unique texture and slight salty taste [14]. Fig. 1 shows the illustration of the seaweed parts of which they utilized.

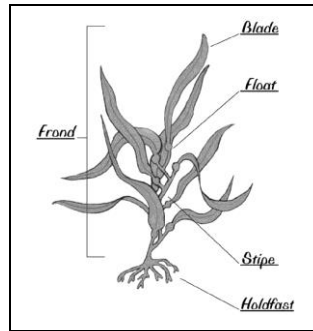


Fig. 1 Seaweed Parts

On the other hand, there is also various bioactive compounds found in seaweed that exhibit promising biomedical applications. For instance, seaweed family from the brown seaweed group that utilise the part of seaweed in medicine sector as it has some healing properties embedded in the plant itself. Sargassaceae family, extracts or compounds from certain *Sargassum* species are used for various purposes including skincare and anti-inflammatory properties [15]. Other than that, one such compound is fucoidan, which is commonly extracted from brown seaweeds. Fucoidan has shown potential in various biomedical applications due to its anti-inflammatory, antioxidant, and anticoagulant properties. Studies suggest that fucoidan may have therapeutic effects on conditions such as cancer, cardiovascular diseases, and inflammation-related disorders. It's been investigated for its ability to inhibit tumour growth, reduce blood clot formation, and modulate the immune response. However, the exact mechanisms and clinical applications often require further research and validation through clinical trials [16].

3.4 Domestication

Majority of the seaweed groups that had been recorded are wild. From 3 groups, 2 of them (67%) are wild while the other 1 species (33%) is cultivated. Fig. 2 show the percentage of wild and cultivated plants that had been recorded for daily activities among Parit Jawa community. Based on the respondents, the wild seaweed groups which is green and brown, are usually harvested along the coast of where they live by. However, in some of the region in Malaysia, there can be found seaweed farm that cultivate these 2 groups of seaweeds for various purposes.

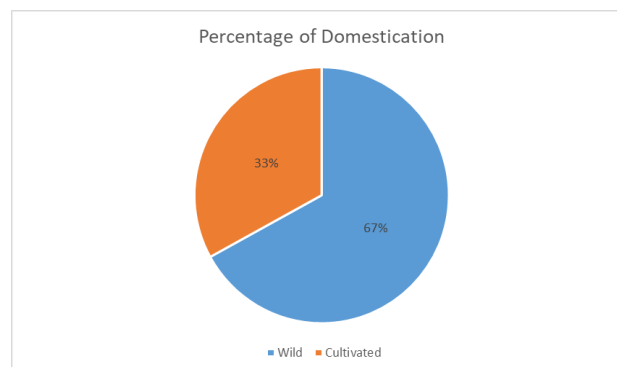


Fig. 2 Percentage of wild and cultivated seaweeds

Based on Fig. 1, The difference in how common wild and grown seaweeds are could mean a few things. It might show that wild seaweeds are more common or have more variety in their natural homes than the ones people grow. It could also show how much people are involved in growing or taking care of certain seaweeds, maybe because of money, culture, or the environment. Knowing this ratio between wild and grown seaweeds in each group helps us understand how seaweed populations work and how much people affect their growth or use [17].

In a study [18], It opens the door for better ways to grow seaweed, helping traditional cultivators learn about modern techniques. The paper also talks about how seaweed can be used in technology, which might inspire local entrepreneurs and researchers to use seaweed in different industries like food, medicine, beauty products, and farming. This could create new chances for people in the communities to make money. Additionally, looking into the medical uses of seaweed could be important, as it might help researchers find new medicines and health innovations within the community.

3.5 Relative Frequency of Citation (RFC)

Table 6 The value of Relative Frequency of Citation for seaweed groups

| No. | Categories | <i>U</i> | <i>N</i> | RFC (%) |
|-----|---------------|----------|----------|---------|
| 1 | Green Seaweed | 59 | | 53.6 |
| 2 | Red Seaweed | 34 | 110 | 30.9 |
| 3 | Brown Seaweed | 17 | | 15.5 |

Based on Table 2, among the categories, green seaweed garnered the highest level of citation, accounting for 53.6% of all citations received from the respondents. This indicates that 59 individuals cited the uses of green seaweed for various purposes, suggesting its substantial presence and significance within the community. In comparison, red seaweed received citations from 34 respondents, representing 30.9% of all citations. This category was specifically cited for various purposes within the Parit Jawa community. The RFC value of 30.9% denotes a considerable but relatively lower level of citation compared to green seaweed. Conversely, brown seaweed received the least citation, with only 17 respondents referencing its uses, amounting to 15.5% of all citations. This lower RFC value implies a comparatively lesser emphasis or recognition of brown seaweed's importance among the surveyed respondents.

The differential citation levels observed among green, red, and brown seaweed varieties within the Parit Jawa community reveal intriguing insights into the community's perceptions and utilization of these natural resources. The dominance of green seaweed, with its substantial citation rate of 53.6%, underscores its widespread recognition and multifaceted applications, potentially spanning culinary, pharmaceutical, and environmental spheres [19]. Conversely, red seaweed, while garnering notable citations (30.9%), displayed a lower Relative Frequency of Citation (RFC) compared to green seaweed. Despite this, its specific mentions suggest targeted uses, potentially rooted in cultural or traditional practices unique to the Parit Jawa region, warranting further exploration. The surprising lower attention towards brown seaweed (15.5%) signifies a relatively diminished emphasis, prompting a need for deeper investigations into the factors shaping its limited recognition, which could range from restricted applications to cultural influences.

This study is important because it shows how much people in Parit Jawa recognize and value different types of seaweed. Knowing this helps us understand how seaweed is used now and can help us make smart changes if needed [20]. By using a lot of green seaweed and exploring types of seaweed that people don't talk about much, we can make specific and lasting plans. These ideas help not only in saving these natural resources but also in making the community better in many ways, like keeping money coming in and preserving their culture [21].

3.6 Cultural Significance Index (CSI)

Table 7 The value of Cultural Importance Index for use categories

| No. | Categories | $\sum U_i$ | <i>N</i> | CII |
|-----|--------------------|------------|----------|------|
| 1 | Food | 66 | | 0.6 |
| 2 | Medicine | 27 | 110 | 0.25 |
| 3 | Cultural practices | 17 | | 0.15 |

Table 8 The value of Cultural Significance Index for seaweed categories

| No. | Categories | CII | RFC | CSI |
|-----|---------------|------|------|-------|
| | | 0.6 | | |
| 1 | Green Seaweed | 0.25 | 53.6 | 0.536 |
| | | 0.15 | | |
| 2 | Red Seaweed | 0.6 | 30.9 | 0.309 |
| | | 0.25 | | |

| | | | | |
|---|---------------|------|------|-------|
| | | 0.15 | | |
| | | 0.6 | | |
| 3 | Brown Seaweed | 0.25 | 15.5 | 0.155 |
| | | 0.15 | | |

The Cultural Significance Index (CSI) serves as a comprehensive measure to assess the cultural importance of different categories of seaweed based on various criteria such as their usage, citations, and cultural practices within a surveyed community.

In this dataset, three categories of seaweed - Green Seaweed, Red Seaweed, and Brown Seaweed - are evaluated based on their Cultural Importance Index (CII) and Relative Frequency of Citation (RFC), which together contribute to their respective CSI values [22]. The Cultural Importance Index (CII) for all three categories of seaweed—Green Seaweed, Red Seaweed, and Brown Seaweed—remains consistent across the dimensions of Food (0.6), Medicine (0.25), and Cultural Practices (0.15). This uniformity implies an equal perceived significance attributed to these seaweed categories concerning their roles in food, medicinal uses, and cultural practices within the surveyed community.

The Relative Frequency of Citation (RFC) quantifies the frequency with which each seaweed category was cited by respondents. Green Seaweed has the highest RFC at 53.6%, indicating that it was cited most frequently among the three categories. Red Seaweed follows with an RFC of 30.9%, and Brown Seaweed has the lowest RFC at 15.5%. These figures depict the varying levels of citation and attention received by each seaweed category within the community.

The Cultural Significance Index (CSI), calculated by multiplying the CII by the RFC for each seaweed category, provides a holistic measure of their cultural importance relative to both their perceived significance and citation frequency [23]. Despite identical CII values across categories, Green Seaweed emerges with the highest CSI of 0.536 due to its significantly higher RFC, indicating substantial cultural significance in both perceived importance and citation frequency. Red Seaweed follows with a CSI of 0.309, denoting a moderate level of cultural significance despite a lower RFC compared to Green Seaweed. Brown Seaweed, having the lowest RFC, registers the lowest CSI of 0.155, indicating comparatively lesser cultural significance within the surveyed community.

The CSI metric underscores the comprehensive evaluation of cultural significance by integrating perceived importance (CII) and citation frequency (RFC) [24]. In this context, despite identical perceived importance, the varying levels of citation frequency led to differences in the overall cultural significance, with Green Seaweed being most culturally significant, followed by Red Seaweed, and Brown Seaweed having the least cultural significance within the surveyed community.

4. Conclusion

In Parit Jawa, people use three types of seaweed—green, red, and brown—a lot in their daily lives. A recent study shows that green seaweed is the most popular because it's versatile and used in food, medicine, and culture. It's easy to find, so it gets mentioned the most. Red seaweed is the second most mentioned, mainly because it's grown in the area due to its scarcity on the shore but is common in Peninsular Malaysia. Brown seaweed, the least mentioned, is found a lot in the wild along the Parit Jawa shore. The community relies on a mix of using wild seaweed and growing it for different things like food, medicine, and cultural practices. The high Relative Frequency of Citation (RFC) at 53.6% for green seaweed shows how important it is in their daily lives. This study helps preserve knowledge about seaweed use and is important for passing this tradition down to future generations in Parit Jawa.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: **study conception and design:** Abdullah Lutfi Mohd Sharimshah, Furzani Pa'ee, Yap Jing Wei, Aqilah Awg Abdul Rahman; **data collection:** Abdullah Lutfi Mohd Sharimshah; **analysis and interpretation of results:** Abdullah Lutfi Mohd Sharimshah, Furzani Pa'ee; **draft**

manuscript preparation: Abdullah Lutfi Mohd Sharimshah, Furzani Pa'ee. All authors reviewed the results and approved the final version of the manuscript.

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