

Study of medicinal plants in the geothermal area of Mount Seulawah Agam, Aceh Besar District, Indonesia

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Abstract. The area of mount Seulawah Agam is an area of active volcano paths that impact the appearance of volcanic symptoms, that will affect the species of plants that grow in the area. This study aims to determine the potential of medicinal plant species and their diversity in the geothermal area of Seulawah Agam, Aceh Besar district. The data collection was carried out using multiple square plots placed using stratified sampling based on the soil temperature zone at a predetermined. Each area is set on four impartial actions in systematic random. The name of the species and its individual quantity of each potential plant was documented and analyzed accordingly. Then, they were analyzed based on scientific journals and identification books for medicinal plants. Data analysis was performed using importance value index and Diversity Index. The study found there were 32 species of 21 families of medicinal plants were identified started from the growth rates of seedlings, saplings, poles, and trees. The medicinal plants' diversity index analysis at each growth rate is classified into the medium category. Based on literature studies, plants' parts are commonly used as medicines such as leaves roots, sap, bark, and flowers. Utilization can be used to treat a variety of diseases and illnesses, as well as a parasitic infection. The result shows that the geothermal area of Seulawah Agam in Aceh Besar district has excellent resources and potential for medicinal plants that become used for the benefit of the surrounding community: they need to be maintained so that they still be beneficial for future generations.

Keywords: geothermal area, diversity plants, growth rate, medicinal plants.

INTRODUCTION

Mount Seulawah Agam is an active volcano located in Aceh. The volcano has two craters, namely the Van Heuzst crater and the Simpago crater. The volcano is also surrounded by fumaroles, and hot springs [1]. Hot springs are an indicator of geothermal energy [2]. The hot springs area of Ie Jue Lamteuba is located at the foot of Mount Seulawah Agam, Aceh Besar district, Aceh. The site is still relatively natural and is rarely disturbed by human activities. Therefore, with such environmental conditions,

many species of plants grow in the area that have adapted to the extreme environment [3].

Medicinal plants are plants used for their medicinal properties in many traditional health treatments and are also utilized in the form of modern medicines [4]. The use of traditional medicine is one of the primary health service programs. It is also an alternative to modern medicine in order to fulfill basic medical needs [5]. Treatment using traditional medicinal plants continues to this day and the practice has even increased in recent years [6].

The use of plants used as restorative materials for various diseases has been known and utilized for a long time by the community [7]. Knowledge of medicinal plants is based on practices and skills passed down from one generation to the next. The tradition of utilizing medicinal plants has been partly validated in this style. However, many of these traditional

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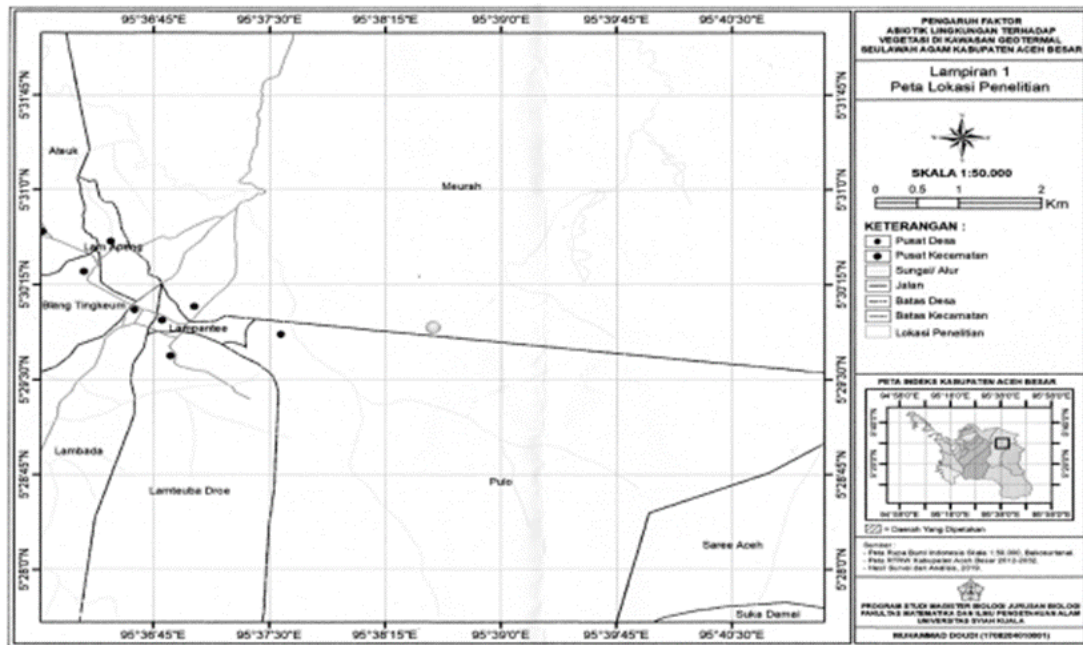


Figure 1. Map of the research area

practices have not been scientifically recorded and disseminated through publications, especially the species of medicinal plants found in geothermal areas. This study is aimed at learning more about the diversity of medicinal plant species in the geothermal area of Seulawah Agam, Aceh Besar District

METHODOLOGY

Place and Time of Research

This research was conducted in a geothermal area (Ie Jue hot springs), Lamteuba, Mount Seulawah Agam, Aceh Besar District (Figure 1). The research was carried out from August 2019 to August 2020.

Data Collection

The data was collected in multiple square plots that were chosen based on the stratified sampling of soil temperature zones at a predetermined location (Figure 2).

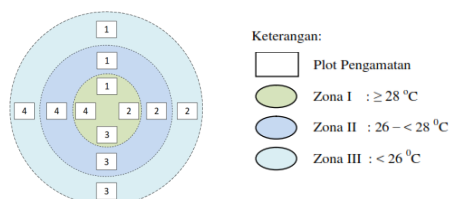


Figure 2. Design sketch of the laying of sample plots in the field based on soil temperature zones

Each observation plot was made into nested plots, namely: 20 m x 20 m for tree strata observation (tree diameter ≥ 20 cm), 10 m x 10 m for pole level (tree diameter 10 cm to < 20

cm), 5 m x 5 m for sapling level (tree diameter < 10 cm, height > 1.5 m) and 2 m x 2 m for seedling level (plant height ≤ 1.5 m). The sample plot scheme carried out in the field can be seen in Figure 3.

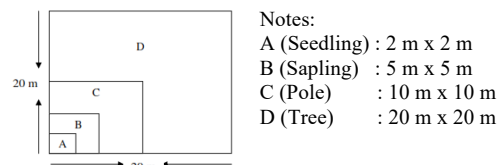


Figure 3. Plot sketch of an observation of medicinal plant data.

For each plot that has been determined, plant species were observed at each growth level, namely seedlings, saplings, poles, and trees. The names and numbers of individuals of each plant species in the observation plot were recorded, then identified using plant determination key books from Steenis [8] and Tjitrosoepomo [9]. Subsequently, plants which had potential for medicinal properties were identified through a literature study using scientific journals and identification books of medicinal plant species. The books used included *The Taxonomy of Medicinal Plants Collection* (Aspan) [10], *Efficacious Family Medicinal Plants* (Wibisono) [11], *The Smart Book of Medicinal Plants* (Utami) [12], and *The Indonesian Medicinal Plants Encyclopedia* (Bangun) [13]. The journals that were used as references to identify medicinal plants can be seen in Table 4.

Table 1. Species of medicinal plants found in the geothermal area of Seulawah Agam, Aceh Besar

No.	Family	Species	Growth Rate			
			Seedlings	Saplings	Poles	Trees
1	Amaranthaceae	<i>Amaranthus spinosus</i>	✓			
2	Anacardiaceae	<i>Lannea nigritana</i>		✓		
3	Anacardiaceae	<i>Mangifera foetida</i>				✓
4	Annonaceae	<i>Annona squamosa</i>		✓		
5	Annonaceae	<i>Annona cherimola</i>			✓	
6	Apocynaceae	<i>Alstonia scholaris</i>	✓	✓	✓	✓
7	Asteraceae	<i>Chromolaena odorata</i>	✓	✓		
8	Asteraceae	<i>Blumea balsamifera</i>	✓	✓		
9	Cleomaceae	<i>Cleome viscosa</i>	✓			
10	Clusiaceae	<i>Calophyllum inophyllum</i>		✓		✓
11	Euphorbiaceae	<i>Acalypha indica</i>	✓			
12	Euphorbiaceae	<i>Claoxylon indicum</i>		✓		
13	Euphorbiaceae	<i>Bischofia javanica</i>			✓	
14	Euphorbiaceae	<i>Bridelia stipularis</i>				✓
15	Euphorbiaceae	<i>Aleurites moluccana</i>				✓
16	Fabaceae	<i>Desmodium triflorum</i>	✓			
17	Fabaceae	<i>Senna tora</i>	✓			
18	Lamiaceae	<i>Ocimum tenuiflorum</i>	✓			
19	Malvaceae	<i>Urena lobata</i>	✓			
20	Malvaceae	<i>Microcos tomentosa</i>		✓	✓	
21	Malvaceae	<i>Ceiba petandra</i>			✓	✓
22	Meliaceae	<i>Melia azedarach</i>		✓	✓	✓
23	Moraceae	<i>Streblus asper</i>	✓	✓	✓	✓
24	Myrtaceae	<i>Syzygium polyanthum</i>		✓	✓	✓
25	Piperaceae	<i>Piper aduncum</i>		✓		
26	Poaceae	<i>Axonopus compressus</i>	✓			
27	Rutaceae	<i>Murraya koenigii</i>		✓		
28	Salicaceae	<i>Flacourtia rukam</i>	✓	✓	✓	
29	Sapindaceae	<i>Erioglossum rubiginosum</i>	✓	✓	✓	✓
30	Ulmaceae	<i>Trema orientalis</i>				✓
31	Verbenaceae	<i>Stachytarpheta jamaicensis</i>	✓			
32	Verbenaceae	<i>Vitex pinnata</i>		✓	✓	✓

Measurements of abiotic environmental factors were carried out in each observation zone from 06.00 am to 08.00 am. The measured data on abiotic environmental factors included soil temperature, air temperature, soil humidity, air humidity, and sunlight intensity

Data Analysis

The data was analyzed using the Importance Value Index analysis (IVI) and the Shannon-Wiener diversity index analysis with the following formula:

1. Importance Value Index (IVI)

IVI species at the growth rate of seedling and sapling = **KR + FR**

IVI species at the level of Pole and Tree
Growth= **KR + FR + DR**

Where:

$$K = \frac{\text{The number of individualsof a species}}{\text{Area of plots}}$$

$$KR = \frac{\text{The density of a species}}{\text{Density of all species}} \times 100$$

$$F = \frac{\text{Number of compartments where a species is found}}{\text{Sum of all sample plots}}$$

$$FR = \frac{\text{Frequency of a species}}{\text{Frequency of all species}} \times 100$$

$$D = \frac{\text{Total basal area of a species}}{\text{Sampel plot area}}$$

$$DR = \frac{\text{Dominance of a species}}{\text{Dominance of all species}} \times 100$$

2. Diversity Index

$$H = -\sum(P_i) (\ln P_i)$$

Notes:

H = Shannon-Wiener's Diversity Index

P_i = n_i/N, Comparison between the number of individuals of species-i with the total number of individuals

n_i = Total of species i (Individual)

N = Total number of individuals

By criteria:

H < 1 = Low diversity

1 < H < 3 = Medium diversity

H > 3 = High diversity [14].

RESULTS AND DISCUSSION

Species of medicinal plants found in the Seulawah Agam geothermal area, Aceh Besar district

The species of medicinal plants found in the geothermal area of Seulawah Agam, Aceh Besar district, consisted of 32 species belonging to 21 families. These species' growth rates were categorized as saplings, poles, and trees (Table 1).

Based on Table 1, the growth rate of saplings is the most common phase of medicinal plant found compared to the others. This category was comprised of 16 species of plants. The high number of saplings is a result of the research site

being an open area with few tree canopies and an intensity of sunlight between 21,300-800 Lux. These environmental conditions allow for sunlight to directly penetrate the soil surface, which results in there being more understory in the area.

Several seedlings grew well in open areas [15]. This is because open spaces make it easier for direct sunlight to penetrate the soil surface. This allows for a higher plant density because there are no tree canopies obstructing the sunlight in the area. Tree canopies make it virtually impossible for an understory to thrive, although there are exceptions in the form of shade-tolerant plant species [16].

The Euphorbiaceae family is the most common family found among the plant species observed. The species found at each growth level were *Alstonia scholaris*, *Streblus asper*, and *Erioglossum rubiginosum*. The presence of these species at each growth stage indicates that these species have good regeneration in the area. *Alstonia scholaris* is a species of medicinal plant that is used by the local community for hair care and enrichment [17]. *Erioglossum rubiginosum* is a species of plant utilized by the sub-ethnic Wolio efficacious to cure disease [18]. Meanwhile, *Streblus asper* is a medicinal plant that has been proven effective in treating hepatitis and ulcers [19].

Table 2. Five dominant species of medicinal plants at each growth rate in the geothermal area of Seulawah Agam, Aceh Besar District

Growth Rate	Dominant Species	KR (%)	FR (%)	DR (%)	Importance Value Index (%)
Seedling	<i>Desmodium triflorum</i>	42.55	5.71	-	48.26
	<i>Chromolaena odorata</i>	13.83	20.00	-	33.83
	<i>Stachytarpheta jamaicensis</i>	12.23	17.14	-	29.37
	<i>Senna tora</i>	5.85	8.57	-	14.42
	<i>Axonopus compressus</i>	8.51	5.71	-	14.22
Sapling	<i>Streblus asper</i>	16.32	13.51	-	29.84
	<i>Erioglossum rubiginosum</i>	14.28	13.51	-	27.79
	<i>Flacourtia rukam</i>	10.20	10.81	-	21.01
	<i>Vitex pinnata</i>	10.20	10.81	-	21.01
	<i>Microcos tomentosa</i>	8.16	8.10	-	16.27
Pole	<i>Alstonia scholaris</i>	15.15	16.00	25.00	56.15
	<i>Streblus asper</i>	15.15	16.00	25.00	56.15
	<i>Vitex pinnata</i>	15.15	12.00	25.00	52.15
	<i>Erioglossum rubiginosum</i>	12.12	12.00	25.00	49.12
	<i>Microcos tomentosa</i>	12.12	8.00	0.00	20.12
Tree	<i>Melia azedarach</i>	26.19	20.00	27.50	73.69
	<i>Vitex pinnata</i>	23.81	20.00	22.50	66.31
	<i>Aleurites moluccana</i>	11.90	10.00	20.00	41.90
	<i>Erioglossum rubiginosum</i>	9.52	13.33	12.50	35.35
	<i>Alstonia scholaris</i>	9.52	10.00	7.50	27.02

Importance value index (IVI) analysis was used to determine the dominant species in an observation plot [20]. The dominant species was defined as a species that can utilize its environment more efficiently than other species in the same place [21]. The index of the importance value of medicinal plants at each growth rate in the geothermal area of al Seulawah Agam, Aceh Besar district, can be seen in Table 2.

Based on Table 2, it is clear that *Desmodium triflorum* is the predominant medicinal plant species present in the area when compared with other medicinal plants in the seedling growth rate category. It comprises about 48.26% of the total species listed in the seedling category. *Desmodium triflorum* is a species of medicinal plant that is widespread in Southeast Asia, South Asia, and East Asia [22]. This is influenced by their ability to spread seeds that are very easily carried away by wind and water [23]. This plant species contains many diseases fighting compounds, including flavonoids, saponins, polyphenols, and trigonelline compounds [24].

Streblus asper is the most dominant medicinal plant compared to other medicinal plants at the sapling growth rate, with a total of 29.84%. The importance value index illustrates that this species has more growth suitability than other plant species [25]. The leaves of this plant can be used to treat ulcers and hepatitis [19].

The species *Alstonia scholaris* and *Streblus asper* were discovered to be the most prominent species of plants in the pole growth rate category. Compared with others, they amounted to a combined total of 56.15% of the total category. These values indicate that these species play a vital role in the area because they have an IVI value of $\geq 15\%$ [20].

Melia azedarach is a species of medicinal plant that is the most dominant compared to other medicinal plants in the tree growth rate category, with a total of 73.69%. The high IVI value indicates that this species is prevalent because it has adapted to the environment better than other species [26]. The bark and leaves of *Melia azedarach* can be used as a medicine to treat high blood pressure and roundworms [19].

Diversity of Medicinal Plant Species in the Geothermal Area of Seulawah Agam, Aceh Besar District

The analysis of the diversity index for medicinal plants in the geothermal area of Seulawah Agam, Aceh Besar district, can be seen in Table 3.

Table 3. The diversity index of medicinal plants in geothermal areas

No	Growth Rate	H	Category
1	Seedling	1,92	Medium
2	Sapling	2,52	Medium
3	Pole	2,24	Medium
4	Tree	2,07	Medium

Based on Table 3, it can be seen that the diversity index of medicinal plants in the geothermal area of Seulawah Agam, Aceh Besar district at each growth rate is classified into the medium category. This indicates that each of the growth rates have a reasonably good level of plant growth stability in the area.

Species diversity can be used to measure community stability, such as the ability of a community to keep itself stable despite the disturbance of its components [27]. The species diversity index also shows the amount of variation in plant species in one place. The higher the diversity index value, the higher the diversity of species, and the ecosystem's stability in an area [28].

Utilization of the potential of medicinal plants in the geothermal area of Seulawah Agam, Aceh Besar District

The utilization of therapeutic plant potential based on literature review in the geothermal area of Seulawah Agam, Aceh Besar District, can be seen in Table 4. The table shows that the parts of plants used as traditional medicine consist of roots, bark, sap from bark, leaves, and flowers.

Table 4 shows that the leaves of medicinal plants are the most widely used as a medicine. The leaves accumulate many secondary metabolites that are useful as medicines, such as alkaloids, tannins, essential oils, and other organic compounds stored in vacuoles or additional tissue in leaves such as trichomes [44].

The utilization of the leaves does not have a negative effect on the survival of medicinal plants. The part of the plant that needs to be limited in its use in medicine is the tuber, because the use of this part can kill the plant [49].

Many different benefits and uses of medicinal plant species were identified in the geothermal Seulawah Agam. Based on the literature study, these plants can be used to treat diarrhea, fever, dysentery, malaria, wounds, toothache, vaginal discharge, ulcers, hypertension, hepatitis, malaria, and many others.

Table 4. Utilization of medicinal plant species and plant parts used

No	Species Names	Usefulness	Plant part used	Ref.
1	<i>Amaranthus spinosus</i>	Used to treat diarrhea, eczema, dysentery, teeth, gonorrhea, and ulcers.	Leaf	[29] [32] [41]
2	<i>Lannea nigritana</i>	Used to treat raho	Leaf	[41]
3	<i>Mangifera foetida</i>	Used to treat itching	Leaf	[41]
4	<i>Annona Squamosa</i>	Used to treat intestinal worms, indigestion, skin wounds, ulcers, and scabies.	Leaf	[30] [19]
5	<i>Annona cherimola</i>	Used to treat internal disease	Leaf	[43]
6	<i>Alstonia scholaris</i>	Used to promote hair growth	Bark sap	[17]
7	<i>Chromolaena odorata</i>	Used as a medication for wounds, scabies or itching, antioxidants	Leaf	[39] [41]
8	<i>Blumea balsamifera</i>	Internal medicine and diarrhea	Leaf	[35] [36]
9	<i>Cleome viscosa</i>	Rheumatic drugs	Leaf	[32]
10	<i>Calophyllum inophyllum</i>	Kidney medicine	Bark	[33]
11	<i>Acalypha indica</i>	Used to treat nosebleeds, lower high blood uric acid levels, rheumatism, diabetes, aches, pains, and wound medication	Roots and Leaves	[31] [43]
12	<i>Claoxylon indicum</i>	Used to treat malaria	Leaf	[40]
13	<i>Bischofia javanica</i>	Used to treat diabetes mellitus, cholesterol, and abdominal pain	Bark	[42]
14	<i>Bridelia stipularis</i>	Used to treat dysentery	Bark	[46]
15	<i>Aleurites moluccana</i>	Used to treat constipation, ambient, promote hair growth, chapped and wet feet.	Bark and Leaves	[19] [41]
16	<i>Desmodium triflorum</i>	Used treat diarrhea	Leaves and whole plant	[46]
17	<i>Senna tora</i>	Used to treat liver disease	Leaf	[45]
18	<i>Ocimum tenuiflorum</i>	Used to treat, expectorant, diaphoretic, anthelmintic, analgesic, as a tonic, and for cancer prevention	Leaf	[34] [36]
19	<i>Urena lobata</i>	Medication for wounds, abdominal pain, fever, anti-inflammatory, anti-rheumatic, anti-malarial, vaginal discharge, vomiting of blood, difficulty giving birth, broken bones, and snake bites.	Root or Whole plant	[42] [48]
20	<i>Microcos tomentosa</i>	Used to treat diarrhea	Leaf	[33]
21	<i>Ceiba petandra</i>	Used to treat hemorrhoids, heartburn dysentery, and asthma	Leaf	[19] [42]
22	<i>Melia azedarach</i>	Used to treat high blood pressure and roundworms	Bark and Leaves	[19]
23	<i>Streblus asper</i>	Used to treat ulcers and hepatitis	Leaf	[19]
24	<i>Syzygium polyanthum</i>	Used to treat hypertension	Leaf	[43]
25	<i>Piper aduncum</i>	Toothache medicine	Leaf	[43]
26	<i>Axonopus compressus</i>	Medicine for stomach pain, cough	Leaf	[36]
27	<i>Murraya koenigii</i>	Diarrhea, dizziness, abdominal pain, influenza, rheumatism, medicine for wounds and diabetes	Leaf	[38]
28	<i>Flacourtia rukam</i>	Diarrhea and dysentery drugs	Fruit	[37]
29	<i>Erioglossum rubiginosum</i>	Used to treat internal disease	Bark	[43]
30	<i>Trema orientalis</i>	Sprain medicine	Bark	[44]
31	<i>Stachytarpheta jamaicensis</i>	Tonsil medicine, sore throat, and vaginal discharge	Flowers, leaves, and roots	[32] [48]
32	<i>Vitex pinnata</i>	Used to treat diarrhea, dysentery, fever, and malaria	Leaves and Leather Trunk	[47]

Furthermore, the most common method used to process the plants was by boiling and pounding them. Boiling is very common and effective because people generally prefer to consume these plants after they have been boiled in water rather than consume them directly. The healing process is also much faster because the healing compounds of the plants are instantly released into the water and more easily processed by the body's metabolism when consumed [50].

CONCLUSION

The species of medicinal plants found in the geothermal area of Seulawah Agam, Aceh Besar district, consisted of as many as 21 families of 32 identified plant species starting from the growth rate of seedlings, saplings, poles, and trees. Meanwhile, the diversity index at each growth rate is classified into the medium category. Plants that were commonly used as medicines were identified based on literature studies, and the parts most commonly used in traditional medicines were the leaves, roots, sap, bark, and flowers. This study is expected to be used by the local community for critical data about the utilization of medicinal plant species found in the geothermal area of Seulawah Agam. This study can also be used as a reference for further research related to medicinal plants in the geothermal area.

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