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Development of traditional medicinal plants on Peatland conditions in Central Kalimantan

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ABSTRACT

Most of the total peatland area in Kalimantan Island and particularly in Central Kalimantan Province is suitable for agricultural development. This condition provides a great opportunity for the development of peatlands for the cultivation of traditional medicinal plants. The local society in their daily lives could not be separated from the inherent elements of tradition even though the development of science and technology is currently very fast. One of the traditional elements that are inherent at this time is the use of medicinal plants as a solution in treating various diseases. The research was conducted in Palangka Raya City, Central Kalimantan Province by conducting interviews to determine the type of selected medicinal plants and carrying out experiments for examining their ability to absorb carbon dioxide and to grow in peatland conditions. The results of the study of four types of traditional medicinal plants show that there is great potential for two types of plants, namely Semar Bags and Karamunting, whose implementation fulfills biodiversity in an agricultural land ecosystem.

KEYWORDS: Peatland, traditional medicinal plants, plant parameters, carbon dioxide transformation

INTRODUCTION

Central Kalimantan Governor Regulation Number 52 of 2008 (CKG, 2008) affirms that land is a stretch of land ecosystem, either dryland or wetland, which is allocated for the cultivation of rice fields, fields and gardens for the community. In particular, peatland is land with a layer of soil rich in organic matter of more than 18% with a thickness of more than 50 cm. The organic material that makes up peat soils is formed from plant debris that has not completely decomposed due to water-saturated and nutrient-poor environmental conditions, making anaerobic conditions to occur (Razif *et al.*, 2006; Ye *et al.*, 2016) and low evaporation rate (Humaira *et al.*, 2020; Wilkinson *et al.*, 2020). Therefore, peatlands are often found in back swamp areas or in basin areas with poor drainage. Peat itself is formed from a heap of dead plant debris, whether rotten or not. The stockpile continues to increase because the decomposition process is hampered by anaerobic conditions and other environmental conditions that cause the low level of development of decomposing biota. The formation of peat soil is a geographical process, namely the formation of soil caused by deposition and transportation processes, in contrast to the process of forming mineral soils which are generally pedogenic processes (Agus & Subiksa, 2008; Klingenfuß *et al.*, 2014). Several classifications of peatlands are differentiated based on physical, chemical, biological characteristics (Subiksa & Wahyunto, 2011; Surahman *et al.*, 2018), but many of them contain sufficient N, P, K nutrients and are suitable for agricultural cultivation. The total area of peatland on the island of Kalimantan is 5,072,249 Ha, which is suitable for agriculture of 1,530,256 Ha. Meanwhile, Central Kalimantan province has a peatland area of 3,010,640 hectares, which is suitable for agriculture covering an area of 672,723 hectares (Agus & Subiksa, 2008; Hooijer *et al.*, 2010). This condition provides great opportunities for the development of peatlands for the cultivation of traditional medicinal plants.

The local society in everyday life cannot be separated from the inherent traditional elements even though the development of science and technology is currently very fast. One of the traditional elements that are inherent at this time is the use of medicinal plants as a solution in treating various diseases. This is supported by the abundance of Indonesia's natural resources, especially the richness of medicinal plants (Krismawati & Sabran, 2006; Cahyaningsih *et al.*, 2021). Medicinal plants are all plant species known or believed to have medicinal properties and are grouped into 3 groups, namely 1) Traditional medicinal plants 2) Modern medicinal plants and 3) Potential medicinal plants (Abdiyani, 2008; Haeruddin *et al.*, 2017).

Traditional medicinal plants are types of plants that are known or believed by the public to have medicinal properties and have been used for hereditary traditional medicine. Traditional medicine is all treatment by means other than medical science based on knowledge rooted in certain traditions (Garvita, 2015; Yuan *et al.*, 2016). Various types of medicinal plants have long been used by people living in and around forests to treat various types of diseases (Fabricant & Farnsworth, 2001; Widhyani *et al.*, 2017). Likewise, the Dayak people who live in Palangka Raya City, Central Kalimantan Province, with their traditional knowledge from generation to generation, use various types of medicinal plants to treat various types of diseases. The continued use of traditional medicinal plants has led to a lot of research on these various plants, especially in the pharmaceutical field. Exploration of medicinal plants is continuously carried out in an effort to maximize the potential of Indonesia's forests which have high biodiversity and ethnobotany studies are beneficial to both humans and the environment through the protection of the types of plants used (Witjoro *et al.*, 2016; Kaya, 2017).

METHODOLOGY

Place and time

The research was conducted in Palangka Raya City, Central Kalimantan Province by conducting interviews to determine the type of selected medicinal plants and examining their growth and ability to absorb CO_2. Measurement of the diameter, height and number of leaves of traditional medicinal plants are put into the chamber. Furthermore, traditional medicinal plants that are put into the chamber are observed for CO_2 samples. CO_2 analysis and analysis of dry weight, percent organic carbon and organic carbon content were carried out at the Greenhouse Gas Laboratory of the Jakenan Agricultural Environment Research Institute, Pati, Central Java. Research time for CO_2 absorption, percentage of organic carbon and organic carbon content of traditional medicinal plants was started on March 23, 2020- April 13, 2020.

Materials and Tools

The instrument used in the study consisted of a chamber totaling 10 units, made of fiberglass measuring 50 x 50 x 30 cm equipped with a battery, thermometer, fan and septum, Gas Chromatography, syringe equipped with silver foil wrapping and solid rubber syringe cover, label paper, calipers, meter, 50 cm ruler, oven, desiccator, blast furnace, ash cup, bucket, small plastic basket, rubber band, paper bag, stereoform, stopwatch, isolation, camera, scissors, 4 x 1 m bed with paranet roof with height facing east 1 m and west 0.75 m, analytical scales, blender and writing instruments.

The materials used in this research are peat, sand, newsprint, plastic carpet, water and types of traditional medicinal plants aged 2-4 months with a height of 30-40 cm. The planting medium is a mixture of fertile soil and polybags with a diameter of 9 cm and a height of 15 cm. Types of medicinal plants are Dayak Onions (*Eleutherine palmifolia* (L.) Merr.), Semar Bags (*Nepenthes mirabilis* Druce.), Masisin/Kemunting (*Rhodomyrtus tomentosa* (Aiton) Hassk.) and Karamunting/ Senggani (*Melastoma malabathricum* D. Don.).

Research design

This research design generally adopts, adapts and modifies from previous studies (Ludang *et al.*, 2007; Jaya *et al.*, 2018; Fernando *et al.*, 2018; Ludang, 2019; Prasetyoko *et al.*, 2020; Susilowati *et al.*, 2020). This experiment is in the condition of the planting medium in the form of peat to determine its effect on the growth of the tested plants. Experimental research design used a design of the stages that will be applied in a growth experiment in the nursery and the amount of plant CO_2 uptake in the indoor chamber (Samudro *et al.*, 2022). Simple linear regression analysis of the dynamics of the growth characteristics of each type of plant was carried out on age, and the relationship between the amount of plant CO_2 uptake per time interval was observed using Microsoft Excel. Measurement of growth medium and plant parameters followed previous research methods (Mangkoedihardjo & Triastuti, 2011).

Research procedure

The method of observing carbon dioxide (CO_2) uses the chamber method with the following equipment: 1) The thermometer is inserted from the top into the hood, which functions to measure the temperature of the air inside the hood; 2) The fan uses a dry battery source, functions to distribute the air in the chamber. On the surface of the hood, there is a closed septum hole, which functions to observe CO_2 in the hood using a syringe. A hood equipped with a thermometer and a fan was used in the study (Ludang, 2013). The method of placing the chamber in the field is shown in Figure 1. Taking CO_2 samples from inside the hood in the implementation of the research is presented in Figure 2. Gas samples that have been taken with a syringe, CO_2 concentration are measured using a Gas Cromathography (GC) tool at the Laboratory of the Indonesian Agricultural Environment Research Institute, Pati, Central Java, as in Figure 3.

Figure 1: Placement of Chambers and Plants in the Field

RESULTS AND DISCUSSION

Plant parameters

Plant Growth Rate

The growth data of traditional medicinal plants per week of observation are presented in Table 1. The development of the average plant growth rate for traditional medicinal plants in the observation week period was showing that the growth pattern of traditional medicinal plants in the first week of week II was decreasing in the period.

The average growth of traditional medicines from week II to III increased in the growth period of traditional medicines from week III to IV. It was confirmed by the results of Ludang *et al.* (2018) and Alpian *et al.* (2018) that the growth pattern expressed in the weight of dry matter is an S-shaped curve (sigmoid) in which in a certain growth period the growth rate is initially slow and continues to increase until a certain age period. After that the growth rate will decrease with the increasing age of the plant. It was only the middle and end of the sigmoid curve is visible. This happens because at the age of 21 days plants are in the active vegetative phase so the photosynthate produced is mostly used to form vegetative organs such as leaves, stems and roots. When plants enter the reproductive phase, photosynthate is translocated to the reproductive organs so that the growth rate decreases.

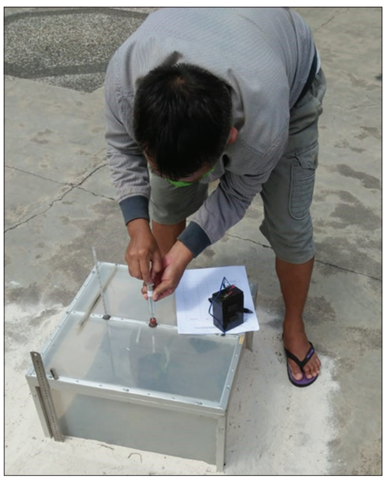

Figure 2: Carbon Dioxide Sampling

Figure 3: Analysis of Carbon Dioxide Using Gas Chromatography in the Laboratory of Greenhouse Gases, Jakenan Agricultural Environment Research Institute, Pati, Central Java

Net Assimilation Rate

The Net Assimilation Rates (NAR) of traditional medicinal plants are provided in Table 2. The development of the average net assimilation rate for traditional medicinal plants in the period of time shows the same pattern during the first week of week II.

The rates from week II to III were increasing in the growth period of traditional medicinal plants from week III to IV. It was suspected that after week III there was a possibility that the leaves have covered each other so that the growth period of traditional medicinal plants will decrease. It was confirmed with the results of previous research results (Hartawan, 2013; Mangkoedihardjo & Samudro, 2014) the plant growth increases rapidly during the vegetative to generative period and decreases with increasing plant age. The decrease in NAR value is due to the leaves that have covered each other, so that the lower leaves get only a little sunlight and the leaves are parasitic. The amount of photosynthate produced is not balanced with the growth in leaf area and as a result NAR decreases. The results of this study are supported by the results of Tavares *et al.* (2011) and Li *et al.* (2016) that increasing leaf area above the critical point will decrease the value of dry matter. This decrease is due

Table 1: Growth rate of medicinal plants

Plants, common name	Scientific name	Growth rate ($g.m^2.d^{-1}$)			
		Week			
		I-II	II-III	III-IV	Average
Bawang Dayak/ Dayak onions	*Eleutherine palmifolia* (L.) Merr.)	0.705	0.824	0.286	0.605
Kantong Semar/ Semar Bags	*Nepenthes mirabilis* Druce.	0.722	0.824	1.019	0.855
Masisin/ Kemunting	*Rhodomyrtus tomentosa* (Aiton) Hassk.	0.681	0.143	1.019	0.614
Karamunting/ Senggani	*Melastoma malabathricum* D. Don	0.976	0.881	1.238	0.944

Table 2: Net assimilation rate of traditional medicinal plants

Plants, common name	Scientific name	Net Assimilation Rate ($g.m^2.d^{-1}$)			
		Week			
		I-II	II-III	III-IV	Average
Bawang Dayak/ Dayak Onions	*Eleutherine palmifolia* (L.) Merr.)	0.002	0.062	0.021	0.028
Kantong Semar/ Semar Bags	*Nepenthes mirabilis* Druce.	0.513	0.433	0.049	0.332
Masisin/ Kemunting	*Rhodomyrtus tomentosa* (Aiton) Hassk.	0.025	0.041	0.716	0.261
Karamunting/ Senggani	*Melastoma malabathricum* D. Don.	0.030	0.093	0.324	0.030

to the reduced function of the leaves as a source due to the shade of other leaves.

Leaf Area Index

The Leaf Area Index (LAI) of traditional medicinal plants is presented in Table 3. In general, it was explained that the average LAI development of traditional medicinal plants in the observation week period shows the same pattern. During the first week of week II the growth decreases.

The growth period from week II to III has increased and continued from week III to IV. The growth pattern is associated with a longer vegetative phase as explained by Aziezt *et al.* (2014), Calders *et al.* (2018) and Tanioka *et al.* (2020) that LAI in early growth increases with increasing plant growth. But the increase in LAI further causes the rate of photosynthesis to decrease because some leaves are protected by other leaves and the spread of sunlight is not evenly distributed across the leaf surface.

Carbon Dioxide Transformation

Carbon dioxide absorption

The carbon dioxide absorption capacity of traditional medicinal plants per week of observation is presented in Table 4.

The absorption capacity of carbon dioxide of traditional medicinal plants in the observations has varied values ranging from -11.03 $mg.m^{-2}.minute^{-1}$ to 13.59 $mg.m^{-2}.minute^{-1}$. The results are supported by previous researchers (Ludang, 2013; Yang *et al.*, 2016; Cheng & He, 2019; Czubaszek, 2019) stated that negative (-) carbon dioxide absorption indicates decreased carbon dioxide absorption.

Based on Table 4, the traditional medicinal plants Semar Bags was the most effective plants to absorb CO_2, because they have the highest average value per week of carbon dioxide absorption of 13.59 $mg.m^{-2}.minute^{-1}$ or 71.40 $ton.ha^{-1}year^{-1}$, followed by Karamunting/Senggani at 2.76 $mg.m^{-2}.minute^{-1}$ or 14.52 $ton.ha^{-1}year^{-1}$, Dayak onions decreased by -1.73 $mg.m^{-2}.minute^{-1}$ or -9,07 $ton.ha^{-1}.year^{1}$ and traditional medicinal plants Masisin/Kemunting the lowest carbon dioxide absorption value of -11.03 76 $mg.m^{-2}.minute^{-1}$ or -57.98 $ton.ha^{-1}.year^{1}$. The differences occurred presumably due to differences in internal factors (types, morphology and physiology of plants) between types of medicinal plants. Hidayati *et al.* (2013) and Bellassen & Luyssaert (2012) stated that one of the factors that influence the absorption of CO_2 in plants is internal (type, plant morphology and physiology) and external (light intensity, air temperature and air pressure). External factors play a role in controlling the opening of the stomata and ultimately the amount of water and CO_2 exchange in the leaves.

However, the results per time period of observation will vary as presented in Table 5. The results from 06.00-06.30 the average absorption of carbon dioxide increased (11.887 $mg.m^{-2}.minute^{-1}$), namely Dayak Onions, Semar Bags, Masisin/Kemunting and Karamunting/Senggani.

At 12.00-12.30 the average negative value of carbon dioxide absorption (-) means that the average carbon dioxide absorption has decreased, namely traditional medicinal plants of Dayak onions, Karamunting/Senggani and Masisin/Kemunting, while the Semar Bag increased. At 15.00-15.30 the average carbon dioxide absorption decreased, namely the traditional medicinal plants of Dayak Onions, Masisin/Kemunting and Karamunting/Senggani, while the Semar Bag increased. Wardhani *et al.* (2018) and Park *et al.* (2014) stated that the average daily CO2 concentration value during the day has the same variation pattern between Monday to Sunday. The highest concentration value occurs at 6.00-7.00

Table 3: Leaf area index for traditional medicinal plants

Plants, common name	Scientific name	Leaf area index ($cm^2.m^2$)			
		Week			
		I-II	II-III	III-IV	Average
Bawang Dayak/ Dayak Onions	*Eleutherine palmifolia* (L.) Merr.)	0.002	0.003	0.004	0.003
Kantong Semar/ Semar Bags	*Nepenthes mirabilis* Druce	0.015	0.010	0.022	0.016
Masisin/ Kemunting	*Rhodomyrtus tomentosa* (Aiton) Hassk.	0.002	0.004	0.002	0.003
Karamunting/ Senggani	*Melastoma malabathricum* D. Don	0.009	0.007	0.008	0.008

Table 4: Carbon dioxide absorption capacity of traditional medicinal plants per observation week

Plants, common name	Scientific name	Carbon dioxide absorption ($mg.m^{-2}.minute^{-1}$)
Bawang Dayak/Dayak Onions	*Eleutherine palmifolia* (L.) Merr.)	-1.73
Kantong Semar/ Semar bags	*Nepenthes mirabilis* Druce.	13.59
Masisin/Kemunting	*Rhodomyrtus tomentosa* (Aiton) Hassk.	-11.03
Karamunting/ Senggani	*Melastoma malabathricum* D. Don.	2.76
Average		0.90

Table 5: Absorption of carbon dioxide of traditional medicinal plants in the observation time period ($mg.m^{-2}.minute^{-1}$)

Plants, common name	Scientific name	Time		
		06.00-06.30	12.00-12.30	15.00-15.30
Bawang Dayak/Dayak Onions	*Eleutherine palmifolia* (L.) Merr.)	13.002	-14.480	-3.698
Kantong Semar/Semar Bags	*Nepenthes mirabilis* Druce.	18.413	9.207	13.164
Masisin/ Kemunting	*Rhodomyrtus tomentosa* (Aiton) Hassk.	1.413	-16.038	-18.474
Karamunting/ Senggani	*Melastoma malabathricum* D. Don.	13.688	-3.984	-1.416
Average		11.887	-6.011	-2.346

Table 6: Biomass deposits of traditional medicinal plants

Plants, common name	Scientific name	Dry weight (g)	Organic carbon content (g.m^{-2})	Organic carbon percent (%)
Bawang Dayak/ Dayak Onions	*Eleutherine palmifolia* (L.) Merr.)	6.24	4.58	47.86
Kantong Semar/Semar Bags	*Nepenthes mirabilis* Druce.	13.15	12.79	56.05
Masisin/ Kemunting	*Rhodomyrtus tomentosa* (Aiton) Hassk.	6.60	4.76	48.78
Karamunting/ Senggani	*Melastoma malabathricum* D. Don.	8.09	7.20	54.86
Average		8.52	7.33	51.89

WIB, then decreases until 13.00 WIB, and increases again at night.

Biomass Deposits

Deposits of biomass as a product of carbon dioxide transformation, which includes Dry Weight and Organic Carbon Content of Traditional Medicinal Plants are presented in Table 6.

Table 6 shows that the dry weight of traditional medicinal plants ranged from 6.24 to 13.15 g, percent organic carbon ranged from 47.86 to 56.05%, while organic carbon content ranged from 4.58 to 12.79 g.m^{-2}. The percentage of organic carbon ranged from 47.86 to 56.05%, the highest was in the traditional medicinal plants Semar Bags 56.05% and the lowest was in Dayak Onions 47.86%. Tuah *et al.* (2017) and Kikuzawa & Lechowicz (2018) stated that plants will reduce (CO_2) in the atmosphere through photosynthetic processes and store them in plant tissues. All components of vegetation, including trees, shrubs, lianas and epiphytes, are part of the aboveground biomass.

Table 6 shows the highest organic carbon content of the Semar Bags traditional medicinal plants was 12.79 gm^{-2}, followed by Karamunting/Senggani 7.20 gm^{-2}, and Masisin/Kemunting 4.76 gm^{-2}, and the lowest was in Dayak Onions 4.58 gm^{-2}. The highest organic carbon content in traditional medicinal plants Semar bags as carnivorous plants is thought to have advantages in the ability to process photosynthesis and store in plant tissue in biomass by forming bags. Istomo and Farida (2017) and Pan *et al.* (2011) explained that carbon is one of the elements that experiences a cycle in the ecosystem. The increase in the amount of biomass will be followed by an increase in the amount of potential carbon storage. This shows that carbon and biomass have a positive correlation so that if there is an increase or decrease in biomass, it will cause an increase or decrease in carbon.

The relationship between weeks of observation and organic carbon content of traditional medicinal plants showed the same pattern, following a strong-very strong category positive correlation. These results show that the increasing number of weeks of plant observation will increase the amount of carbon stored in the form of carbon stocks in traditional medicinal plants of Dayak Onions, Masisin/Kemunting and Karamunting/Senggani, and Semar Bags. Nuranisa *et al.* (2020) and Stirbet *et al.* (2020) revealed the carbon content in plants describes how much these plants can bind CO_2 from the air. Part of the carbon that is absorbed by plants is used in the photosynthesis process and the rest enters the plant structure and is stored in the form of carbon stocks.

Table 7: Specific carbon dioxide absorption rate of several plants (Ludang, 2013)

Rank	Plants, common name	Scientific name	Carbon dioxide specific absorption rate (mg.m^{-2}.minute^{-1})	Origin
1	Pinang Merah	*CyrtostachyslakkaBecc.*	1.37	Local
2	Serai	*Cymbopogoncitratus*	1.35	Local
3	Pepaya	*Carica papaya*L.	1.29	Local
4	Kenanga	*Canangium odoratum* (Lamk.) Hook. dan Thorms. (Lat.)	1.22	Local
5	Bambu Jepang	*Dracaenasurculosa*Lindl.	1.22	Greenspace plant
6	Trembesi	*Samanea saman* (Jacq.) Merr.	1.19	Greenspace plant
7	Tanjung	*Mimusops elengi* L.	1.11	Greenspace plant
8	Pasak Bumi	*Eurycoma longifolia* Jack.	1.10	Greenspace plant
9	Mangga	*Mangiferaindica*L.	0.88	Greenspace plant
10	Rambutan	*Nepheliumlappaceum* L.	0.54	Greenspace plant
11	Kelapa Kuning	*Cocos eburen*	0.47	Local
12	Nangka	*Artocarpus heterophyllus* Lam.	0.43	Local

From the research results above, which show that there are variations in the ability of plants, it is important and necessary to implement biodiversity (Samudro & Mangkoedihardjo, 2020; Samudro & Mangkoedihardjo, 2021, Soares *et al.*, 2021; Samudro, 2020) in the effort to use peatlands for the development of traditional medicinal plants. There are two types of traditional medicinal plants that have the potential to be developed as an intensification of biodiversity, namely Semar Bags and Karamunting/Senggani, and a further development of the use of plants that have high absorption capacity for carbon dioxide as provided in Table 7.

CONCLUSION

From a number of tested plants, there are 2 types of plants that are very potential for development in peatlands, namely Semar Bags and Karamunting/Senggani. At least these two types in addition to various types of plants that absorb carbon dioxide have fulfilled the need for biodiversity in a crop land ecosystem. Therefore, it is recommended that the two plants be recommended for conservation of traditional medicinal plants for the city government of Palangka Raya in line with the use of peatlands.

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