DISTRIBUTION AND HIGH ABUNDANCE OF MEDICINAL PLANTS POTENTIALLY USEFUL IN CANCER TREATMENT FOUND ON THE LAWU MOUNTAIN, INDONESIA

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Received: 21 October 2023, Revised: 21 March 2025, Accepted: 2 April 2025

DISTRIBUTION AND HIGH ABUNDANCE OF POTENTIALLY ANTICANCER MEDICINAL PLANTS IN THE LAWU MOUNTAIN, INDONESIA. Traditional medicines derived from natural resource plants have gained attention since modern medications are expensive for certain diseases, including cancer. The Lawu Mountain ecosystem has shown that the environment supports plant distribution, including species with anticancer properties. This study aimed to determine the distribution and abundance of medicinal plants that could serve as cancer preventives, particularly along the Cemoro Sewu hiking trail. The purposive sample method was employed to make the observations, wherein plots measuring 5 m x 5 m for shrubs and 1 m x 1 m for herbs were created. Plots were made by systematic distribution on both sides of the hiking trail, with four plots at each station. This study had six stations at 2,000 m, 2,200 m, 2,400 m, 2,600 m, 2,800 m, and 3,000 m asl. The distribution of plant species was evaluated using the Morishita index distribution, whereas the abundance of species is observed to get the average value in plant individuals per unit area. Depending on the environmental conditions where the growth occurs, the nine species were found along the hiking track with an abundance ranging from 180 to 4,580 individuals per hectare for the shrub category and 5,000 to 50,830 individuals per hectare for the herbaceous category. The distribution patterns of the species were found to be regular and clumped, respectively.

Keywords: Anticancer medicinal plant, Lawu Mountain, distribution, abundance

DISTRIBUSI DAN KEMELIMPAHAN TUMBUHAN OBAT ANTIKANKER DI GUNUNG LAWU, INDONESIA. Obat-obatan tradisional yang berasal dari tumbuhan alami telah mendapatkan perhatian karena obat-obatan modern memiliki biaya yang tinggi untuk penyakit tertentu termasuk kanker. Ekosistem Gunung Lawu mengindikasikan adanya pola persebaran berbagai jenis tumbuhan, termasuk tumbuhan sebagai kandidat anti kanker. Tujuan riset ini adalah untuk mengidentifikasi keragaman, persebaran, dan kelimpahan tumbuhan dengan potensi sebagai kandidat obat anti kanker, khususnya di lintasan pendakian Cemoro Sewu. Survei dan pengukuran dilaksanakan menggunakan metode purposive sampling dengan membuat plot berukuran 5 m x 5 m untuk tumbuhan perdu serta 1 m x 1 m pada kategori tumbuhan herba. Plot dibuat secara disebar dengan sistematis pada kedua sisi lintasan pendakian, dengan empat kuadrat di setiap stasiun. Stasiun penelitian dibuat mengikuti gradien ketinggian, pada ketinggian 2.000 m, 2.200 m, 2.400 m, 2.600 m, 2.800 m, dan 3.000 m dpl. Keragaman tumbuhan kandidat anti kanker dianalisis secara deskriptif. Pola persebaran tumbuhan obat dianalisis dengan indeks persebaran Morishita dan menghitung kelimpahan jenis tumbuhan yang menunjukkan nilai rata-rata jumlah individu tumbuhan per satuan luas. Kesembilan jenis tersebut ditemukan di sepanjang lintasan pendakian dengan kelimpahan antara 180 hingga 4.580 individu per hektar untuk kategori perdu dan 5.000 hingga 50.830 individu per hektar untuk kategori herba dengan pola penyebaran yang teratur (reguler) serta mengelompok (bergerombol), serta bergantung terhadap kondisi habitatnya.

Kata kunci: Tanaman obat anti cancer, Gunung Lawu, keanekaragaman, distribusi, kemelimpahan

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 doi:10.59465/ijfr.2025.12.2.189-207

I. INTRODUCTION

Lawu Mountain ranges from 1.000 m asl to 3.265 m asl in altitude. These conditions enable the growth of various plant species, particularly medicinal plants (Prayoga, 2019; Sugiyarto et al., 2006). Based on Sugiyarto et al. (2006) research, there are 77 species of Cryptogame (Pteridophyte/fern and Bryophyte/mosses) and 50 species of Spermatophyte, which include the Angiospermae and Gymnospermae inhibits on Lawu Mountain. In particular, the medicinal flora comprised 67 species of the total population, including 53 species of Spermatophyta, 13 species of Pterydophyta, and one species of Lichenes (Sugiyarto et al., 2006).

The residents living near Lawu Mountain are tirelessly working towards preserving the knowledge of the local culture and the biodiversity of the mountain environment to maintain the plant population, including medicinal plants (Wibowo et al., 2021). Based on Dai and Mumper (2010), plant species with potential as anticancer agents have certain active compounds. These active compounds can affect proliferation, apoptosis, cell cycle arrest, and angiogenesis, thus preventing tumor growth and spread (Banerjee et al., 2023). Plants can have medicinal properties due to the presence of chemical compounds known as secondary metabolites, which impact specific physiological conditions in the human body. Among the bioactive compounds found in plants are alkaloids, flavonoids, tannins, and phenolic compounds (Nisa et al., 2011).

Commonly, cancer has become a menace in all countries, including Indonesia. In 2008, cancer ranked third as the leading cause of death worldwide after cardiovascular disease and stroke (WHO, 2008). Cancer is a leading cause of death worldwide, accounting for nearly 10 million deaths in 2020 (Ferlay et al., 2021). Therefore, cancer can be recognized as one of the primary threats in the field of health (King & Robins, 2016). The skyrocketing costs and adverse effects of synthetic drugs for cancer treatment are rekindling opportunities for utilizing traditional medicine and natural resources surrounding the residents (Robotin, 2011). This research was a crucial first step in helping communities understand the medicinal properties of plants in their environment over the long term.

Currently, surgical intervention, radiation therapy, and chemotherapy are the primary options for cancer treatment, whereas natural compound ingredients are still considered an alternative treatment supplement (Golbeck et al., 2018). Interestingly, according to Asma et al., 2022 more than 60% of contemporary anticancer drugs, in one form or another, have originated from natural sources. Medications derived from natural compounds are claimed to be more effective for cancer patients compared to synthetic chemical drugs (Atanasov, 2021). To reach our long-term goal, we have been researching to determine the distribution and abundance of potential anti-cancer plant species in Lawu Mountain. This study also describes the potential anti-cancer plant in Lawu Mountain via Cemoro Sewu.

II. STATE OF THE ART AND RESEARCH POSITION

Traditional medical treatment often uses natural resources that have various benefits. According to the WHO (2023), traditional medicine is safer than synthetic medicine. Especially in rural areas, traditional medicine is a culture or habit that uses a potion or therapy that the community has traditionally accepted (Rizvi et al., 2022). Natural products and traditional medicines have diverse contents in the form of chemical structures and biological reactions. According to Yuan et al. (2016), as much as 40% of pharmaceutical products have formulations and essential ingredients extracted from natural ingredients and utilised as traditional medicines. Indonesia is a country with a tropical climate and a very diverse flora. These excesses can be explored as a form of plant utilisation with a chemical structure and biological properties suitable as a medicine or basic treatment ingredient. An example is the experimental process conducted by Soltani et al. (2020), who used *Plantago major* L. to treat cancer mucositis in head and neck patients. The second example is research conducted by Mutiah et al. (2019), who used Ethyl Acetate solvent to extract sabrang onion (*Eleutherine palmifolia*) to treat cervical cancer.

The exploration of flora that has anti-cancer benefits has been carried out in many regions of Indonesia. Table 1 shows various studies conducted, especially the exploration of anti-cancer flora in the Indonesian region, and a comparison of the results of observations in this study.

Table 1. State of the art and research positions

Ref.	Survey region	Data collecting method	The discovered anticancer medicinal plant
Pandiangan et al. (2019)	Sangihe Island, North Sulawesi	Snowball Sampling Method	*Catharanthus roseus*, *Dischidia nythesiana, Artemisia vulgaris* L., *Coleus* sp*., Eleutherine americana Merr., Hibiscus* sp.
Nahdi and Kurniawan (2019)	Southern Slope Merapi Mountain, Yogyakarta	Purposive Sampling with the combination of Snowballing Samping Method	*Cymbopogon citratus* (DC.) Stap
Rahmawati et al. (2020)	Menui Island, Morowali District, Central Sulawesi	Purposive Sampling Method	*Macaranga peltata* (Roxb.), *Abrus precatorius* L., *Sida rhombifolia* L, *Breynia* sp*., Peperomia pellucida* (L.), *Piper betle* L*., Piper nigrum* L., *Cymbopogon citratus* (DC.), *Phymatosorus scolopendria*, *Citrus aurantiifolia*
Batoro and Siswanto (2017)	Poncokusumo district, Malang, East Java P	Snowball Sampling Method	*Calocasia esculentum* Schott., *Ageratum conyzoides* L., *Loranthus* sp*., Calvatia bovista* (L.)., *Curcuma xanthorhiza* L.,
Nugroho et al. (2022)	Lambung Mangkurat Education Forests, South Kalimantan	Cruise Rectangular Method	*Merremia peltate*
Nuraeni et al. (2022)	Rawamerta Region Karawang, West Java	Not Given	*Abrus precatorius* L, *Annona muricata* L., *Curcuma zanthorrhiza* Roxb., *Garcinia mangostana* L.
Arbiastutie et al. (2017)	Gunung Gede Pangrango National Park (West Java, Indonesia)	Clustering Region Sampling	*Cestrum elegans, Clidemia hirta* (L).D.Don, *Lantana camara* L., *Physalis peruviana* L., *Solanum verbascifolium* L., *Stephania venosa* (Blume) Spreng., *Tithonia diversifolia* (Hemsl.) A. Gray
Ammar et al. (2021)	Karst Area of Pacitan District, East Java,	Snowball Sampling Method	*Garcinia mangostana*
Syafruddin et al. (2022)	Dayak Tamambaloh Tribe	Purposive Sampling Method	*Clinacanthus nutans* Lindau, *Annona muricata* L., *Impatiens balsamina* L., *Selaginella doederleinii* Hieron
Pratiwi and Nurlaeni (2020)	Cibodas Botanic Gardens, Indonesia	Not Given	*Sambucus javanica* Blume., *Crinum macowanii* Baker., *Serenoa repens* (W.Bartram) Small,
Present Study	Cemoro Sewu Hiking Trail, Lawu Mountain, Central Java	Purposive Sampling with the Plots Region Method	*Debregeasia longifolia* (Burm. f.) Wedd, *Rubus chrysophyllus* Miq., *Rubus lineatus* Bl., *Rubus fraxinifolius* Poir., *Rubus niveus* Thunb., *Hypericum leschenaultii* Choisy, *Bryonia* sp*., Plantago major* L.

III. MATERIALS AND METHODS

Lawu Mountain is situated between the Central Java and East Java provinces, at 7.63° S and 111.18° E. The top view map of Lawu Mountain is shown in Figure 1. This mountain has an altitude of about 3,265 m asl. Lawu Mountain has several hiking trails but the research was conducted specifically on the Cemoro Sewu hiking trail. The observed sample comprises all plants with potential anticancer content, and the species were clearly defined before the site visit, following the purposive sampling procedure. The survey is conducted alongside the Cemoro Sewu hiking track. The equipment used during the observation process were a camera, field guidebook, scissors, sasak, newsprint, raffia, cutter, labels, herbarium etiquette, and several measuring instruments. The measuring instruments used include the SUNOH 7030 altimeter for assessing the altitude of each observation station, the Luxmeter KRISBOW KW06-288 for measuring radiation intensity, the Hygrometer 45.2007A to measure air humidity, the soil tester TAKEMURA DM-5 for evaluating soil pH acidity, the Canon SX720 HS camera for documenting medicinal plant vegetation, and the GPSMAP 78s for identifying the hiking track to be observed.

The study was conducted on the Cemoro Sewu hiking trail, which various herbaceous plants, shrubs, and trees lushly populated. The research location was divided into six stations following an altitudinal gradient, and plots were made with a systematic distribution on both sides, with four plots per station (Table 2). The determination of this station is based on elevation differences every 200 m asl, ranging from 2000-3000 m asl. It is also based on environmental differences such as lighting, temperature, humidity, and pH, which are stressors of the environment at different altitudes (Ibrahim et al., 2022).

Observation stations I and II entered the mountain zone. However, the subalpine zone dominates Observation Station III to Observation Station VI. In this study, abiotic environmental factors measured include climatic (radiation intensity, air temperature, and humidity) and edaphic (moisture and soil pH), which were noticed and averaged at each station (Table 4).

The measurements of adiabatic environmental factors at the station show a fluctuation; for example, the average light intensity at each station ranged from 10.95×100 lux – to 1317.75×100 lux (Table 2). Based on previous studies, densely vegetated areas, which are areas with low radiation intensity, commonly have wetter moisture in the soil than in open areas (Malinovsky & Krause, 2001). In addition, the temperature differences between each station depended on the population density, season, observation time, and air humidity.

IV. DATA ANALYSIS

Initial screening utilized a list of plant species found in Lawu Mountain, based on the study by Krisanti et al. (2017), which are believed to have anti-cancer properties. The screening revealed that 11 species of plants in

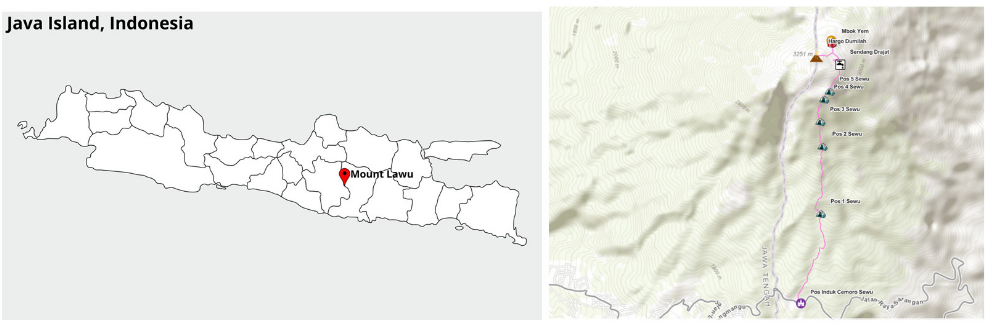


Figure 1. Top view map of Lawu Mountain via Cemoro Sewu

Table 2. An observation station for anticancer medicinal plants on the Cemoro Sewu hiking trail.
Observed station PlotAltitude (m asl)

Observed station	Plot	Altitude (m asl)
I	1	2,064
	2	2,057
	3	2,059
	4	2,066
II	1	2,202
	2	2,209
	3	2,201
	4	2,206
III	1	2,416
	2	2,418
	3	2,423
	4	2,422
IV	1	2,559
	2	2,564
	3	2,572
	4	2,582
V	1	2,800
	2	2,806
	3	2,819
	4	2,821
VI	1	3,000
	2	3,045
	3	3,089
	4	3,092

Table 3. The averaged climatic and edaphic factors of each observed station

Station	Climatic factors			Edaphic factors	
	Radiation intensity (× 100 lux)	Air temperature (ºC)	Humidity (%)	Moisture (%)	pH
I	10.95	20.00	73.00	20.00	6.90
II	645.18	27.00	59.50	20.00	7.00
III	30.55	16.25	89.25	-	-
IV	844.50	28.00	54.50	28.75	6.95
V	1317.75	22.50	59.00	32.50	6.80
VI	665.35	19.00	65.25	12.50	6.90

Lawu Mountain were found to be appropriate for the anti-cancer drug, such as *Brasicca juncea*, *Digitalis purpurea*, *Gaultheria leucocarpa*, *Gaultheria nummularoides*, *Melisa axillaris*, *Plantago major*, *Polygonum chinense*, *Solonum nigrum*, *Sonchus asper*, *Sonchus javanicus*, and *Vaccinium varingaefolium*. The purposive sampling method is used to identify the potentially anticancer medicinal plant along the trails. Purposive sampling was frequently used in qualitative research to select participants based on specific criteria (Saini, 2012; Etikan, 2016). Generally, this method did not use random sampling. Instead, it specified sampling criteria to cut off the large amounts of data, resulting in a participant sample representing the population and research objectives (Ames et al., 2019). Furthermore, this method allows for results with comprehensive discussions focused on the research objectives (Saini, 2012). Therefore, this method was suitable for the conducted observations because the Cemoro Sewu Hiking Trail has many non-herbal plant habitats. Purposive sampling is used in qualitative research to select plant samples based on certain criteria (Saini, 2012; Etikan, 2016), by sampling with sampling criteria, namely the height criteria of the sampling location on the Cemoro Sewu Hiking Trail. Therefore, this method does not use random sampling. This method produces a sample of participants that is representative of the population and research objectives (Ames et al., 2019). In addition, this method allows for results with comprehensive discussions that focus on the research objectives (Saini, 2012). Therefore, this method is suitable for the observations made because the Cemoro Sewu Hiking Trail has many non-herbal plant habitats.

In this study, specific criteria for medicinal plants were established at the beginning of the research. Plot selection is based on purposive sampling or the presence of plants with anticancer potential. Plots with 5 m x 5 m were made for shrubs and 1 m x 1 m for herbaceous plants (Osborn, 1950). The plots were spaced 5-10 m from each other. There were six stations (Table 2), each with four plots on both sides of the hiking trail (Barbour et al., 1988).

Table 4. The distribution of observed stations based on altitude

Stations	Altitude (m asl)
I	2,000
II	2,200
III	2,400
IV	2,600
V	2,800
VI	3,000

Identification was based on Backer's (1968) Flora of Java identification book using morphological characters. Observations were made using three analyses: distribution and abundance. The first is a distribution analysis conducted to explain the anti-cancer medicinal plants that were found descriptively. The second analysis remained a distribution analysis. These were intended to determine the distribution of anti-cancer plants on the hiking trail, expressed by frequency at each observation station. Denoted that *Id* represents the Morishita distribution index, with *n* as the species sampling number, *N* as the total species obtained from the observation, and *Xi* as the number of individuals in each sample. The obtained value can be interpreted based on the calculation result. The random distribution is obtained if the *Id*=1, the regular distribution is obtained if the *Id*<1, and the random distribution is obtained if the *Id*>1. The distribution pattern was determined using the Morishita distribution index value with the following equation (Fitriana, 2006):

$$Id = \frac{[(\sum_1^n xi^2)-N]}{N(N-1)} \quad \text{...(1)}$$

The last analysis is considered to be the abundance analysis. Based on this analysis, the average number of individual anticancer plants per unit area was determined. *Di* is considered as the abundance of individuals of the *i*, with *ni* as the number of individual species and the *A* as the sampling area in m^2. The equation is given below.

$$Di = \frac{ni}{A} \quad \text{...(2)}$$

V. RESULT AND DISCUSSION

A. Various of Medicinal Plants with Anti-cancer Potentially in Cemoro Sewu Hiking Trail

Based on research on the hiking trail, eight medicinal plants with the potential to anticancer were found on both sides. The public information considers the species found, and the earlier literature specifically discussed the chemical compound within the anticancer medicinal plant. The specific information is represented in Table 5.

Table 5. The species of anticancer plants along the Cemoro Sewu hiking track

No.	Species	Family	Habitus
1.	*Debregeasia longifolia* (Burm. f.) Wedd	Urticaceae	Shrubs
2.	*Rubus chrysophyllus* Miq.	Rosaceae	Shrubs
3.	*Rubus lineatus* Bl.	Rosaceae	Shrubs
4.	*Rubus fraxinifolius* Poir.	Rosaceae	Shrubs
5.	*Rubus niveus* Thunb.	Rosaceae	Shrubs
6.	*Hypericum leschenaultii* Choisy	Hypericaceae	Shrubs
7.	*Bryonia* sp.	Cucurbitaceae	Herb
8.	*Plantago major* L.	Plantaginaceae	Herb

1. *Debregeasia longifolia (Burm. f.)* Wedd.

Shrub plants have an orientation of upright stems with a height of 5 m. This plant has spiral-shaped and varied leaf arrangements. The upper leaf surface was rough and green, while the lower surface was white-gray. This plant can also produce fruits, and the skin becomes red when the fruit is ripe. According to Rustaman et al. (2000) findings, the *Debregeasias* sp. at the Simpang Mountain West Java contains secondary metabolic, including the alkaloid against the antimitosis characteristic. The advantage of these compounds is that they are better to stop cancer cell growth. The ethanolic leaf extract of *Debregeasia longifolia* has free radical scavenging activity in various oxidation inhibition mechanisms. Glycoside compounds such as saponins, phenols, and flavonoids are also known to inhibit tumor growth. On the other hand, flavonoids are water-soluble antioxidants and free radical scavengers, which can prevent oxidative cell damage and have strong anticancer activity (Radhamani & Britto, 2016). The founded *Debregeasia longifolia* (Burm. f.) Wedd. depicted in Figure 2.

Devi and Chongtham (2016) analyzed the methanol extract of *Debregaesia longifolia* leaves and found that the 1,1-diphenyl-2-picryl hydroxyl (DPPH) radical scavenging activity was 65.41 inhibition, reducing power ability was 1.66 equivalent to ascorbic acid. The total phenol content was 72.11 mg/100 g as catechol equivalent. The flavonoid content was 45.15 mg/100 g as quercetin equivalent; carotene content was 2.56 mg/100 g, and total alkaloids were 18.07 mg/100 g as caffeine equivalent. Therefore, these leaves can support the prevention and cure of inflammatory diseases caused by oxidative stress, such as diabetes, cardiovascular disease, cancer, arthritis, gout, and neurodegenerative diseases.

(a)

(b)

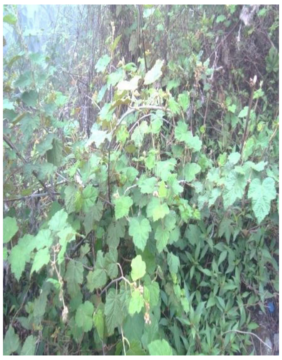
Figure 2. Morphology of *Debregeasia longifolia* (Burm. f.) Wedd (a) its habitus, and (b) its fruit

2. *Rubus chrysophyllus* Miq.

Rubus chrysophytes Miq (Figure 3) is a creeping shrub whose height reaches 5-10 m. This species has a single leaf with a rounded shape resembling a broadened egg. In addition, on the top side there are small bumps. The bottom of the leaf has brown hairy with a leaf venation. With a panicle-type arrangement, the flowers are white, and the fruit is generally pale orange-red. The fruit of *R. chrysophyllus*, which is a dense and attractive-looking aggregate fruit, also has the potential to be developed as an alternative source of consumption fruit from wild plants (Sundarini, 2016). The fruit of *R. chrysophyllus* has the best flavor among the various Rubus species in Java, hence its potential to be cultivated as a table fruit producer (Surya, 2009). According to Bhatt et al. (2023), caffeic acid, m-coumaric acid, and ascorbic acid found in *Rubus* sp. act as an anticancer agent, inhibiting ROS formation and preventing DNA damage and mutation.

3. *Rubus lineatus* Bl

Rubus lineatus Bl. (Figure 4) had the ability to propagate or creep up along other surfaces or, commonly referred to as a type of shrub vine with a height that could reach 1.5-3 meters. It has a stem with dense hair when it is young and sparsely hairy when it is old. A distinctive silver color was found on the underside of the leaves. This species has orange-red fruits. An extract from Rubus fruits was discovered to potentially inhibit the growth of several human tumour cell lines, such as oral (KB, CAL-27), colon (HT-29, HCT116), breast (MCF-7), and prostate (LNCaP) cells. The study further demonstrated that the extract was effective in causing apoptosis in a COX-2-expressing colon cancer cell line (Bhatt et al., 2023).


(a)


(b)

Figure 3. Morphology of *Rubus chrysophytes* Miq. in Lawu Mountain (a) habitus and (b) leaves & flowers


(a)


(b)

Figure 4. Morphology of *Rubus lineatus* Bl. in Lawu Mountain (a) habitus and (b) leaves & flowers

4. Rubus fraxinifolius Poir

Rubus fraxinifolius Poir (Figure 5) is a shrub with a height of up to 1.5-3 meters. The stems are not covered with waxy white. The leaves are compound with pinnate leaf veins and have 5-9 leaflets. It has a greenish-white flower crown with an egg-round shape and red fruit. At doses ranging from 25 to 200 μg/mL, the berry extracts were assessed for their capacity to suppress the growth of human oral (KB, CAL-27), breast (MCF-7), colon (HT-29, HCT116), and prostate (LNCaP) tumor cell lines. All cell lines showed increased suppression of cell growth with increasing berry extract concentrations, albeit to varying degrees of efficacy. The capacity of the berry extracts to induce apoptosis in the COX-2-expressing colon cancer cell line HT-29 was also assessed (Seeram et al., 2006).

5. Rubus niveus Thunb.

Rubus niveus Thunb (Figure 6) is an upright shrub that possibly growth up to 1-2 meters. Its stems are covered with thick waxy white, especially when it was young. The leaf structure has a pinnate compound leaf type. This species has red fruits, sometimes appearing blue, green or yellow. Various of medicinal plants species that have potential as anticancer in the Cemoro Sewu hiking trail is more commonly found in the Rubus genus because it has antioxidants that can minimize the activity of cancer growth due to free radicals. The antioxidants that have potential as anticancer are flavonoids (Deighton et al., 2000). Tannins are natural phenolic compounds that protect plants against fungi and insects. Szczurek (2021). In this investigation, methanol extracts of three plant species, *Rubus niveus*, *Rubus fairholmianus*, and *Rubus ellipticus*,

(a) (b)

Figure 5. Morphology of *Rubus fraxinifolius* Poir in Lawu Mountain (a) habitus and (b) leaves and flowers

(a) (b)

Figure 6. Morphology of *Rubus niveus* Thunb in Lawu Mountain (a) habitus and (b) leaves and flowers

exhibited high cytotoxicity (Muniyandi et al., 2019; Indrayanto et al., 2020). Another portion of *Azadirachta indica* A. Juss and *Melia azedarach* Linn. including different solvents (such as ether, petroleum, methanol, hexane, and water). Both species show less anticancer activity with an IC50 value greater than 100 εg/mL (Malar et al., 2020; Indrayanto et al., 2020). The action method against cancer cells was not mentioned in any research. More purification is required to obtain the active ingredient in the Rubus genus methanol extract.

6. Hypericum leschenaultii Choisy

Hypericum leschenaultii Choisy (Figure 7) is an upright shrub species with a maximum growth of up to 12 meters. The stem has a reddish-brown color. The leaf structure consists of seated leaves with an ovate shape and a white bottom side. The leaves on this species' crowns are yellow. According to the research of Szegedi et al., the active compound in *Hypericum perforatum* L (St. John's Wort) isolation was stated as having the special characteristic of Napthodianthrone derivatives (Szegedi et al., 2005). The founded compound *H. perforatum* has resistance to killing cell cancer growth, especially glioma cells.

7. Bryonia sp.

Bryonia sp. (Figure 8) is a type of herbaceous vine with stems up to 3-5 m long covered by soft hairs, and its diameter ranges from 1.2-3.2 mm. When it was young, the stem was covered with fine hairs, but when it was old, it was not anymore. They also have Spiralling tendrils

(a) (b)

Figure 7. Morphology of *Hypericum leschenaultii* Choisy in Lawu Mountain (a) habitus and (b) leaves & flowers

(a) (b)

Figure 8. Morphology of Bryonia sp. in Lawu Mountain (a) habitus and (b) leaves & flowers

which grow from the leaf axils. The leaves that grow have a heart-shaped form and greenish-white flower color. This species produced green fruit close to dark blue, but there were changes into black when it ripped. The bitter taste when the fruit was eaten. Based on research conducted by Bernarba et al. and Bachir et al. *Bryonia dioica* extract could suppress the growth of cancer cells. First, the extract could apoptotic Burkitt's lymphoma BL41 cancer cells and induce G2/M cell cycle arrest in MDA-MB 231 Breast Cancer cells (Bernad et al., 2008; Benarba et al., 2012).

8. Plantago major L.

Plantago major L. (Figure 9) is an upright perennial herb that ranges between 30-70 cm. This species has rosette-type leaves with varied morphology, such as round or irregularly serrated, smooth or moderately smooth. The plant has a tight flower structure with an elliptical shape, with a (4-)6-34 seed structure, and the flowers are black. *P. major* has several subspecies and varieties, but each cannot be clearly distinguished, considering the presence of intermediate forms (Simmonds et al., 2002). Based on previous research, *Plantago* spp. contains efficacy to suppress the growth of cancer cells. The cancer cells that could suppress their growth are breast adenocarcinoma (MCF-7) and melanoma cell (UACC-62) (Gálvez et al., 2003), MCF-7, MDA-MB-231, HeLaS3, A549, and KB cancer cell lines MCF-7, MDA-MB-231, HeLaS3, A549, and KB cancer cell lines (Kartini et al., 2017).

At an altitude of 3,161 m asl (above station VI), the species *Digitalis purpurea* L. was found in a very small population and was only found at this altitude. Each plant species requires suitable environmental conditions to live, so the living requirements of each species are different. There was a tolerance zone where forced seed breakage occurs naturally in an inappropriate environment; this occurs in a limited number of species and they cannot grow appropriately in those conditions (Steenis & Friedberg, 2018).

9. Digitalis purpurea L.

Digitalis purpurea L (Figure 10) was an upright herbaceous species, its height ranging from 30-50 cm. The soft steam with yellowish green dominated their steam. This species has a single leaf arrangement with a green color and both sides are hairy. *D. purpurea* L produces the cluster arrangements flower, has five petals, and the crown is purplish white. The fruit has a conical shape with fine hairs on the skin surface with a yellow color. Finally, the seeds have a flat round shape and are yellow when young and brown when they are old. Considering the Lazaro research, the *D. purpurea* contained the compound with suppressed and apoptosis-induced characteristics for the cancer cell (López-Lázaro, 2007). According to Fujino et al. (2015), cardenolide glycosides from *Digitalis purpurea* L. have selective cytotoxicity against renal adenocarcinoma and hepatocellular carcinoma cells, making them prospective anticancer therapeutic candidates (Fujino et

(a) (b)

Figure 9. Morphology of *Plantago major* L. in Lawu Mountain (a) habitus and (b) leaves & flowers


(a)


(b)

Figure 10. Morphology of *Digitalis purpurea* L. in Lawu Mountain (a) habitus and (b) leaves and flowers

al., 2015). *D. purpurea* was found outside the designated station, precisely at an altitude of 3,161 m asl. The community widely uses this plant as a medicinal plant, and it has the potential to be an anticancer. This species is only found at that altitude with a very small population.

B. Distribution and Abundance of Medicinal Plants Potentially Anticancer

The distribution and abundance of potentially anticancer medicinal plants along the Cemoro Sewu trail depended on environmental factors. The founded species with the location are displayed in Table 6..

The distribution pattern of anti-cancer plants is analyzed based on the frequency of presence and distribution patterns calculated using Eq 1 (Morishta Indeks). The processed data obtained from observations are shown in Table 7 with the number of individual plants counts per land area (Ha)..

At an altitude of 2,000 m asl (station I), only *R. chrysophyllus* species were found, which is 1 of 8 medicinal plant species with potential as anticancer. Medicinal plant species with anticancer potential at this station are indeed few because the station I is an area with quite a dense tree shade. The average light intensity measurement at the station I only shows 10.95 x 100 lux and is the lowest of the other observation stations. This causes sunlight not to penetrate the forest canopy to the forest floor, making it impossible for shrubs and bushes to develop in the shade of tree canopies, except

Table 6. Species of anti-cancer plants based on the station where they were found

No	Species	The Altitude (m asl)					
		2,000	2,200	2,400	2,600	2,800	3,000
1.	*Debregeasia longifolia* (Burm. f.) Wedd.	-	√	-	-	-	-
2.	*Rubus chrysophyllus* Miq.	√	√	-	-	-	-
3.	*Rubus lineatus* Bl.	-	√	√	√	√	√
4.	*Rubus fraxinifolius* Poir.	-	√	-	-	-	-
5.	*Rubus niveus* Thunb.	-	√	-	√	-	-
6.	*Hypericum leschenaultii* Choisy	-	-	-	√	√	√
7.	*Bryonia* sp.	-	√	-	-	-	-
8.	*Plantago major* L.	-	-	-	√	√	√

Table 7. Abundance, frequency, Morishita distribution index (Id) and distribution pattern of anticancer medicinal plants along the hiking trail.

No	Nama Spesies	Abundance (Individu per hectare)	Frequency (%)	Morishta index (Id)	Distribution pattern
1.	*Debregeasia longifolia* (Burm. f.) Wedd.	180	0.04	2.18	clumped
2.	*Rubus chrysophyllus* Miq.	470	0.21	0.87	regular
3.	*Rubus lineatus* Bl.	4,580	0.79	0.09	regular
4.	*Rubus fraxinifolius* Poir.	1,320	0.13	0.30	regular
5.	*Rubus niveus* Thunb.	250	0.13	1.64	clumped
6.	*Hypericum leschenaultii* Choisy	2,070	0.42	0.19	regular
7.	*Bryonia* sp.	5,000	0.08	2.00	clumped
8.	*Plantago major* L.	50,830	0.42	0.20	regular

for plant species that do live in the shade. (Arief, 1994). When cultivated in intricate and changing lighting conditions, plants actively fight with one another for the few available light sources. Chlorophylls and other pigments of the photosynthetic machinery absorb light once it reaches plant leaves and use it for photosynthesis (Xu, 2021). At an altitude of 2,200 m asl (station II), medicinal plant species with anticancer potential were found, namely *D. longifolia*, *R. chrysophyllus*, *R. lineatus*, *R. fraxinifolius*, *R. niveus*, and *Bryonia* sp. Station II has the highest number of medicinal plant species with anticancer potential and is the only station where all species of the genus Rubus can be found. However, not all Rubus species can grow optimally at station II. Environmental conditions at station II are the most optimal environment for the growth of *D. longifolia*, *R. fraxinifolius*, and *Bryonia* sp. species because the three species are only found in abundance at this station. The life of plant species in mountainous areas cannot be separated from the influence of abiotic components that make up the ecosystem. The ability of organisms to live in certain environmental conditions is called the tolerance range. Each species in the ecosystem has a tolerance limit so that other species found have their optimal environmental conditions for growth. At an altitude of 2,400 m asl (station III), only one medicinal plant species was found, namely *R. lineatus*. The richness of medicinal plant species that have the potential anticancer at this station is also small because station III has rocky soil conditions. Monk et al. (2000) stated that the distribution of plant species according to altitude is related to changes in soil type. Important changes in soil due to changes in altitude will affect the decrease in pH, increase in organic carbon, and decrease in rooting depth so that only certain plant species can adapt. *Digitalis purpurea* L. is widely used by the community as a medicine and has potential as an anticancer; besides, the location of the growth of this species is not far from the designated observation station. At an altitude of 3,161 m asl (above station VI) can be found *D. purpurea* species in a very small population and only located at this altitude. Each plant species requires appropriate environmental conditions to live, so the life requirements of each species are different, where they only occupy parts suitable for their lives (Djufri, 2002).

Figure 11 shows that *D. longifolia* was distributed in station II with an abundance of 1,100 individuals per hectare. The species of Rubus genus members are distributed

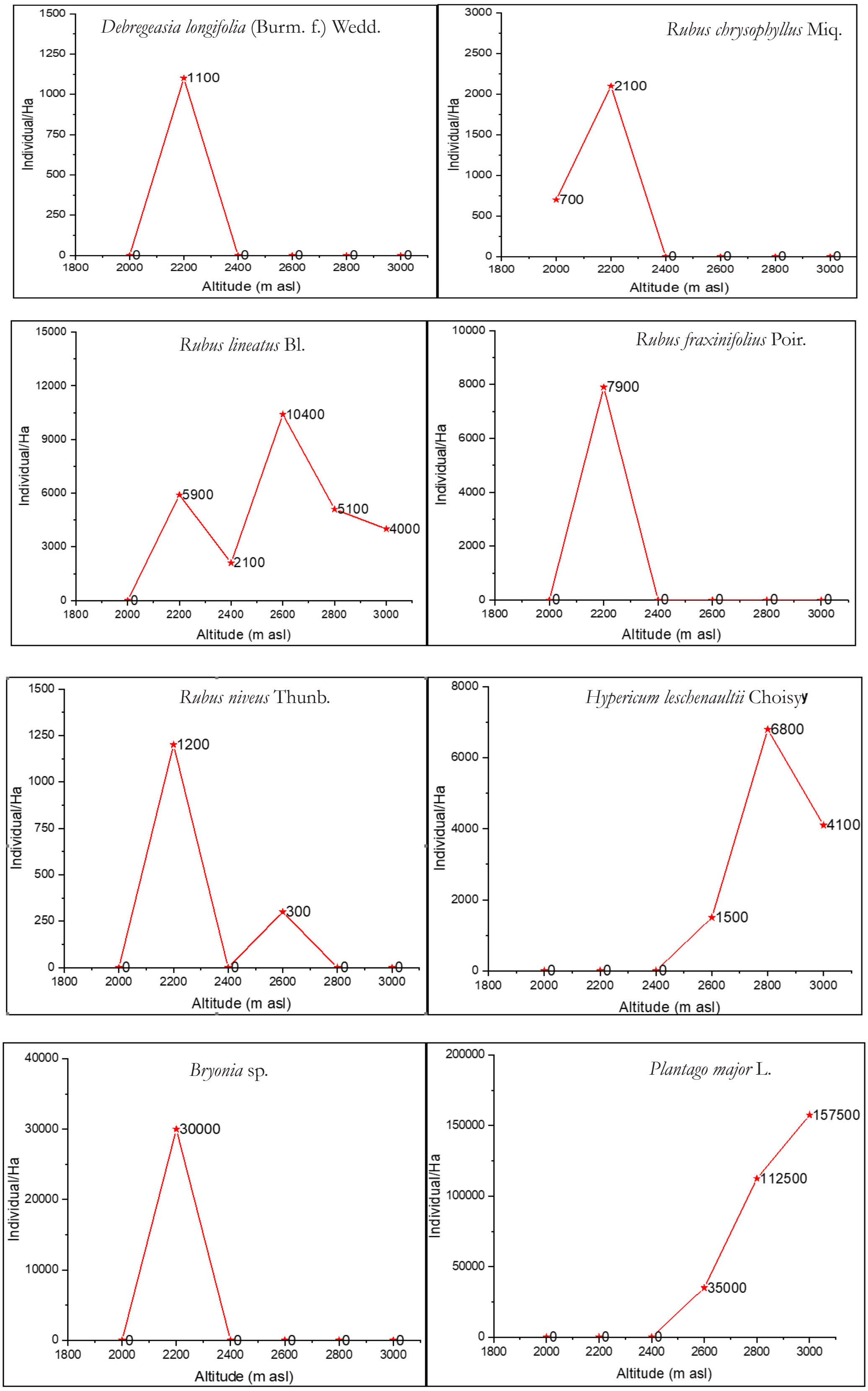


Figure 11. Graph of the abundance of each medicinal plant species potentially as anticancer in the Cemoro Sewu hiking trail observation station

and have different abundance values at each observed location. However, *R. lineatus* was the most widely distributed Rubus species along the stations. The highest abundance of *R. lineatus* was found at station IV where 10,400 individuals were found per hectare. According to station II, the species *R. chrysophyllus*, *R. fraxinifolius*, and *R. niveus* were found to have the highest abundance. In addition to Rubus species, there are also *Bryonia* sp. species with the highest abundance at station II, valued at 30,000 individuals per hectare. The adaptability of each species remained different, and it became possible that the species found along the trail were also different. Furthermore, the species with low-altitude habits are difficult to find in higher places. Additionally, station V was dominated by the *H. leschenaultii*, which was considered 6,800 individuals per hectare. The *P. major* species had the highest abundance value of 157,500 individuals per hectare compared to others in the observed station.

This exploration of the anticancer potential of plants in the Cemoro Sewu hiking trail is a finding with promising implications for discovering new cancer therapeutic agents from different altitudes. Plant growth's geographical location differences produce different secondary metabolite compound content (Rohmani et al., 2024). Although there have been several studies related to these plants, comprehensive studies that include phytochemical analysis, pharmacological studies, investigation of the mechanism of action, ecological assessment, and exploration of traditional uses can also be future research to validate the anticancer potential. It is essential to conserve Mount Lawu's biodiversity and ensure these natural resources' sustainable availability for future scientific exploration and potential therapeutic applications.

IV. CONCLUSION

Medicinal plants that potentially served as anticancer in the Cemoro Sewu hiking trail were found in six stations of eight species, such as *Debregeasia longifolia* (Burm. f.) Wedd., *Rubus chrysophyllus* Miq., *Rubus lineatus* Bl., *Rubus fraxinifolius* Poir., *Rubus niveus* Thunb., *Hypericum leschenaultii* Choisy, *Bryonia* sp., and *Plantago major* L., respectively. Medicinal plants that potentially served as anticancer in the Cemoro Sewu hiking trail, which is categorized as shrubs with specifically regular distribution patterns are *R. chrysophyllus*, *R. lineatus*, *R. fraxinifolius*, and *H. leschenaultii.* In contrast, the clumped distribution patterns are *D. longifolia* and *R. niveus*. On the other hand, the herbaceous category with a regular distribution pattern is *P. major*, while with a clumped distribution pattern is *Bryonia* sp. Medicinal plants that potentially served as anticancer in the Cemoro Sewu hiking trail have abundance values between 180-4,580 individuals per hectare for the shrub category and 5,000-50,830 individuals per hectare for the herb category, depending on the environmental conditions surrounding the hiking trails.

ACKNOWLEDGEMENT

The research was funded by Universitas Sebelas Maret Surakarta though the Hibah Riset Group (HRG) Scheme with contract number 228/UN27.22/PT.01.03/2023.

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