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ETHNOBOTANY STUDY OF SEAWEED DIVERSITY AND ITS UTILIZATION IN WARAMBADI, PANGUHALODO AREAS OF EAST SUMBA DISTRICT

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Abstract

This paper reports the ethnobotany study of seaweed diversity in Warambadi – Panguhalodo areas of East Sumba District, the island of Sumba. The study recorded 19 genera of 54 species of seaweed, which were utilized as food or edible seaweed. The group consisted of 17 species of green algae, 17 species of red algae, and 20 species of brown algae. The study also reported that 18 genera of 38 species were traditionally utilized for medicinal purposes as herbal medicine. The herbal species consisted of 7 species of green algae, 13 species of red algae, and 18 species of brown algae.

Seaweed is traditionally consumed as food in various forms: raw as salad and vegetable, as pickle with sauce of allspice or with vinegar, as relish or sweetened jellies and also cooked for vegetable soup. As herbal medicine seaweed is usually used for traditional cosmetics, as antipyretic and antiseptic, as vermifuges, and treatments for cough and asthma, hemorrhoid, nosebleed and boils, goiter and scrofula, stomach ailments and urinary diseases.

Indigenous knowledge on seaweed still exist and are continually employed by people living in particular areas such as the Sumba and Sabu ethnic groups. Yet, the knowledge is gradually decreasing due to localities, socio-economic change and cultural development.

Key words: *ethnobotany, seaweed diversity, edible, herbal medicine, indigenous knowledge, Sumba and Sabu ethnics*

1. INTRODUCTION

Local people have been using seaweed and its extracts as ethnic food. Extensive use of fresh and dried seaweed by coastal population over the world can furnish clues to potential food and other uses of seaweed. The Chinese have used seaweed for both medicine and food since before 2000 BC, and estimated that about 100 million jin of fresh and dried seaweed are consumed in China each year (1 jin is equivalent to about 0.5 kg) [1,2,3]. In Japan, more than one hundred species of seaweed are traditionally used as food. The annual consumption of seaweed among the Japanese is estimated to as much as 1.6 kg (*dry weight*) per capita[4] .

The food values of seaweed are currently reconsidered in the hope of coping with future food shortages. A variety of chemical compounds are contained in seaweed, such as carbohydrates, proteins, salts, vitamins and minerals. Research in natural products of seaweed have made significant progress in recent years and seaweed is able to produce a variety of

compounds and some of them possess biological activity of potential medicinal value [5,6].

Indonesians, particularly people living in the coastal areas have traditionally utilized several seaweed species as food supplement and herbal medicine. As food, seaweed is usually consumed in various forms such as salad, sweetened jellies and other products. Yet, as herbal medicine they are not recorded in Indonesian herbal medicine literature.

The primary purposes of this study were (a) to identify and to evaluate both edible and herbal medicine seaweed, (b) to evaluate indigenous knowledge on seaweed of local people. The study was focused on the Warambadi seashore in the island of Sumba. The shore was known as an attractive area for seaweed diversity and distribution. The people living in the area were Sumba and Sabu ethnic. The results of the study are expected to provide information for future study on natural products of seaweed. The basic of the information and data on Indonesian seaweed species used as food and as herbal medicine were obtained from reports of the Siboga Expedition 1899-1900 [7,8,9,10,11,12,13,14,15].

2. METHODOLOGY

Employing an interview method by structured questionnaire the study attempted to focus on Sumba and Sabu ethnic, the major ethnic living in the District of Waingapu. As comparison, interview on similar subject was also conducted among other ethnic (the Javanese, Lomboks, Sumbawas, Minangs and Chinese) in various study sites.

The study sites covered Kampung Warambadi in Desa Mburukulu, Sub-district of Panguhalodo; Central of Desa Mburukulu, Sub-district of Panguhalodo; Central of Melolo Sub-district, and Central of Waingapu City, East Sumba District. The interviews were focused to 31 respondents living along the coastal areas of the study site. The respondents were of Sumba and Sabu ethnic in Kampung Warambadi, Desa Mburukulu, Panguhalodo Sub-district, and East Sumba District. To compare the knowledge of local people, interviews were also conducted among 23 other respondents from the same ethnicity in the same Sub-district of Panguhalodo. Furthermore, similar interviews were also aimed to 21 respondents of various ethnic in the central part of Melolo Sub-district and to 20 respondents of diverse ethnic in the central part of the city of Waingapu (Figure 1).

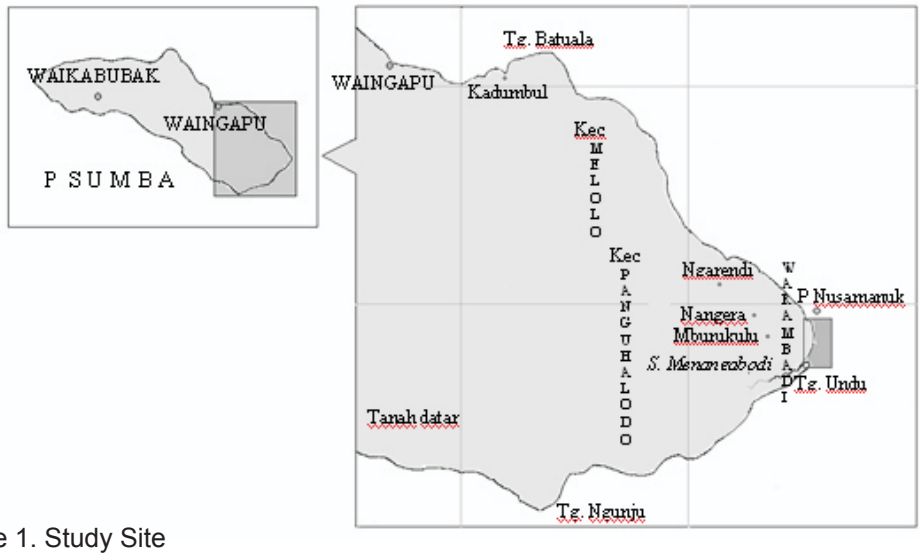

Figure 1. Study Site

Descriptive analysis was employed to compare the respondent's perception according to ethnicity and study location. The numbers of respondent have been taken randomly in each study location. To assist the interview all identified seaweed species which have been collected on Warambadi seashore were shown to the respondents as a reminder to their habit of using certain species. The exhibit also helped them to recall the species they used and how they used them.

3. RESULTS

Previous research in this area explained, about 23 genera of seaweed including 79 species growing on Warambadi seashore have been identified. These are 37 species of Chlorophyceae (green algae), 22 species of Rhodophyceae (red algae) and 20 species of Phaeophyceae (brown algae). Local people did not use specific local name for seaweed species in this area. They usually used the same local name for several species. For example, they called "anggur laut" for all Caulerpa species and they called "agar-agar besar" for all Eucheuma species.

During this study of 55 species were found and they were used as food supplement and herbal medicine. This study also reported that of 54 species of seaweed were utilized as food, consisted of 17 species of green algae, 17 species of red algae and 20 species of brown algae (Table1).

This study also recorded that 38 species of seaweed were utilized as herbal medicine. These are consisted of 7 species of green algae, 13 species of red algae, and 18 species of brown algae (Table 2).

As traditional food, seaweed was consumed in various forms. They were consumed raw as fresh salad, boiled or dipped into boiling water, or cooked into various forms as vegetable soup. Coconut milk or coconut oil was often added for taste. They were often accompanied with sauce of allspice or with vinegar as a pickle. Some species were cooked in coconut milk or coconut water with sugar as relish or sweetened jellies. It was also used for thickening soups and puddings.

For centuries, the coastal communities in many parts of Indonesia have been using seaweed for various medicinal purposes. Yet there is not any literature support to the particular use of this herbal medicine. Seaweed as a herbal medicine was usually used in various ways, including traditional cosmetics (skin powder and refreshing liquid), as antipyretic and antiseptic compounds, as vermifuges with an anthelmintic property, and as treatment for sunstroke and dropsy, cough and asthma as well as hemorrhoid, nosebleed and boils, goiter and scrofula, stomach ailments and urinary diseases.

The study also unveiled the relationship between indigenous knowledge on seaweed among the study sites and ethnicity. Figure 2 and 3 present the proportions of the respondents' knowledge on seaweed and in relation to their uses and purposes with considering ethnicity and study location.

The proportion of respondent who stated that they were familiar with seaweed were 81.1% and 75.3% of total respondent consumed seaweed d traditionally as food and/or herbal medicine.

Figure 4 and 5 describe the respondents' knowledge on agar (extracted compound from agarophytes seaweed) with their uses and purposes in relation to ethnicity and study location. These figures indicate that 50.5% of total respondent were familiar about agar and 33.70% of total respondent consumed agar as food.

Table 1. Edible seaweed of Warambadi seashore, Sumba island

#	Name of Species	Utilization
Chlorophyceae		
1-4	a).Caulerpa cupressoides (Vahl) C. Agardh, b).Caulerpa lentillifera J. Agardh, c). Caulerpa microphysa (Weber-van Bosse) J. Feldman, d).Caulerpa peltata Lamouroux	Salad, vegetable soup with or without coconut milk/oil, pickle
5-8	a).Caulerpa racemosa v. laetevirens (Montagne) Weber-van Bosse, b). Caulerpa racemosa v. macrophysa (Kutzing) Taylor, c). Caulerpa racemosa v. occidentalis (J. Agardh) Borgesen, d).Caulerpa racemosa v. uvifera (Turner) Weber-van Bosse	Salad, vegetable soup, pickle
9-11	a). Caulerpa serrulata (Forsskal) J. Agardh, b). Caulerpa sertularioides (Gmelin) Howe, c). Caulerpa taxifolia (Vahl) C. Agardh	Salad, vegetable soup with or without coconut milk/oil, pickle
12-13	a). Codium arabicum Kutzing, b). Codium edule Silva	Salad, vegetable soup with coconut milk/oil, pickle
14-15	a).Dictyosphaeria cavernosa (Forsskal) Borgesen, b).Dictyosphaeria Versluysii Weber-van Bosse	Salad, vegetable soup with or without coconut milk/oil, pickle
16	Ulva lactuca Linnaeus	Salad, vegetable soup with coconut milk/oil, pickle
17	Valonia aegagropila C. Agardh	Salad, vegetable soup, pickle
Rhodophyceae		
1	Acanthophora specifera (Vahl) Borgesen	Pickle, salad
2-3	a). Corallopsis salicornia J. Agardh, b).Corallopsis urvillae J. Agardh	Salad, vegetable soup with or without coconut milk/oil, pickle
4	Eucheuma denticulatum (N. L. Burman) Collins & Hervey	Sweetened jellies with or without coconut milk, salad, pickle, vegetable soup, material for carrageenan
5-6	a). Eucheuma edule J. Agardh, b). Eucheuma gelatinae J. Agardh	Sweetened jellies with or without coconut milk, material for carrageenan
7	Eucheuma isiforme (C. Agardh) J. Agardh, 2). Eucheuma serra J. Agardh	Sweetened jellies with or without coconut milk, pickle, material for carrageenan
8-9	a). Gracilaria arcuata Zanardini, b). Gracilaria gigas Harvey	Sweetened jellies with or without coconut milk, pickle, vegetable soup, material for agar
10	Gracilaria gigas Harvey	Sweetened jellies with or without coconut milk, salad, pickle, vegetable soup, material for agar
11	Gracilaria coronopifolia J. Agardh	Sweetened jellies with or without coconut milk, salad, pickle, material for agar
12	Hypnea cervicornis J. Agardh	Sweetened jellies with or without coconut milk, pickle
13	Hypnea musciformis (Wulfen) Lamouroux	Sweetened jellies with or without coconut milk, vegetable soup
14	Kappaphycus alvarezii Doty	Sweetened jellies with, salad, pickle, vegetable soup, material for carrageenan
15	Kappaphycus striatum (Schmitz) Doty	Sweetened jellies with or without coconut milk, salad, pickle, material for carrageenan
16	Laurencia Obtusa (Hudson) Lamouroux	Salad, vegetable soup
17	Meristotheca papulosa (Montagne) J. Agardh	Sweetened jellies with or without coconut milk, material for agar
Phaeophyceae		
1	Ascophyllum sp. Stackhouse	Sweetened jellies
2-8	a). Dictyota bartayresii Lamouroux, b). Dictyota cervicornis (Kutzing) Sonder,c). Dictyota ciliolata Kutzing, d). Dictyota crenulata J. Agardh, e). Dictyota dichotoma (Hudson) Lamouroux, f). Dictyota divaricata Lamouroux, g). Hydroclathrus clathratus (Bory) Howe.	Salad
9-10	a).Padina australis Hauck, b).Padina japonica Borgesen	Vegetable soup, sweetened jellies
11-17	a). Sargassum crassifolium J. Agardh, b). Sargassum cristaefolium C. Agardh, c). Sargassum echinocarpum J. Agardh, d). Sargassum hemiphyllum (Turner) C. Agardh, e). Sargassum polyphyllum J. Agardh, f). Sargassum siliquosum J. Agardh, g). Sargassum ilicifolium (Turner) C. Agardh	young thallus for salad and vegetable soup with coconut milk, sweetened jellies, material for alginate
21-20	1). Turbinaria conoides (J. Agardh) Kutzing, 2). Turbinaria decurens Bory de Saint-Vincent, 3). Turbinaria ornata (Turner) J. Agardh	young thallus for salad and vegetable soup with coconut milk

Table 2. Herbal medicine seaweed of Warambadi seashore, Sumba island

#	Name of Species	Utilization
Chlorophyceae		
1	Chaetomorpha linum (Muller) Kutzing	Antipyretics, treatments for cough, antiseptic, traditional cosmetics (refreshing liquid & skin powder)
2-3	a). Codium arabicum Kutzing,b). Codium edule Silva	Vermifuges, treatments for urinary diseases
4-5	a). Dictyosphaeria cavernosa (Forsskal) Borgesen, b). Dictyosphaeria Versluysii Weber-van Bosse	Vermifuges
6	Ulva lactuca Linnaeus	Antipyretic and refreshing liquid, treatments for boils, dropsy, urinary diseases, nose-bleeds
7	Valonia aegagropila C. Agardh	Antiseptic, treatments for cough and boils, refreshing liquid
Rhodophyceae		
1	Acanthophora specifera (Vahl) Borgesen	Treatments for goiter and scrofula and urinary diseases
2-3	a). Corallopsis salicornia J. Agardh, b). Corallopsis urvillae J. Agardh	Treatments for goiter and scrofula, cough and asthma
4-5	a). Eucheuma edule J. Agardh, b). Eucheuma gelatinae J. Agardh	Treatments for goiter and scrofula, cough, asthma, stomach- ailment, haemorrhoids
6	Eucheuma serra J. Agardh	Treatments for goiter and scrofula, cough, asthma, stomach- ailment and urinary diseases
7	Gracilaria arcuata Zanardini	Treatments for goiter and scrofula, urinary diseases, and stomach ailment
8	Gracilaria gigas Harvey	Treatments for goiter and scrofula, stomach-ailment and urinary diseases
9	Gracilaria coronopifolia J. Agardh	Treatments for goiter and scrofula, cough, stomach-ailment, urinary diseases, haemorrhoids
10	Hypnea cervicornis J. Agardh	Antipyretics, antiseptic, vermifuges, traditional cosmetics (refreshing liquid)
11	Hypnea musciformis (Wulfen) Lamouroux	Antipyretics, antiseptic, traditional cosmetics (refreshing liquid)
12	Laurencia Obtusa (Hudson) Lamouroux	Antiseptic, treatment for stomach ailment
13	Meristotheca papulosa (Montagne) J. Agardh	Treatments for goiter and scrofula, haemorrhoids
Phaeophyceae		
1	Ascophyllum sp. Stackhouse	Vermifuges, treatments for goiter and scrofula, stomach ailment, laxative
2-5	a). Dictyota cervicornis (Kutzing) Sonder, b). Dictyota ciliolata Kutzing,c). Dictyota dichotoma (Hudson) Lamouroux, d). Dictyota divaricata Lamouroux	Treatments for goiter and scrofula
6	Hydroclathrus clathratus (Bory) Howe	Treatments for goiter and scrofula, vermifuges
7	Padina australis Hauck	Treatments for goiter and scrofula
#	**Name of Species**	**Utilization**
8	Padina japonica Borgesen	Treatments for goiter and scrofula
9	Sargassum crassifolium J. Agardh	Antipyretic, refreshing liquid, treatments for urinary diseases, goiter and scrofula
10	Sargassum cristaefolium C. Agardh	Treatments for goiter and scrofula
11	Sargassum echinocarpum J. Agardh	Antipyretic, refreshing liquid, treatments for goiter and scrofula
12	Sargassum hemiphyllum (Turner) C. Agardh	Treatments for goiter and scrofula, refreshing liquid
13-14	a). Sargassum polyphyllum J. Agardh, b). Sargassum siliquosum J. Agardh	Antipyretic, refreshing liquid, treatments for goiter and scrofula
15	Sargassum ilicifolium (Turner) C. Agardh	Treatment for goiter and scrofula
16	Turbinaria conoides (J. Agardh) Kutzing	Antipyretic, treatments for urinary diseases, goiter and scrofula, stomach ailment
17	Turbinaria decurens Bory de Saint-Vincent	Treatments for goiter and scrofula, refreshing liquid
18	Turbinaria ornata (Turner) J. Agardh	Antipyretic, treatments for goiter and scrofula, stomach ailment

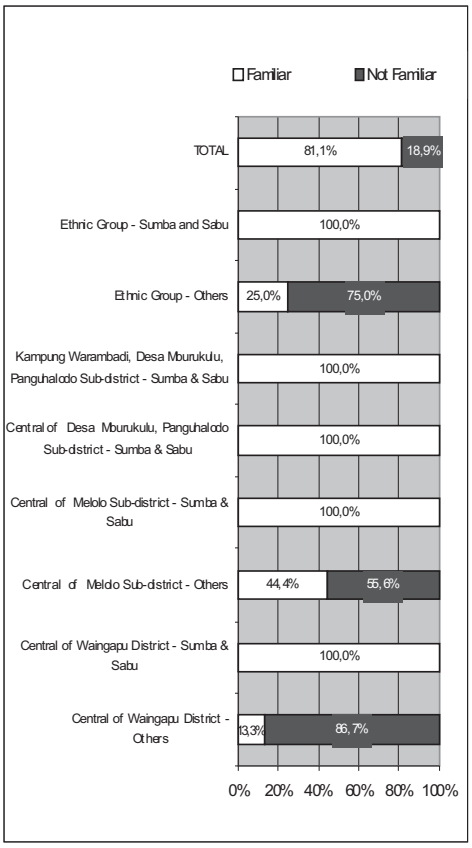

Figure 2. Indigenous knowledge of the local peoples on seaweed

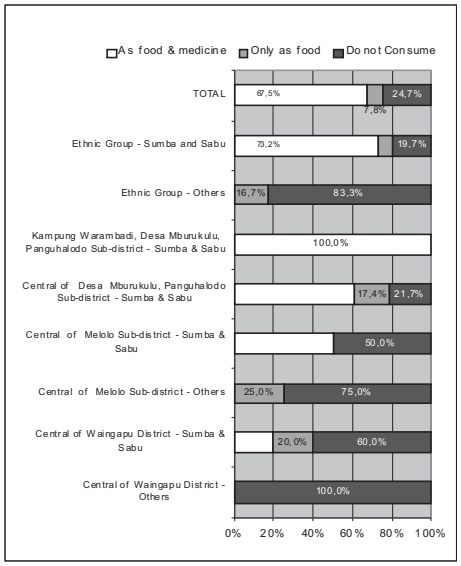

Figure 3. The local peoples consumed seaweed

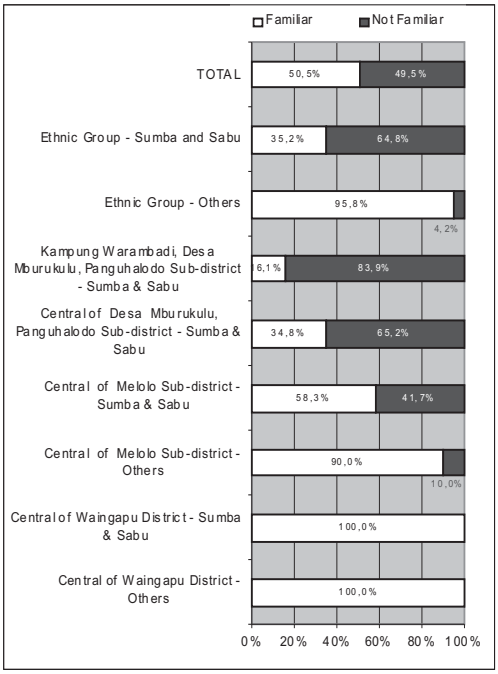

Figure 4. Indigenous knowledge of the local peoples on extract of seaweed

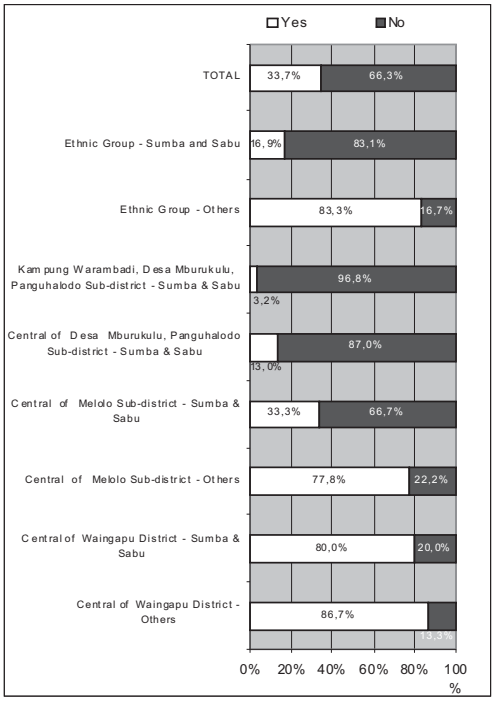

Figure 5. The local peoples consumed the extract of seaweed

Table 3. Comparison of useful seaweed species

Name of Species	Anggadiredja (Warambadi)	Heyne (1922)	Tondo (1926)	Zaneveld (1955)	Anggadiredja (1992)
A	B	C	D	E	F
Chlorophyceae					
Acetabularia mayor		X		X	X
Caulerpa crasa				X	X
Caulerpa cupressoides	X				
Caulerpa javanica				X	X
Caulerpa lentillifera	X				
Caulerpa microphysa	X				
Caulerpa peltata	X	X	X	X	X
Caulerpa racemosa		X	X	X	
Caulerpa racemosa v. clavifera			X		
Caulerpa racemosa v. laetevirens	X	X	X	X	X
Caulerpa racemosa v. macrophysa	X				
Caulerpa racemosa v. occidentalis	X				
Caulerpa racemosa v. plavifera				X	X
Caulerpa racemosa v. uvifera	X			X	X
Caulerpa serrulata	X			X	X
Caulerpa sertularioides	X			X	X
Caulerpa taxifolia	X				
Chaetomorpha linum	X				
Codium arabicum	X				
Codium edule	X				
Codium tenue				X	X
Codium tomentosum		X	X	X	X
Dictyosphaeria cavernosa	X				
Dictyosphaeria versluysii	X				
Enteromorpha compressa				X	X
Enteromorpha intestinalis				X	X
Enteromorpha prolifera				X	X
Ulva lactuca	X			X	X
Valonia aegagropila	X				
Rhodophyceae					
Acanthophora specifera	X	X	X	X	X
Bostrychia radicans				X	X
Caloglosa leprieurii				X	X
Caloglosa adnata				X	X
Catenella impudica				X	X
Catenella nipae				X	X

Corallopsis minor			X		
Corallopsis salicornia	X	X	X	X	X
Corallopsis urvillae	X				
Eucheuma denticulatum	X	X			X
Eucheuma edule	X			X	X
Eucheuma gelatinae	X	X		X	X
Eucheuma horridum		X		X	X
Eucheuma isiforme	X				
Eucheuma muricatum				X	X
Eucheuma serra	X	X		X	X
Gelidiopsis rigida		X	X		
Gelidium amansii				X	X
Gelidium rigidum				X	X
Gelidium latifolium				X	X
Gracilaria arcuata	X			X	X
Gracilaria blodgettii				X	X
Gracilaria confervoides				X	X
Gracilaria crasa				X	X
Gracilaria coronopifolia	X				
Gracilaria eucheumoides				X	X
Gracilaria gigas	X				X
Gracilaria lichenoides		X	X	X	X
Gracilaria taenioides		X	X	X	X
Gracilaria verucosa					X
Grateloupia filicina				X	X
Gymnogongrus javanicus			X		X
Halymenia durvilliae				X	X
Hypnea cenomyce		X		X	X
Hypnea cervicornis	X	X	X	X	X
Hypnea divaricata				X	X
Hypnea musciformis	X			X	X
Kappaphycus alvarezii	X				X
Kappaphycus striatum	X				
Laurencia obtusa	X		X		X
Mastocarpus klenzeanus		X			
Meristotheca papulosa	X				
Porphyra atropurpurae				X	X
Rhodymenia palmata				X	X
Sarcodia montagneana		X	X	X	X
Phaeophyceae					
Ascophyllum sp.	X				
Chnoospora pacifica				X	

Dictyota apiculata				X	X
Dictyota bartayresii	X				
Dictyota cervicornis	X				
Dictyota ciliolata	X				
Dictyota crenulata	X				
Dictyota dichotoma	X				
Dictyota divaricata	X				
Hydroclathrus clathratus	X			X	X
Padina australis	X			X	X
Padina japonica	X				
Sargassum aquifolium		X		X	X
Sargassum crassifolium	X				
Sargassum cristaefolium	X				
Sargassum echinocarpum	X				
Sargassum granuliferum		X			
Sargassum hemiphyllum	X				
Sargassum ilicifolium	X				
Sargassum polycystum		X		X	X
Sargassum polyphyllum	X				
Sargassum siliquosum	X			X	X
Sargassum sp.			X		
Turbinaria conoides	X	X		X	X
Turbinaria decurens	X				
Turbinaria ornata	X	X		X	X
Turbinaria sp.			X		

4. DISCUSSION

During the 1899-1900 Siboga Expedition, approximately 782 species of Indonesian seaweed were collected and identified. Sixty-one species have been utilized traditionally by Indonesians, particularly by the people living along the coastal areas, either or both as food supplement or herbal medicine [7-15].

Table 3 describes the comparison of seaweed species used as food and herbal medicine found during the present study was in accordance to those of Heyne, Tondo, Zaneveld and Anggadiredja. This particular table shows those 32 species of 55 species of useful seaweed which growing on Warambadi seashore is new recorded if compared to others studies. These are consisted of 12 species of green algae, 5 species of red algae and 15 species of brown algae. This table also describes the dependency of respondents to the proximity of related species that grew nearby. It was also unveiled that the availability of several species such as Caulerpa, Sargassum, Eucheuma and Dictyota in Warambadi has made them the favorite use for food. Similar case was found in East Java in which the abundance of species of Gracilaria, Gelidium and Gelidiopsis have also brought them to become the favorite uses for food in sweetened jellies form. Moreover, the tendency of using seaweed among local people also depended upon ethnic food habit in terms of traditional food. In Kampung Warambadi, for example, the favorite food was lawar (pickle) and many seaweed species were traditionally suitable to make lawar. On the contrary, among the

habits of the communities living in the coastal area of Lombok Island, many species of seaweed were eaten as salad after plunged into boiling water and mixed with shredded coconut and sauce of allspice, and they were called urap.

4.1. Indigenous knowledge on seaweed

The amalgam of Sumba and Sabu ethnic groups for more than five generation has made it difficult to distinguish their physical appearance, particularly among the societies along the coastal areas. Therefore, for the purpose of the study the Sumba and Sabu ethnic were considered as one ethnic group.

All of the Sumba and Sabu ethnic (100%) were familiar with seaweed, and 80.3% of Sumba and Sabu ethnic groups consumed seaweed traditionally, both as food and/or herbal medicine. From them only 35.2% were familiar with agar and only 16.9% consumed its compound. The proportion of other ethnic groups (the Javanese, Lomboks, Sumbawas, Minangs and Chinese) was 25.3% from total respondent, and 25.0% of them were familiar with seaweed including 16.7% of them who consumed seaweed as food only. This study also recorded that 95.8% of other ethnic groups were familiar with agar. From this percentage 83.33% consumed its compound. These data also indicated that although Sumba and Sabu ethnic possess indigenous knowledge on seaweed, not all of them consumed it. They knew about seaweed, how and for what purposes they were used for, but only few of them were familiar with agar as seaweed product. On the contrary, only few of other ethnic groups possess indigenous knowledge on seaweed. Instead, they were quite familiar with agar.

Relationship on indigenous knowledge on seaweed according to ethnicity and the study localities was shown in Figure 2 and 3. This figure showed that all of Sumba and Sabu ethnic living in all of four study sites knew about seaweed (100%), although they did not all consume seaweed. All (100%) of Sumba and Sabu ethnic living in Kampung Warambadi traditionally consumed seaweed as both food and medicine. In central of Desa Mburukulu, 78.3% consumed seaweed as food and herbal medicine including 17.4% consumed only as food. In central of Melolo sub-district, 50% of Sumba and Sabu ethnic consumed seaweed as both food and herbal medicine, and in central of Waingapu district, only 40% consumed seaweed as food and herbal medicine including 20% consumed it as food only. These figures showed that the closer the proximity to the central town, indigenous knowledge on seaweed of particular ethnic groups including the use of the knowledge itself was decreasing. By contrast the knowledge on seaweed product such as agar and its use was fading away as the distance from the central town increased. Information and education level, which influenced economic and socio-culture condition, which further affected the consumption pattern of food and medicine, may cause this particular phenomenon.

4.2. Edible seaweed

The favorite use of seaweed was lawar (pickle). Lawar was prepared by washing the seaweed stems first, and then cut them up into fragments for species with big thallus and they were mixed with vinegar and sauce of all¬spice or soya-bean sauce. Seaweed species that were prepared for pickle were Caulerpa, Codium, Dictyosphaeria, Ulva and Valonia of green algae; Acanthophora, Corallopsis, Eucheuma, Gracilaria, Hypnea and Kappaphycus of red algae; Dictyota and Hydroclathrus of brown algae.

Caulerpa, Codium, Dictyosphaeria, Ulva and Valonia of green algae; Acanthophora, Corallopsis, Gracilaria, Hypnea, Kappaphycus and Laurencia of red algae; Dictyota, Hydroclathrus, Padina, Sargassum and Turbinaria of brown algae were eaten raw as salad after plunged into boiling water for a few minutes. Those seaweed species were used for vegetable soup by cooking with or without coconut milk or oil and sauce of allspice were the favorite for particular ethnic groups.

The other favorite food was sweetened jellies. After washing and cutting them up into fragments, seaweed stems was cooked in coconut milk or coconut water with sugar as relish or sweetened jellies. The food was usually prepared from red algae such as Eucheuma, Gracilaria, Hypnea, Kapphaphycus, and Meristotheca as well as from brown algae such as Ascophyllum, Padina, and Sargassum. Recently, various kind of food made from Gracilaria, Eucheuma, Gelidium, and Gelidiopsis in a variety of forms such as pickle salad and sweetened jellies are available in the markets with attractive packaging.

More advanced food usually did not use seaweed in whole pieces, but use seaweed extractives like agar, carrageenans and alginate in the preparation and combined them with other ingredients. The variety of prepared food containing seaweed products was very broad, and appeared to be a direct reflection of the need for long self-life storage without deterioration and quick food preparation. Commercially grown seaweed species for extractive products which grow on Warambadi seashore were Gracilaria and Meristotheca as agarophytes (raw material for agar), Eucheuma and Kappaphycus as carrageenophytes (raw material for carrageenan), Sargassum and Turbinaria as alginophytes (raw material for alginate).

The principal content of edible seaweed species are carbohydrates (sugars or vegetable gums), proteins and fat and ash, which largely composed of salts of sodium and potassium [16]. Seaweed contains various carbohydrates differ from those of higher plants. Considering the digestibility of the sugar and starches, it was important to distinguish different kind of carbohydrates due to different digestibility. Human intestinal enzymes cannot totally digest all carbohydrates of seaweed. Carbohydrate content around 50% implied total available food in such seaweed species [16]. For this reason seaweed could provide the human system with no calories. Seaweed may also contribute to future human life in particular areas as weight reduction.

In addition, a fairly high protein content in seaweed has been reported, eventhough the protein quality and its digestibility, however, have not been elucidated like those of higher plants [17,18,19]. The alkali soluble proteins of nine species of Indonesian edible seaweed species (Gelidium amansii, G. Latifolium, Gracilaria lichenoides, G. verucosa, Grateloupia filicina, Rhodymenia palmata, Caulerpa peltata, Enteromorpha sp., and Ulva lactuca) composed of 18 common amino acids. In addition, five species of them contained complete the essential amino acids composition [18]. It was interesting that the amino acid scores (according to the provisional ratio the FA0/ WHO, 1973) of seaweed proteins were higher than those in the land plants were. This indicated that the alkali soluble proteins in all these five edible seaweed were from very good quality. Seaweed also have more vitamins A (δ carotene), B1, B2, B6, B12, niacin and, in addition, the very important minerals calcium and iron compared to those of vegetables and fruit [4]. The locality of the material was of great importance and, therefore, the diversity of chemical compounds of seaweed depending upon species and different localities. Therefore further study is certainly necessary.

4.3. Herbal medicine seaweed

The evidence for the use of marine algae in treatment of human ailments was extensive [11,20]. Seaweed species, like other algae or other living organism, were able to biologically synthesize some active substances, most of which were secondary metabolites. Sometimes these substances acted as protective agents; sometimes they played a structural role as in cell walls, or they were physiologically active in/on/to organism, or temporarily inactive as in the case of, respectively, pigments and sugars. Many natural products were antibiotic, antiseptic, and cytotoxic, which possess physiological activity or pharmacological uses and thus also possess economic potential[21].

The term of herbal medicine seaweed as used in this study applied to those which people collected and utilized as herbal seaweed, generally by boiling them in water and using the decoction as drugs or using them raw as salad, or by grinding and using the seaweed pulp as drugs. The same plant was often used for different medical treatments. Seaweed species such as Chaetomorpha linum, Ulva lactuca, Valonia aegagropila, Hypnea musciformis, Sargassum crassifolium, S. echinocarpum, S. hemiphyllum, S. polyphyllum, S. siliquosum and Turbinaria decurens were used as traditional cosmetics in forms of refreshing liquid and skin powder. They were also prepared in pulp form for skin sunlight protection. Recently, there were various kind of modern cosmetics made from material from Ulva lactuca, Enteromorpha prolifera, Enteromorpha intestinalis, Caulerpa spp. in various forms such as shampoo, refreshing liquid and lotion which were available in the market.

Seaweed species with antiseptic property were Chaetomorpha linum, Valonia aegagropila, Hypnea cervicornis and H. musciformis. Seaweed species with anthelmintic property content and usually used as vermifuges were Codium arabicum, Dictyosphaeria cavernosa, D. versluysii, Ascophyllum sp. and Hydroclathrus clathratus. The species used as antipyretic were Chaetomorpha linum, Ulva lactuca, Hypnea cervicornis, H. musciformis, Sargasum crassifolium, S. echinocarpum, S. polyphyllum, S. siliquosum, Turbinaria conoides, T. ornata and they were prepared in forms of decoction or as salad. To treat asthma and cough decoction or salad Chaetomorpha linum, Valonia aegagropila, Corallopsis salicornia, C. urvillae, Eucheuma edule, E. gelatinae, E. serra, and Gracilaria coronopifolia were often consumed. The decoction of Eucheuma edule, E. gelatinae, E. serra, Gracilaria arcuata, G. gigas, G. coronopifolia, Laurencia obtusa, Meristotheca papulosa, Ascophyllum sp., Turbinaria conoides and T. ornata were used in curing treatment of hemorrhoids and stomach ailment. The pulp of Ulva lactuca, and Valonia aegagropila were to be used for boils and nosebleed treatments. The decoction of Codium arabicum, C.edule, Ulva lactuca, Acanthophora specifera, Eucheuma serra, Gracilaria arcuata, Sargassum crassifolium, and Turbinaria conoides were used for urinary disease treatment.

Chemical investigations have illustrated that seaweed produced a wide variety of structurally unique and biologically active secondary metabolite antibiotics and in general many red algae produced halogenated terpenoids and acetogenins, which showed antimicrobial activities, cytotoxicities, and other pharmacological effects. The brown algae were not known as producer of halogenated metabolites, but it was known as the producer of complex diterpenoids and metabolites of mixed terpenoid-aromatic compounds. These compounds possess various types of biological activities and their applications as antibiotics [22].

The crude extracts of several species which grew in Warambadi such as Caulerpa spp., Halimeda spp., Corallopsis urvilae, Laurencia obtusa, Gracilaria spp., Dictyota spp., Sargassum spp. and Turbinria ornata showed antimicrobial activities, against gram-positive bacteria (Staphyllococcus aureus and Bacillus subtilis) and gram-negative bacteria (Escherichia coli and Pseudomonas aeruginosa). These crude extracts also possess biological activities as antifungal and antioxidant [23,24].

For iodine prevalence and treatment for goiter and scrofula, local people used Ascophyllum, Dictyota, Hydroclathrus, Padina, Sargassum, Turbinaria of brown algae and Acanthophora, Corallopsis, Eucheuma, Gracilaria, Meristotheca of red algae, and Codium of green algae. The results of some analysis of iodine content in several species of those genera mentioned above showed a wide divergence in organic form as well as in inorganic form [19].

5. CONCLUSION

1. The study revealed various genera with many species of seaweed that were used as food supplement and herbal medicine. Quantitatively, there were 20 genera of 55 species that were used as food supplement and herbal medicine in the study sites. Both of edible seaweed and medicine seaweed species consisted of green algae, red algae and brown algae.
2. 32 species of 55 species of useful seaweed which growing on Warambadi seashore is new recorded as edible and/or herbal medicine seaweed in Indonesia.
3. Seaweed were traditionally consumed as food in various forms: raw as salad and vegetable, boiled or dipped into boiling water, cooked as vegetable soup, prepared as pickle with a sauce of allspice or with vinegar, cooked as relish or sweetened jellies.
4. Seaweed as herbal medicine were used for traditional cosmetics (*skin powder and refreshing liquid*), as antipyretic and antiseptic, as vermifuges, and treatments for cough and asthma, hemorrhoid, nosebleed and boils, goiter and scrofula, stomach ailments and urinary diseases.
5. The development of indigenous knowledge on seaweed among ethnic groups depended upon the process of exchange of information and the accessibility of modern knowledge. Moreover, socio-culture and economic development contributed to particular roles of their daily lives.

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