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Ethnopharmacology Potentials of Mangrove Bulalo, North Gorontalo

Ernikawati[1], Daud Sandalayuk[1], Alexander Ruruh[1], Zeinab Nurlela Y. Suma[1]

[1] Forestry Study Program, Faculty of Forestry, Gorontalo University, Gorontalo, Indonesia.

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Corresponding Author:
Ernikawati
ernikawatimikha@gmail.com

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Abstract: Ethnopharmacology is the study of the practical utilization of mangrove plants which have been used as a source of traditional medicine by people living in certain areas since ancient times for generations. This study aims to determine the diversity of mangrove species as the ethnopharmacology of Bulalo, Kwandang District, North Gorontalo. The research was conducted from March to May 2023. The method used in this study was semi-structured interviews. The results showed that species that have the potential for ethnopharmacology are widely used by local people as traditional medicines. Based on the results of interviews with the local community, of the 14 ethnopharmacological species found in Bulalo Village, 7 species have medicinal properties and have been used as traditional medicines by the community for generations, such as Avicennia alba, Bruguiera gymnorriza, Ceriops decandra, Rhizophora apiculate, Rhizophora mucronate, Rhizophora stylosa, and Sonneratia casseolaris, which has been used as a medicine containing phytochemical compounds such as alkaloids, saponins, terpenoids, flavonoids, and phenols. The parts used in traditional medicine are the fruit, leaves, and sap. The ways to use it include hypertension, hepatitis, asthma, flatulence, recovering energy after giving birth, mouth sores, malaria, dysentery, ulcers, cholera, sore eyes, itching, internal injuries, boils, healing burns, and bruises.

Keywords: Ethnopharmacology; Mangrove; Species Diversity

Introduction

Ethnopharmacology is the study of the practical use of mangrove plants which have been used as a source of traditional medicine carried out by people who inhabit certain areas since ancient times. Plants that have the potential to be used as medicine have been found in mangrove forests (Bintoro, 2014). Mangrove forests are areas that are very useful for protecting beaches from abrasion and also provide benefits for coastal communities such as ingredients for medicines. From a health perspective, mangrove fruit has the potential to be beneficial or has anti-oxidant and anti-microbial potential (mangrove fruit, leaves, and sap). Traditionally, many coastal community groups have used mangrove leaves to make tea. Mangrove leaves contain active natural biochemical compounds including flavonoids, anthraquinones, phenolics, alkaloids, and triterpenoids (Hardiningtyas et al., 2014). A group of very high and active compounds can make mangrove fruit have anti-microbial activity and mangrove fruit extracts have high antioxidant activity. Antioxidants are related to human health, especially related to aging and degenerative diseases. Active ingredients which act as antioxidants are known to be able to inhibit the aging process and degenerative diseases, and can prevent cancer. Likewise, the leaf extract of Avicenia sp. known as api-api fruit has found activity as a natural antimicrobial. Mangroves are rich in steroid compounds, saponins, flavonoids, and tannins (Purwanti & Rini 2016).

Bulalo Village, Kuandang District, North Gorontalo County, covers an area of 99.47 hectares, including mangrove areas. The majority of residents living in Bulalo Village are indigenous people. People living in Bulalo Village have long used mangrove plants as

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medicinal ingredients. Plants that are strongly suspected to contain bioactive ingredients are mangroves. Indonesia, as a country with a tropical climate, has very diverse ethnopharmacology, so the tradition of using ethnopharmacology has been going on for a long time since their ancestors (Ernikawati et al., 2020). Local people believe that mangrove species can cure various types of diseases, both internal and external diseases. Nowadays, much of the ethnopharmacology is made synthetically, but mangrove plants produce ingredients that have medicinal properties, so they really need to be paid attention to. Plants with medicinal properties are still not widely known. So far, knowledge about traditional medicine has only been obtained through public information but has not yet been explored. The people of Bulalo Village have long had knowledge about medicines that have been passed down from generation to generation, but information about the use of these plants has not been well documented, so much of this knowledge has been lost due to the erosion of developments in the field of medicine and modern medicine. Therefore, qualitative research is needed on the use of traditional medicines, so that later these medicines can be used safely and effectively and can be developed in the pharmaceutical industry (Henny et al., 2017).

The purpose of this study was to analyze the diversity of species pharmacological species in the Bulalo mangrove forest and to examine the superior ethnopharmacological potential of seven species. It is hoped that this research can become a source of knowledge for the general public and as new data for managers to be used as reference material for further research related to potential mangrove ethnopharmacology. This is useful as a basis for the use and sustainability of ethnopharmacology. Apart from that, it can also provide balanced and objective information regarding ethnopharmacology by looking at the potential of mangroves and their sustainability and conservation prospects.

Method

This study was conducted in the Bulalo mangrove forest in Guandang District, North Gorontalo County. The research was carried out from March to May 2023. Methods for collecting data on plant species diversity and Ethnopharmacology. Data collection on plant diversity and Ethnopharmacology was carried out using a multiple plot sampling method which was placed purposively in the green belt area. Observation plots are placed considering the diversity and dominance of vegetation visually. Determination of samples (plots) is determined by purposive sampling, namely, plots are determined first according to the distribution of trees found during observation (Larasati et.al, 2020). Then the relief is determined and observation routes are made according to field conditions. The measuring plot area for each growth level includes seedlings measuring 2 m x 2 m; stake 5 m x 5 m; 10 m x 10 m for pole level and 20 m x 20 m for tree size.

The sample plots that were made at the four corners and in the middle of the plot were installed with stakes that had been painted red as plot markers. The collected data was analyzed to see the number of individuals of each species according to family and then calculated using quantitative data analysis with the Margalef richness index, Shanon-Wiener diversity index, and Evenness Index (Bengen & Dutton, 2004). Furthermore, the Diversity Index is the Shanon-Wiener diversity index. The criteria for the species diversity index value based on the Shanon-Wiener, (H') ranges from 0-7 with criteria including if H' (0<2) is low, H' (2<3) is medium, H' (>3) or more relatively high. High species diversity is an indicator of the stability or stability of a growth environment.

Data collection on ethnopharmacological potential used a snowball sampling method, i.e. targeting the next respondent rather than the previous respondent. This method can be applied using key respondents (key persons). The criteria for respondents are people who have knowledge of ethnopharmacology and who use mangroves in their daily lives as traditional medicine. Interviews were conducted in a semi-structured manner using a questionnaire that had been prepared with in-depth questions as needed. There were 30 respondents in this study, then in-depth interviews were conducted by determining informants based on their status and role using a purposive and snowball method. Purposive determination of informants who understand biodiversity resources. The data source is based on initial instructions from informants who recommend other informants (snowball), who understand the use of medicinal plants, based on information from new key figures (Diba & Anwari, 2017). Identification of the potential benefits/utilities of the plant species found was analyzed by cross-checking using the Microsoft Excel program which was then compared with various books or literature about the uses of mangrove plants and other literature.

The prospects for the conservation of ethnopharmacological diversity were analyzed by assessing the categories and criteria for mangrove ethnopharmacological conservation (Table 1). Plant conservation assessments are carried out based on the plant population structure categories from Shankar (2011), namely the sustainable category if the regeneration conditions of more plant species are

included in the "good" sustainable category, the moderately sustainable category if the regeneration conditions of more plants are included in the "fair and poor" category. less sustainable category if the regeneration conditions of more plant species fall into the "none and new" category.

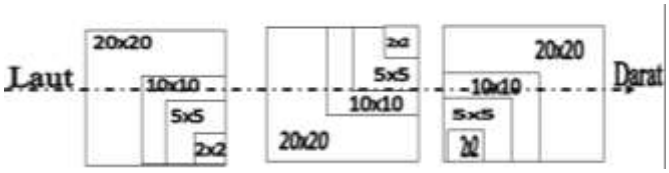

Figure 1. Vegetation Analysis Observation Plot (a) Seedlings (2 m × 2 m); (b) Stake (5 m × 5 m); (c) Pole (10 m × 10 m) and (d) Tree (20 m x 20 m).

Table 1. Categories and criteria for ethnopharmacological conservation of Bulalo Village Mangroves

Category	Category
Sustainable	>50% of local plant species were found to have a species population structure in the good category
Quite Sustainable	>50% of local plant species were found to have a species population structure in the fairly good category (poor and fair)
Not yet Sustainable	>50% of local plant species were found to have an unfavorable species population structure (none and new)

Result and Discussion

Diversity of Medicinal Plant Species

Based on the results of field observations in the local Bulalo mangrove community, the plant biodiversity known to the community is 14 plant species and belongs to 5 families, namely: Avicenniaceae, Rhizophoraceae, Sonneratiaceae, Meliaceae, and Arecaeae palmae, based on their growth level. Based on the research results, it shows that the average diversity index (H') at the growth level of trees, poles, saplings, and seedlings is classified as moderate in Table 2.

Table 2 shows that the growth rate of poles, saplings and seedlings in the Bulalo forest location has an evenness index value close to 1. Krebs et al. (1972), shows an evenness index value close to 1, meaning a plant community is becoming more evenly distributed, while the closer it is to 0, the more uneven it becomes. This happens because there are no individual species dominating the observation location and spreading evenly. Based on Magurran & Ramnarine (2004), a value of R1 < 3.5 indicates low species richness, R1 = 3.5-5.0 indicates medium species richness, and R1 > 5.0 indicates high species richness. The R1 value at various growth stages, including growth levels (trees, poles, saplings and seedlings), is relatively low. If we look at the magnitude < 0.3, it shows that evenness is low, = 0.3-0.6 species evenness is classified as medium and above > 0.6, then species evenness is classified as high.

Table 2. Diversity Index (H'), richness (R1) and evenness of species (E)

Growth Rate	Wealth Index (R1)	Number of Species	Diversity Shanon-Wiener(H)	Evenness Index Shanon (E)
Tree	1.80	255	2.32	0.42
Pole	1.92	184	2.32	0.45
Stake	2.32	272	2.55	0.46
Seedling	1.52	366	2.20	0.37

Magurran & Ramnarine (2004), to determine the level of stability of a species in a community, the E value is used as follows: E = 0 < 0.3 The level of stability of species diversity is low; E = 0.3 < 0.6 The level of stability of species diversity is classified as moderate; E = > 0.6 The level of stability of species diversity is relatively high. This is in line with the statement by Mukhlisi & Sidiyasa (2014) that a higher species evenness index indicates that the distribution of individual species is more even or not concentrated in several places.

The abundance of plant species as an indicator for estimating the diversity of plant species in a community is shown quantitatively by calculating the Shannon diversity index (Octavia et.al, 2016). High species are an indicator of the steadiness or stability of a growth environment. This is in accordance with the statement (Nebula et al., 2013). However, high stability indicates a high level of complexity, this is due to high interaction so that it will have a higher ability to deal with disturbances.

The Potential of Ethnopharmacology

The results of the research show that species that have high ethnopharmacological potential are widely used by local communities as a source of medicine. This is in accordance with the statement by Karmilasanti & Suparini (2017); and Ernikawati et al. (2017), stated that species that have ethnopharmacological potential can be used by local communities as a source of medicine that can cure various diseases. Ethnopharmacological density is an indicator for estimating the density of ethnopharmacological types in a community.

Stand density (number of trees/ha) in a community is one of the factors that influences species diversity in addition to the quantity of species and the level of distribution of various species. The density of ethnopharmacology in an area can provide an overview

of the availability and potential of ethnopharmacology (Sarkar & Devi 2014). Based on the results of field measurements, the total plant density at the tree, pole, sapling, and seedling level in the Bulalo Mangrove Forest can be seen in (Table 3). Species density is related to the distance between trees and the number of individuals as well as the area of the research location. The more individuals you get, the higher the density value. Mangrove density is influenced by the presence of a suitable substrate for mangrove growth, in addition to community activities in utilizing mangrove forests.

Table 3. Seven species that have ethnopharmacological potential based on density/abundance in the Bulalo Mangrove Forest, North Gorontalo Regency

Species Name	Density/ha Growth rate				Sustainability category
	Tree	Pole	Stake	Seedling	
Yapi-yapi (*Avicennia alba)*	12	31	140	1425	Sustainable
Songge *(Bruguiera gymnorriza)*	5	13	84	950	Sustainable
Tangalo *(Ceriops decandra)*	8	19	112	0	Not yet sustainable
Wu'ata Buyuhu (*Rhizophora apiculata)*	10	24	124	1300	Sustainable
Wu'ata *(Rhizophora mucronata)*	7	21	100	1125	Sustainable
Wu'ata *(Rhizophora stylosa)*	0	0	84	1525	Quite sustainable
Tamenda'o *(Sonneratia casseolaris)*	0	0	48	0	Not yet sustainable

The overall observation results show that the highest density value is at the seedling level, while the lowest density is at the tree level. This is in line with the statement by Kuswandi et.al., (2015) that a good population structure will show higher density values at the seedling level compared to trees. Thus, density indicates the availability of plants in that area. Plant sustainability can be seen from the level of density at each growth stage which shows the structure of the high population. This can be supported by stand physiology in response to environmental changes, soil fertility, species variation factors, climatic instability and a tendency to dominate one or several particular plant species. Furthermore, it can also be influenced by climatic, tidal, biogeographic, edaphic factors, mangrove environmental conditions and other biotic factors (Barbara et.al., 2011).

The results of vegetation analysis, interviews, and literature studies show that there are seven (7) species in the most important ethnopharmacological mangrove forests that are most widely used (Table 4), including: Yapi-yapi (Avicennia alba), Songge (Bruguiera gymnorriza), Tangalo (Ceriops decandra); Wu'ata Buyuhu (Rhizophora apiculata), Wu'ata (Rhizophora mucronata), Wu'ata (Rhizophora stylosa) and Tamenda'o (Sonneratia casseolaris). Observation results show that the most widely used parts of mangrove leaves are: Bruguiera gymnorriza, Ceriops decandra, Rhizophora apiculata, Rhizophora stylosa, and Sonneratia casseolaris. Meanwhile, the least used are the sap, the Avicenia alba species, and the fruit of the Rhizophora mucronata species. Along with advances in science and technology (IPTEK), research on ethnopharmacology also continues to be carried out. However, more and more ethnopharmacological mangroves will be cultivated. Apart from being used traditionally and as a subsystem, several ethnopharmacological species have also been cultivated on an industrial scale (Ernianingsih et al., 2014).

Table 4 shows that mangroves have a lot of ethnopharmacological potential. The number of ethnopharmacological species used by the community is 7 species and 3 families, including: Avicenniaceae (Avicenia alba), Rhizophoraceae (Bruguiera gymnorriza, Bruguiera gymnorriza, Rhizophora apiculata), Rhizophora mucronata), Rhizophora stylosa) and Sonneratiaceae (Rhizophora stylosa). Several types of mangroves contain active ingredients that can cure various diseases (Utina et al., 2019). Avicennia alba is used by the community as a medicine for stomach aches and the Sap part is used as a medicinal plant. Apart from medicine for stomach aches, Avicennia alba is also used to maintain general body fitness.

The local people of Bulalo Village think that Avicennia alba sap is difficult to find. Sap is found at certain times, for example during the dry season. This is in line with the statement by Sarno et al. (2013) that mangrove sap does not appear as a result of scratches from human hands, but the sap appears by itself. Thus, secondary metabolic processes are metabolite compounds that are not essential for the growth of organisms and are found in unique or different forms between one species and another. There are several mangrove species that have potential medical properties, including: Avicennia alba is useful as a medicine for rheumatism, smallpox, and ulcers (Bhimba et al., 2010). R. mucronata is efficacious for treating swelling and sprains. Another part of R. apiculata that

has not been used by the public is the stem bark, which can be used as an anti-vomiting, antiseptic, diarrhea, haemostatic, to stop bleeding and tupoid. For the fruit, R. Apiculata flowers are also able to inhibit the Human Immunodeficiency Viruses (HIV) virus (Prabhu et al., 2012). The use of types and parts of mangroves for treatment varies depending on the disease suffered.

Table 4. Seven Species that have Ethnopharmacological Potential by Respondents

Species Name	Parts used	Efficacy
Yapi-yapi (*Avicennia alba)*	Sap	Medicine for skin, stomach ache, rheumatism, smallpox
Songge *(Bruguiera gymnorriza)*	Leave	Medicine for diarrhea, boils, diarrhea
Tangalo *(Ceriops decandra)*	Leave	Medication for gout, ringworm, postpartum, antiseptic
Wu'ata Buyuhu (*Rhizophora apiculata)*	Leave	Medicine for vomiting, neutralizes toxins, hepatitis, inhibits bacteria
Wu'ata *(Rhizophora mucronata)*	Fruit	Medicine for diabetes, swelling, sprains
Wu'ata *(Rhizophora stylosa)*	Leave	Burn medicine
Tamenda'o *(Sonneratia casseolaris)*	Leave	Cervical cancer medicine, anticancer, internal wounds

The Rhizophoraceae family grows more in Bulalo Village, because the substrate conditions at the research location really support the growth of this family, such as sand, sandy mud, and mud as a growing medium for this family. According to Abubakar et al. (2019), stated that the influence of soil properties on mangroves is shown, among other things, by the distribution of the Rhizophora genus. In areas with deep muddy soil, Rhizophora mucronata is the dominant vegetation, while areas with shallow muddy soil are dominated by Rhizophora apiculata. If the soil contains a lot of sand or coral, Rhizophora stylosa dominates.

Ethnopharmacology Sustainability Prospects

Based on the growth rate of the mangrove ethnopharmacological population structure (Table 3), it shows that the ethnopharmacological sustainability at the observation location based on the growth rate of various ethnopharmacological species including the species Avicenia alba, Bruguiera gymnorriza, Rhizophora apiculata and Rhizopora mucronata is categorized as sustainable (good). Ethnopharmacological sustainability is also one of the components that must be assessed in determining the prospects of the Bulalo mangrove forest. The level of sustainability is known from the measured population structure of the most important plant species. When viewed from the growth rate of trees, poles, saplings and seedlings, the 4 species are in the sustainable category (good). Then, if we look at the Rhizophora stylosa species, one of these species is in the category (fair) and the category (new) is the Ceriops decandra species and the Sonneratia casseolaris species is in the (none) category.

The research results showed that the growth rate of seedlings for 4 species was sustainable (good). This is in line with Leunufna's (2016) statement that the condition of a good plant population can be seen from the good category, where the number of individual saplings is greater than that of the parent tree. This sustainability shows that plant species have more offspring than parents. According to Agustini et al. (2012), there are obstacles in the process of forming regeneration strata if a plant population does not have regeneration strata. So, species that do not have regeneration strata can be caused by several factors that become obstacles. Obstacles that occur can be influenced by biotic and abiotic conditions. One of the influencing abiotic factors is environmental disturbance by humans.

The sustainability prospects for plant species in the Bulalo Mangrove Forest show that conditions are quite sustainable. This can be seen from the condition of the population structure found in the none and new categories. Low population levels of this important plant species can threaten the sustainability of the species. Poor population structure of these species can also be caused by competition for nutrients, soil minerals, water, sunlight and space between individuals of a species or various species. This competition causes the formation of certain plant community structures and the number of species and the number of individuals according to the conditions in which they grow. From a review of the population structure of the prospects for the sustainability of these ethnopharmacological species, it is feared that these species will become extinct (Edwar et al., 2012).

Conclusion

Based on the results of the analysis of species diversity data, 14 species were found and the number of ethnopharmacological species used by local communities was 7 species and seven superior ethnopharmacological species, namely Yapi-yapi (Avicennia alba), Songge (Bruguiera gymnorriza), Tangalo (Ceriops decandra), Wu'ata Buyuhu (Rhizophora apiculata), Wu'ata (Rhizophora

mucronata), Wu'ata (Rhizophora stylosa) and Tamenda'o (Sonneratia casseolaris) are most widely used by the community.

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The author declares no conflict of interest.

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