Vol. 11(2): 298-319, May 2023 DOI: https://doi.org/10.23960/jsl.v11i2.715

Jurnal Sylva Lestari

P-ISSN: 2339-0913
E-ISSN: 2549-5747

Journal homepage: https://sylvalestari.fp.unila.ac.id

Full Length Research Article

Naturalized Alien Plant as Traditional Medicine Resources: A Study from Cibodas Biosphere Reserve, West Java

Aisyah Handayani[1,3*], Ervizal Amir Muhammad Zuhud[2], Decky Indrawan Junaedi[3]

[1] Natural Resources and Environmental Management Science, Graduate School, IPB University. Kampus IPB Baranangsiang, Bogor, 16000, Indonesia
[2] Department of Forest Resource Conservation and Ecotourism, Faculty of Forestry and Environment, IPB University. Jl. Ulin, Kampus IPB Darmaga Bogor, 16680, Bogor, Indonesia
[3] Research Center for Ecology and Ethnobiology, National Research and Innovation Agency (BRIN). Jl. Raya Jakarta-Bogor Km. 46, Cibinong, Bogor, 16911, Indonesia
[*] Corresponding Author. E-mail address: aisyah.handayani@brin.go.id

ARTICLE HISTORY:

Received: 17 March 2023
Peer review completed: 6 June 2023
Received in revised form: 16 June 2023
Accepted: 24 June 2023

KEYWORDS:

Alien plant species
Cibodas Biosphere Reserve
Index Cultural Significance
Invasion risk
Medicinal plant

ABSTRACT

Cibodas Biosphere Reserve, with Gunung Gede Pangrango National Park as the core zone area, has an enormous number of naturalized alien species spread within it. There are 88 alien plant species, and more than 50% are utilized for many purposes. This research documented the utilization of these naturalized alien plant species, particularly for traditional medicine. Data were obtained by interviewing 90 respondents in three locations around Cibodas Biosphere Reserve using questionnaire sheets. The questionnaire used the Index Cultural Significance framework to quantify the value of every species for traditional medicine. The results showed that the community used 41 naturalized alien plant species from 15 families. Asteraceae is the family with the most widely used species and has various medicinal benefits. The most frequently treated health problems are anti-inflammatory, dental and oral health, and fever. ICS value showed that the utilization rate is low, yet these plants have promising properties as sources of natural medicine. Moreover, the utilization of these alien plants can be an option in controlling these species to prevent the invasion of Gunung Gede Pangrango National Park.

1. Introduction

Alien plant species are plants introduced into a new area all over the world outside their original range. Alien species successfully naturalized in a new area when the species established self-sustaining populations by reproducing in the wild without human intervention and thus become permanent parts of the flora (Milanović et al. 2020; Richardson and Pyšek 2013). The latest data shows that 13,168 alien plant species have been naturalized worldwide, at least 1,345 in the Malesia region (Holmes et al. 2023; van Kleunen et al. 2015).

Alien plant species become invasive when the species dominate an ecosystem and alter the ecosystem's function, causing ecological, social, and economic losses (Pyšek et al. 2020; Rai and Singh 2020; Setyawati et al. 2021). Invasive alien species are considered one of the most significant threats to native species diversity and ecosystem function. The spread of invasive plant species in Indonesia caused many adverse impacts on the environment and human well-being. The

most famous is the case of the massive spread of *Vachellia nilotica* in Baluran National Park (van Etten and Sutomo 2016; Zahra et al. 2020). In Sumatra, the invasion of *Merremia peltata* in Bukit Barisan Selatan National Park is also a notable conservation issue due to its negative impact on biodiversity (Duryat et al. 2023).

In Indonesia, the spread of alien plant species has been recorded in a number of conservation areas, especially national park areas. Padmanaba et al. (2017) recorded 67 naturalized alien plant species in several national parks in Java, one of which is the Gunung Gede Pangrango National Park (GGPNP). Gunung Gede Pangrango National Park is a national park that is the core zone of the Cibodas Biosphere Reserve, a pilot area for sustainable development (UNESCO 2011). More than 80 species of naturalized alien plants were recorded in this area, with 50% potentially invasive (Handayani et al. 2021a; Handayani and Hidayati 2020). Cibodas Biosphere Reserve is the site for understanding and managing biodiversity also interactions between social and ecological systems; thus, controlling the spread of alien plant species in the CBC area is challenging. On the other hand, our previous research found many alien plant species used by the community, with the highest utilization in traditional medicine (Handayani et al. 2021b).

Based on this information, this study would like to record the local knowledge about the utilization of these naturalized alien plant species as a traditional medicine from communities around Cibodas Biosphere Reserve. Although the study on ethnomedicine has been widely carried out in many places or communities in Indonesia, the study with the specific object of naturalized alien plant species utilization has not been recently studied. Furthermore, this utilization data is expected as the novelty input in controlling these alien plant species because the approach to managing invasive alien species through utilization has not been widely implemented in Indonesia.

2. Materials and Methods

2.1. Research site

The study was conducted sampling and data collection from October to December 2020 in three buffer zones of Cibodas Biosphere Reserve (CBR), directly located next to the CBR core zone: Bodogol, Cibodas, and Gekbrong (**Fig. 1**). The elevation of the sampling location in Bodogol is approximately 600 masl. Sampling locations in the Cibodas area range from 1100–1200 masl. The Gekbrong area sampling location is located at 1200 masl.

2.2. Data collections

This research interviewed 90 respondents with a number of questions on questionnaire sheets. Selecting the respondent used a simple random sampling method because all the community members assumed they had an equal chance of utilizing alien plant species. The questionnaire was designed to quantify the value of every species utilization for traditional medicinal purposes using the Index of Cultural Significance by Turner (1988). The questionnaire was made in a mixed structure, with a number of questions regarding the name (local name) of the used species, the parts of the plants used (choice given: leaves, fruits, seeds, bark, flowers, all parts, and other), the type of disease being treated, processing method, the source of the plants (yard, farm, forest edges, or in the forest area), the frequency of utilization (rarely to often; score given 1-5), and the level of preference to the used plant species (score given: 0.5, 1, and 2). To ensure that the used plant species are alien plant species, the identification process is carried out to know the scientific name of the used plant species. The identification of these alien plants is

performed by picking the samples of these plants and documenting them for identification process by field assistant. In addition, identification is also strengthened by searching through online databases, accessed on World Flora Online's database (WFO 2023) and Plants of the World Online by the Royal Botanic Gardens Kew (POWO 2023). Questionnaires with species that have been identified as alien plant species are processed to calculate the ICS value.

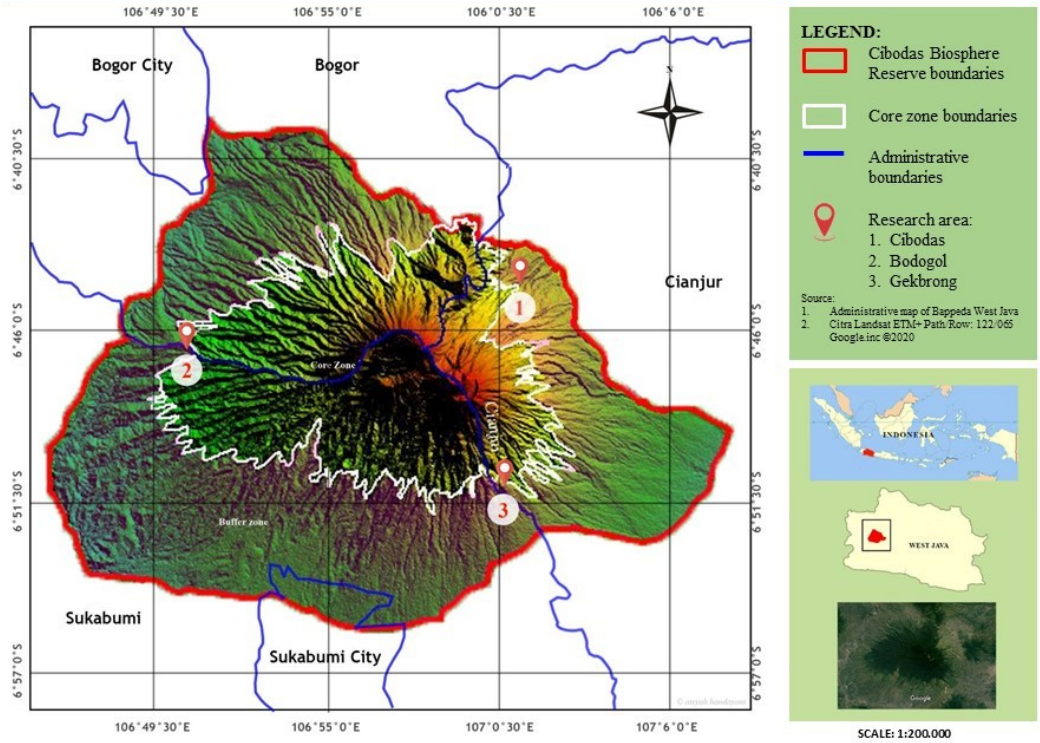

Fig. 1. Research site within Cibodas Biosphere Reserve area: Bodogol, Cibodas, and Gekbrong.

2.3. Data analysis

This study used the Index of Cultural Significance (ICS) as the questionnaire framework. ICS is a method to quantify the importance value of utilized species by communities (Turner 1988). The value obtains from species utilization (in this case, category as a medicine given score 3), utilization intensity (score given 1-5), and the exclusivity or preferences of the species (score 0.5, 1, and 2) (Turner 1988). Data from the questionnaire was processed into Microsoft Excel to calculate the ICS value. Calculating ICS value using the following formula:

$$ICS = \sum_{i=1}^{n} (q \; x \; i \; x \; e) u_i \qquad (1)$$

where *ICS* is the Index of Cultural Significance, *q* is utilization quality, *i* is the intensity of utilization, *e* is the level of preference of species utilization, and *n* is the utilization category (this study only used the medicine category).

The result of the calculation was classified based on the categorization proposed by Turner (1988): ICS > 100 (very high significance), 50-99 (high significance), 20-49 (medium significance), 5-19 (low significance), 1-4 (very low significance). The ICS value of each species was analyzed based on the practice of its utilization.

3. Results and Discussion

3.1. Naturalized Alien Plant Species for Medicinal Purposes

The results of this study show that the communities utilize 41 naturalized alien plant species (NAPS) from 15 families, with Asteraceae and Solanaceae as the dominant families (**Fig. 2**). As the largest family number from angiosperms, Asteraceae has about 25,000 species distributed worldwide and is widely known has many potential uses, such as medicinal plants (Fauziana and Susandarini 2019). Unsurprisingly, this family has become dominant in its utilization of traditional medicine. Its abundance around the community makes people easy to gather it for many purposes.

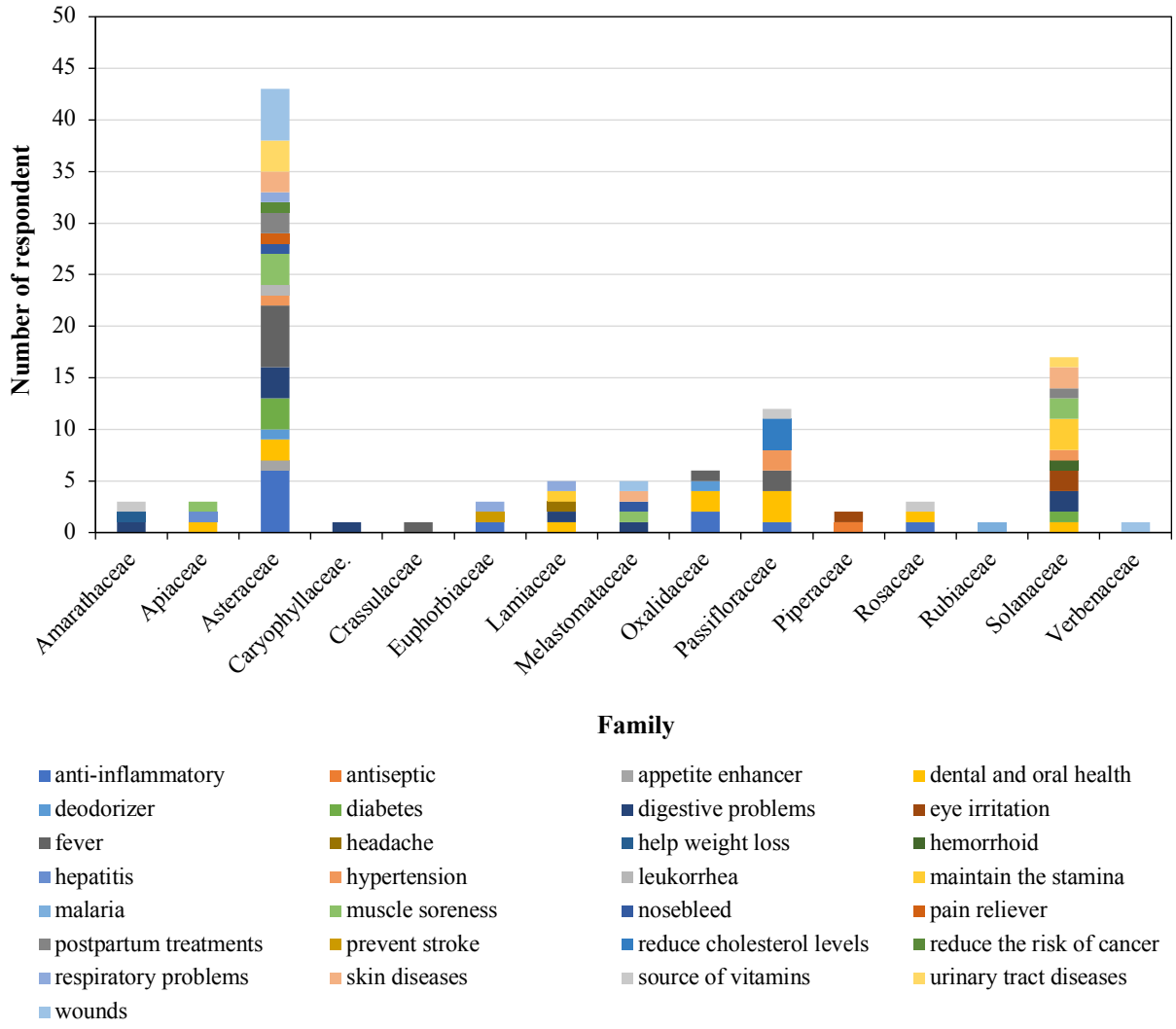

Fig. 2. Health problem categories treated per family.

From three research locations, 39 respondents in Cibodas used as many as 38 species, 29 respondents in Bodogol used 16 species, and 22 respondents used only seven species in Gekbrong. The respondent number difference from each location depends on the community's voluntary participation in the questionnaire. Then, the difference in utilized species number from each location depends on the respondents' knowledge. In this utilization activity, the most well-known species by respondents from the three locations were *Ageratum conyzoides, Artemisia vulgaris (Asteraceae), Kalanchoe pinnata (Crassulaceae),* and *Physalis peruviana* (Solanaceae). These four species are well known in all research locations, except *Artemisia vulgaris,* only in Cibodas

and Bodogol. The practice of using these species is quite common in Indonesia. It was recorded in several ethnobotanical studies, both *Ageratum conyzoides* (Navia et al. 2022; Supiandi et al. 2019), *Artemisia vulgaris* (Rohman et al. 2019), *Kalanchoe pinnata* (Rambey and Lubis 2022), and *Physalis peruviana* (Oktavia et al. 2017) are widely known for their efficacy.

The results showed that Asteraceae is the most widely used to treat a number of diseases. As many as 18 categories of health problems can be treated by species from Asteraceae (**Fig. 2**), ranging from anti-inflammatory, appetite enhancers, dental and oral health, deodorizers, diabetes, digestive problems, fever, hypertension, leukorrhea, muscle soreness, nosebleed, pain reliever, postpartum treatment, reduce risk of cancer, respiratory problems, skin diseases, urinary tract diseases, and wound. The high diversity of Asteraceae species is in line with the number of health problems that can be treated.

Based on ICS calculation, no species had high ICS scores. Only one species had a moderate ICS score, namely *Fragaria vesca*, while the remaining 23 had low ICS, and 17 had very low ICS scores. Most utilized NAPS have low ICS scores, indicating that NAPS utilization for medicinal purposes is rarely practiced. This means that the community is not dependent on these NAPS for medicinal needs. However, based on the utilization practices of this community, the properties obtained from these NAPS are potentially developed as natural medicine sources.

3.2. Health Benefit, Biological Activities and Future Potential of Naturalized Alien Plant Species as Natural Medicinal Resources

Data from respondents show there are 29 health problem categories treated by these NAPS, such as dental and oral health, eye irritation, wound, skin diseases, and postpartum treatment (**Fig. 2**). The most efficacy of plant species are to treat inflammation or anti-inflammatory properties, maintain dental and oral health, and relieve fever. Species that are efficacious as anti-inflammatory are *Amaranthus spinosus, Bidens pilosa, Biophytum intermedium, Blainvillea acmela, Cosmos caudatus, Fragaria vesca, Oxalis corniculata, Passiflora ligularis, Euphorbia hirta, Galinsoga parviflora, Ageratum conyzoides, Austroeupatorium inulifolium*. Species that are used for treating oral and dental health are *Erechtites valerianifolius, Mentha arvensis, Bidens pilosa, Biophytum intermedium, Eryngium foetidum, Fragaria vesca, Oxalis corniculata, Passiflora edulis, Passiflora ligularis, Passiflora suberosa, Solanum americanum,* and *S. betaceum*. To relieve fever, the plant species used are *Ageratina riparia, Ageratum conyzoides, Artemisia vulgaris, Cosmos caudatus, Galinsoga parviflora, Kalanchoe pinnata, Oxalis corniculata, Passiflora edulis, Passiflora suberosa, Tithonia rotundifolia*, and *Solanum americanum.*

In addition to the efficacy of these NAPS, a literature search was conducted to find pharmacological effects for each species. Several studies regarding pharmacological studies have revealed the importance of several compounds owned by these NAPS (**Table 1**). Therefore, these species can be developed as a source of modern natural-based medicine. There is a number of their potential for treating several types of diseases which are major health problems such as diabetes (Puente et al. 2019), hypertension (Ahda et al. 2023; Darkwah et al. 2020), some cancers (Irani et al. 2022; Kumar et al. 2020), as well as antivirals such as those for COVID-19 treatment (Khan 2021; Mekam et al. 2019). In developing countries, plant-derived medicine continues to increase in traditional and modern medicine. For example, *A.conyzoides* has been used as an antiseptic, antihemorrhagic, antileprosy, and wound-healing (Kotta et al. 2020).

Table 1. Summary of the utilization of naturalized alien plant species based on questionnaires

No.	Family	Species	Lifeform	Used part	Medicinal use	Formulation	Pharmacological effects	References
1	Amarathaceae	*Amaranthus spinosus*	Herbs	Leaves, stems	Help to improve digestive health, weight loss, heartburn, sore throat, and source of vitamins for children's growth	Young leaves and stems are steamed and consumed as a side dish	Anti-inflammatory, antioxidant, antidiabetic, antimicrobial, diuretic, antimalarial, anti-ulcer, antipyretic, anti-androgenic, anthelmintic, antigenic, and immunomodulatory activity	(Abir and Ahmad 2021; Ganjare and Raut 2019)
2	Apiaceae	*Eryngium foetidum*	Herbs	All parts	Canker sore, muscle soreness, hepatitis	Drink the decoction from boiled parts of the plant	Antimicrobial, antioxidant, anti-inflammatory, and antidiabetic potential	(Paw et al. 2022; Silalahi 2021)
3	Asteraceae	*Cosmos caudatus*	Herbs	Leaves	Sore throat, cough, fever, hypertension, diabetes, and reduce the risk of cancer.	Sore throat, cough, fever (fresh leaves consumed as a side dish), hypertension, diabetes, and reduced risk of cancer (drink the decoction from boiled leaves)	Antidiabetic, antioxidant, anti-inflammation, antibacterial, antifungal, anti-osteoporosis, anti-hyperlipidemic, anticancer, antihypertensive, antihepatoprotective, and to manage fertility problems	(Ahda et al. 2023)
4	Asteraceae	*Artemisia vulgaris*	Herbs	Leaves	Pain reliever, typhoid fever, rheumatism, itchy skin, reduced body odor	Pain reliever, typhoid fever, rheumatism, itchy skin (drink the decoction from boiled leaves), reduce body odor (crush the leaves for dermal application, and drink the decoction from boiled leaves)	Antioxidant, antispasmolytic, antinociceptive, hepatoprotective, cytotoxic, estrogenic, antibacterial, and antifungal effects	(Eikert et al. 2020)
5	Asteraceae	*Ageratina riparia*	Herbs	All parts	Fever, diarrhea, wounds, breastmilk booster	Fever, diarrhea, breastmilk booster (drink the decoction from boiled all parts of the plant), wounds (crushed the leaves for dermal application)	Antifungal activity against banana disease by fungus	(Ratnayake et al. 2018)
6	Asteraceae	*Ageratum conyzoides*	Herbs	All parts	Nosebleed, fever, wounds, gastritis	Wounds, nosebleeds (crushed the leaves for dermal application), fever, gastritis (drink the decoction from boiled all parts of the plant)	Antifungal activity, antioxidant, anticancer, antimicrobial, anti-inflammatory, analgesic, antiprotozoal, antidiabetic, spasmolytic, allelopathy	(Chahal et al. 2021; Yadav et al. 2019)

No.	Family	Species	Lifeform	Used part	Medicinal use	Formulation	Pharmacological effects	References
7	Asteraceae	*Austroeupatorium inulifolium*	Shrubs	Leaves, stems	Diabetes, gastritis, itchy skin, treat bee stings	Diabetes, gastritis (drink the decoction from boiled leaves), itchy skin (the decoction water from leaves and stems is used for bathing, and the boiled leaves and stems are used to scrub the itchy skin)	The bactericidal activity of all compounds was evaluated against four bacterial strains: *Staphylococcus aureus, Enterococcus faecalis, Escherichia coli,* and *Pseudomonas aeruginosa*	(Chacón-Morales et al. 2019)
8	Asteraceae	*Bidens pilosa*	Herbs	Leaves	Sore throat, toothache, postpartum treatment, leukorrhea	Sore throat (fresh leaves consumed as a side dish), toothache, postpartum treatment, leukorrhea (drink the decoction from boiled leaves)	Antimetabolic activities and anti-coccidial potency	(Kuo et al. 2021; Yang et al. 2019)
9	Asteraceae	*Erechtites valerianifolius*	Herbs	Leaves	Reduce halitosis, appetite enhancer, and back pain	Fresh leaves are consumed as a side dish, or drink the decoction from boiled leaves	Antioxidant activity and mosquito larvicidal activity	(Hung et al. 2019; Puspaningtyas et al. 2020)
10	Asteraceae	*Ageratum houstonianum*	Herbs	All parts	Diarrhea, wounds	Diarrhea (drink the decoction from boiled all parts of the plant), wounds (crushed the leaves for dermal application)	Repellent, antifeedant, and larvicidal activities	(Hadidy et al. 2022)
11	Asteraceae	*Blainvillea acmella*	Herbs	All parts	Sore throat, muscle soreness	Drink the decoction from all boiled parts of the plant	Antioxidant and anti-osteoporosis agent	(Abdul Rahim et al. 2022)
12	Asteraceae	*Galinsoga parviflora*	Herbs	Leaves	Fever, gastritis	Drink the decoction from boiled leaves	Antibacterial, antifungal, antioxidant, anti-inflammatory, nematicidal effects, anti-inflammatory, hyaluronidase-inhibiting activities, and wound healing	(Ali et al. 2017; Studzińska-Sroka et al. 2018)
13	Asteraceae	*Sonchus arvensis*	Herbs	All parts	Nephrolithiasis, laxative	Nephrolithiasis treatment (drink the decoction from boiled leaves), laxative (drink the decoction from boiling all parts of the plant)	Antioxidant activity, anti-fatigue effects, and antiplasmodial activity	(Wahyuni et al. 2021; Yuan et al. 2019)

No.	Family	Species	Lifeform	Used part	Medicinal use	Formulation	Pharmacological effects	References
14	Asteraceae	*Sonchus oleraceus*	Herbs	All parts	Nephrolithiasis, diuretic	Drink the decoction from all boiled parts of the plant	Gastroprotective effects, a natural antioxidant, and anti-cholinesterase	(Aissani et al. 2022; Vecchia et al. 2022)
15	Asteraceae	*Tithonia rotundifolia*	Herbs	Leaves	Diabetes, fever	Drink the decoction from boiled leaves	Antimycobacterial treatments	(Omokhua et al. 2019)
16	Asteraceae	*Sonchus asper*	Herbs	All parts	Wounds	Drink the decoction from all boiled parts of the plant	Against free-radical-associated oxidative damage	(Khan et al. 2012)
17	Asteraceae	*Sphagneticola trilobata*	Herbs	Leaves	Wounds	Crushed the leaves for dermal application	Antidiabetic, antioxidant, antitumor, anti-inflammatory, and cytotoxic activity	(Buddhakala and Talubmook 2020; Mardina et al. 2020; Sun et al. 2020)
18	Asteraceae	*Taraxacum officinale*	Herbs	All parts	Diuretic	Drink the decoction from all boiled parts of the plant	Hepatoprotective, antioxidant, anticancer, anticoagulant, and anti-platelet activities	(Jedrejek et al. 2019; Di Napoli and Zucchetti 2021)
19	Caryophyllaceae	*Stellaria media*	Herbs	Leaves	Flatulence	Crushed the leaves for dermal (belly skin) application	Anti-obesity, antifungal, antibacterial, antioxidant, anti-proliferative, anti-inflammatory, antioxidant, wound-healing, analgesic, antidiabetic, and anxiolytic activities,	(Miere (Groza) et al. 2021; Oladeji and Oyebamiji 2020)
20	Crassulaceae	*Kalanchoe pinnata*	herbs	leaves	Fever	Crushed the leaves for dermal (forehead) application	Anti-inflammatory activity and adjuvant in cancer treatment	(de Araújo et al. 2019; Hernández-Caballero et al. 2022)
21	Euphorbiaceae	*Euphorbia hirta*	Herbs	All parts	Dyspnea, prevent stroke, gastritis	Dyspnea (drink the decoction from boiled leaves), prevent stroke (drink the decoction from boiled all parts of the plant), gastritis (drink the decoction from boiled leaves and stems)	Antimicrobial, antimalarial, anti-asthmatic, antioxidant, anticancer, antifungal, and antiviral. Antiviral agents are possible as an application to control COVID-19	(Khursheed et al. 2022; Mekam et al. 2019)

No.	Family	Species	Lifeform	Used part	Medicinal use	Formulation	Pharmacological effects	References
22	Lamiaceae	*Mentha arvensis*	Herbs	Leaves	Reduce halitosis, headache, warm up the body/maintain stamina, flatulence, cough	Reduce halitosis (fresh leaves consumed as a side dish), headache (crushed the leaves for dermal application, warm up the body/maintain stamina, flatulence, cough (drink the decoction from boiled leaves.	Antibacterial, antifungal, and natural larvicide and repellent against *Aedes aegypti*	(Ahmad et al. 2020; Manh and Tuyet 2020)
23	Melastomataceae	*Clidemia hirta*	Shrubs	Leaves	Diarrhea, muscle soreness, nosebleed, ulceration, wounds	Diarrhea, muscle soreness (drink the decoction from boiled leaves), nosebleed (roughly crush the leaves, and apply them to the bleeding nose), ulceration, wounds (crush the leaves for dermal application)	Antibacterial activity against *Staphylococcus aureus* and *S. typhi*	(Pratami et al. 2021)
24	Oxalidaceae	*Oxalis corniculata*	Herbs	Leaves	Fever, canker sore, sore throat	Fresh leaves consumed as a side dish, or drink the decoction from boiled leaves.	Antioxidant, anticancer, anthelmintic, anti-inflammatory, antimicrobial, astringent, diuretic, febrifuge, cardio-relaxant, and wound healing potential	(Sarfraz et al. 2022; Sarkar et al. 2020)
25	Oxalidaceae	*Biophytum intermedium*	Herbs	Leaves	Canker sore, sore throat	Fresh leaves consumed as a side dish, or drink the decoction from boiled leaves		
26	Oxalidaceae	*Oxalis barrelieri*	Herbs	Leaves	Remove the fishy smell	Fresh leaves are consumed as a side dish	Bacteriostatic, antidiarrheal, and reduces damages caused to intestinal mucosa barrier by pathogenic mechanisms of Shigella.	(Fokam Tagne et al. 2018)
27	Passifloraceae	*Passiflora edulis*	Vines	Fruit	Canker sore, reduce cholesterol levels, hypertension, fever	Consume the fruit	Antioxidant, anticancer against various tumor cell lines, and antibacterial on meat as a food preservative	(He et al. 2020; Ramli et al. 2020)
28	Passifloraceae	*Passiflora ligularis*	Vines	Fruit	Canker sore, reduce cholesterol levels, sore throat, source of vitamin C	Consume the fruit	Antioxidants and good inhibition of the tyrosinase enzyme	(Wiliantari et al. 2022)

No.	Family	Species	Lifeform	Used part	Medicinal use	Formulation	Pharmacological effects	References
29	Passifloraceae	*Passiflora suberosa*	Vines	Fruit	A canker sore, reduce cholesterol levels, hypertension, fever	Consume the fruit	Antibacterial activities against all the strains of gram-negative and gram-positive bacterial	(Bandara et al. 2018)
30	Piperaceae	*Piper aduncum*	Small tree	Leaves	Eye irritation, antiseptic	The decoction from boiled leaves used as eye drops or antiseptic	Insecticide, acaricide and antiparasitic	(Durofil et al. 2021)
31	Rosaceae	*Fragaria vesca*	Herbs	Fruit	Source of vitamin C, canker sore, sore throat	Consume the fruit	Antioxidant activity	(Couto et al. 2020)
32	Rubiaceae	*Cinchona pubescens*	Tree	Bark	Malaria	Drink the decoction from brewed crushed bark	Quinine for antimalaria	(McCarthy and Price 2020; Nair 2021)
33	Solanaceae	*Solanum americanum*	Herbs	Leaves, fruit	Maintain stamina, canker sore, common cold, flatulence, fever	Maintain stamina and canker sore (consume mature fruit), common cold, flatulence (crushed the leaves for dermal application, fever (drink the decoction from boiled leaves)	Hepatoprotective, antitumor, immunomodulatory, anti-ulcer, calming, hostile to convulsant, cardio-defensive, antibacterial, antidiabetic, pain-relieving, antioxidant, and antiradical scavenging activity	(Campisi et al. 2019; Mani et al. 2022; Ogundola et al. 2022)
34	Solanaceae	*Physalis peruviana*	Herbs	All parts	Diabetes, muscle soreness, postpartum treatment, hemorrhoid	Diabetes (drink the decoction from boiled leaves and stems), muscle soreness, postpartum treatment, hemorrhoid (drink the decoction from boiling all parts of the plant or consume the fruit)	Antioxidant and antimicrobial	(El-Beltagi et al. 2019)
35	Solanaceae	*Solanum betaceum*	Small tree	Fruit	A canker sore, diabetes, hypertension, laxative	Consume the fruit	Possesses higher antioxidant activity than apples and kiwifruit, antimicrobial, antifungal, and antibacterial activity against *E. coli, P. aeruginosa*, and *S. aureus*	(Diep et al. 2020, 2021, 2022)

No.	Family	Species	Lifeform	Used part	Medicinal use	Formulation	Pharmacological effects	References
36	Solanaceae	*Solanum torvum*	Shrubs	Fruit	Back pain, diuretic, maintaining stamina, hypertension	Back pain, diuretic, maintaining stamina (drink the decoction from boiled mature fruits and consume the boiled fruits), hypertension (consume boiled fruits or fresh fruits)	Antibiotics, cardio, and nephro protection, antihypertensive, analgesic, anti-inflammatory, anti-ulcer, antimicrobial activities	(Darkwah et al. 2020; Khunbutsri et al. 2022)
37	Solanaceae	*Brugmansia candida*	Small tree	Flower	Eye irritation	Water from a bud flower is used as eye drops	Anti-inflammatory, cytotoxic, antioxidant, antibacterial, antispasmodic, anti-asthmatic, antinociceptive, antiprotozoal, and larvicidal activity against *Aedes aegypti* and *C. quinquefasciatus*	(Algradi et al. 2021; Himmi et al. 2020)
38	Solanaceae	*Brugmansia suaveolens*	Small tree	Flower	Eye irritation	Water from a bud flower is used as eye drops	Analgesic, antimicrobial antinociceptive, wound healing, nematicidal, and immunomodulation-mediated anticancer activity	(Kumar et al. 2020; Petricevich et al. 2020; Pundir et al. 2022)
39	Solanaceae	*Cestrum aurantiacum*	Shrubs	Leaves	Itchy skin	Crushed the leaves for dermal (itchy skin) application	Antimicrobial	(Sivaraj et al. 2015)
40	Solanaceae	*Cestrum elegans*	Shrubs	Leaves	Itchy skin	Crushed the leaves for dermal (itchy skin) application	Antifungal and antiviral	(Nasr et al. 2021)
41	Verbenaceae	*Stachytarpheta jamaicensis*	Herbs	Leaves	Wounds	Crushed the leaves for dermal application	Anti-inflammatory, antioxidant, antidiabetic, and antibacterial activities against gram-positive bacteria only	(Eskander et al. 2021; Idu et al. 2021; Khan et al. 2020)

3.3. Utilization of Naturalized Alien Plant Species as a Management Option

Plant invasions are a complex social-ecological phenomenon (Vaz et al. 2017). Invasive plants were introduced and cultivated intentionally in the past, intended to fulfill socioeconomic and cultural value for communities (Arrington 2021). The use of alien plant species as shortcuts to create "ideal" conditions for an area is also often used, in the case of parks or urban forests, because they are easier to obtain and usually are fast-growing species (Heriyanto et al. 2023). This causes the use of these NAPS could be commonly practiced considering the original purpose of their introduction. In this study, the NAPS utilization as medicine is not a high activity rate in the community around Cibodas Biosphere Reserve. However, considering the medicinal potential possessed by the properties of these NAPS, this utilization activity should still be practiced. The results of interviews showed the use of NAPS as medicine to treat a number of minor ailments such as wounds, flatulence, toothache, canker sores, fever, common cold, or diarrhea. Thus, the use of NAPS can be consistently practiced as first aid for minor ailments in the community. The utilization of these species, especially if harvesting the parts of the plant related to their reproduction, can indirectly reduce or control the spread of the species. Thus, the spread of these NAPS can be controlled and minimize invasion risk, especially in Gunung Gede Pangrango National Park area.

These NAPS can also be made as medicinal plant simplicia for long-lasting storage. Harvesting large amounts of NAPS for drying can also be processed into *jamu*, a form of herbal medicine. Furthermore, the community can commercialize herbal medicine as one of the local products of Cibodas Biosphere Reserve's community. This practice, along with studies on plant species and their phytochemical content comprehensively, considers their use as medicine which needs precaution. In the end, the activity of utilizing NAPS is not only useful for controlling the NAPS population but also as the form of preserving traditional knowledge owned by the community.

The utilization of NAPS as the management option has been carried out in several sites. The other study on NAPS as traditional medicine was also carried out in South Africa, which recorded 89 invasive plant species (McGaw et al. 2022). In Indonesia, *Merremia peltata*, an invasive species in Bukit Barisan Selatan National Park, Sumatra, is used as animal feed to control its spread (Garsetiasih et al. 2019), and its biomass can be processed as organic fertilizer or soil enhancer (Duryat et al. 2023). Apart from medicine, the utilization of NAPS also includes the production of biochar from Ragweed and horseweed to efficiently adsorb Cd (II) and Pb (II) (Lian et al. 2020), charcoal production from *Prosopis juliflora* (Tabe-Ojong 2023), also animal feed and organic fertilizer from water hyacinth (Yan et al. 2017). *Centrosema pubescens*, known as an invasive weed species, also has the potential as forage under pine stands at Forest Area with Special Purpose in Mount Bromo (Zaki et al. 2022). Another utilization comes from the aquatic ecosystem in the Mediterranean basin, which harvests invasive fish species to use their poison for cosmetic industry purposes (Papadaki et al. 2022).

Consideration about the invasive risk, there is a critical stage between naturalized species into invasive species. Many factors play a role in making a species invasive. However, the main factor that causes the spread of an alien species to a location to become uncontrollable is associated with traits of the species, traits of recipient communities, and species-community interactions (Catford et al. 2019). Some traits associated with plant invasiveness are specific leaf area, growth

rate, flowering phenology, higher fecundity, and seed dispersal mechanism (Milanović et al. 2020).

Search results of the invasive status of these used NAPS showed that 39 species are included in the invasive species list in the CABI Compendium (CABI 2022), and 14 species of them are invasive species in Indonesia (KLHK 2016; Tjitrosoedirdjo et al. 2016a). The 14 invasive species in Indonesia are *Ageratina riparia, Bidens pilosa, Brugmansia suaveolens, Erechtites valerianifolius, Stachytarpheta jamaicensis, Austroeupatorium inulifolium, Cestrum aurantiacum, Cinchona pubescens, Clidemia hirta, Passiflora edulis, Passiflora ligularis, Piper aduncum, Sphagneticola trilobata,* and *Tithonia rotundifolia*. However, these invasive plant characteristics may not be the same as the condition of the species in the Cibodas Biosphere Reserve.

Therefore, it is necessary to have a risk analysis to assess the invasive risk of each species. The number of species traits and different environmental conditions resulted in different risks for each species in different locations. It causes a species can be invasive in one location while not in another. However, through a risk assessment, it can be known which species have a high risk of invasiveness and which are not at risk of being invasive so that the utilization of their populations can still be controlled, especially those in forest areas. There are two invasive risk analyses in the form of pre-border and post-border in Indonesia (Tjitrosoedirdjo et al. 2016a; Tjitrosoedirjo et al. 2016b). This risk analysis scheme is by scoring some questions and statements regarding the traits of the species and its environmental conditions. In the pre-border analysis, the result score determines whether the species is potentially invasive. In contrast, in the post-border analysis, the score will determine the management for handling the species in the field.

In this case, because most of the species used come from the environment around the community's settlement, such as yards and gardens, the risk analysis that can be applied is pre-border analysis. The results will indicate which species have high or low invasive potential. Species with low risk can be utilized optimally for the community's needs. In contrast, high-risk species need precaution in their utilization so that these species do not spread widely, especially into TNGGP forest areas. In the end, the community still practices the NAPS utilization as a medicinal plant to fulfill their healthcare need. At least, regular use of NAPS for medicinal purposes is expected to control the spread of NAPS while preserving the community's traditional knowledge.

4. Conclusions

Utilizing naturalized alien plant species as a source of raw materials for natural medicines benefits the community. Most of the used species have proven to have pharmacological effects that benefit health needs. Nevertheless, the precautional principle is needed in this utilization, especially for species declared invasive in Indonesia. Thus, it is necessary to have a risk analysis for each used species to determine the risk of invasiveness. Furthermore, harvesting these species can be a management option to control the spread of these species to avoid invasion risk into the Gunung Gede Pangrango National Park area. This utilization also to preserves the traditional knowledge of the community around Cibodas Biosphere Reserve.

Acknowledgments

The authors thank LPDP for the research funding support. The authors also thank Mr. Muslim from Cibodas, Mr. Jamaludin from Bodogol, and Mr. Uden from Gekbrong, who supported all fieldwork activities and the questionnaire survey data collection.

References

Abdul Rahim, R., Jayusman, P. A., Lim, V., Ahmad, N. H., Abdul Hamid, Z. A., Mohamed, S., Muhammad, N., Ahmad, F., Mokhtar, N., Mohamed, N., Shuid, A. N., and Naina Mohamed, I. 2022. Phytochemical Analysis, Antioxidant and Bone Anabolic Effects of *Blainvillea acmella* (L.) Philipson. *Frontiers in Pharmacology* 12(796509): 1–19. DOI: 10.3389/fphar.2021.796509

Abir, M. H., and Ahmad, M. 2021. Phytochemical, Nutritional and Pharmacological Potentialities of *Amaranthus spinosus* Linn.: A review. *Archives of Ecotoxicology* 3(2): 49–59. DOI: 10.36547/ae.2021.3.2.49-59

Ahda, M., Jaswir, I., Khatib, A., Ahmed, Q. U., and Syed Mohamad, S. N. A. 2023. A Review on *Cosmos caudatus* as a Potential Medicinal Plant Based on Pharmacognosy, Phytochemistry, and Pharmacological Activities. *International Journal of Food Properties* 26(1): 344–358. DOI: 10.1080/10942912.2022.2158862

Ahmad, W., Jaiswal, K. K., and Soni, S. 2020. Green Synthesis of Titanium Dioxide (TiO2) Nanoparticles by Using *Mentha arvensis* Leaves Extract and Its Antimicrobial Properties. *Inorganic and Nano-Metal Chemistry* 50(10): 1032–1038. DOI: 10.1080/24701556.2020.1732419

Aissani, F., Grara, N., Bensouici, C., Bousbia, A., Ayed, H., Idris, M. H. M., and Teh, L. K. 2022. Algerian *Sonchus oleraceus* L.: A Comparison of Different Extraction Solvent on Phytochemical Composition, Antioxidant Properties and Anti-Cholinesterase Activity. *Advances in Traditional Medicine* 22(2): 383–394. DOI: 10.1007/s13596-021-00553-y

Algradi, A. M., Liu, Y., Yang, B.-Y., and Kuang, H.-X. 2021. Review on the Genus Brugmansia: Traditional Usage, Phytochemistry, Pharmacology, and Toxicity. *Journal of Ethnopharmacology* 279(113910): 1–28. DOI: 10.1016/j.jep.2021.113910

Ali, S., Zameer, S., and Yaqoob, M. 2017. Ethnobotanical, Phytochemical and Pharmacological Properties of *Galinsoga parviflora* (Asteraceae): A Review. *Tropical Journal of Pharmaceutical Research* 16(12): 3023–3033. DOI: 10.4314/tjpr.v16i12.29

Arrington, A. 2021. Urban Foraging of Five Non-Native Plants in NYC: Balancing Ecosystem Services and Invasive Species Management. *Urban Forestry and Urban Greening* 58(126896): 1–5. DOI: 10.1016/j.ufug.2020.126896

Bandara, K. R. V, Padumadasa, C., and Peiris, D. C. 2018. Potent Antibacterial, Antioxidant and Toxic Activities of Extracts from *Passiflora suberosa* L. Leaves. *PeerJ* 6(5): e4804. DOI: 10.7717/peerj.4804

Buddhakala, N., and Talubmook, C. 2020. Toxicity and Antidiabetic Activity of Ethanolic Extract of *Sphagneticola trilobata* (L.) Pruski Flower in Rats. *Journal of Ethnopharmacology* 262(113128): 1–7. DOI: 10.1016/j.jep.2020.113128

CABI. 2022. *CABI Compendium Invasive Species, CABI Digital Library*. CABI Compendium Invasive Species. https://www.cabidigitallibrary.org/product/qi.

Campisi, A., Acquaviva, R., Raciti, G., Duro, A., Rizzo, M., and Santagati, N. A. 2019. Antioxidant Activities of *Solanum nigrum* L. Leaf Extracts Determined in In Vitro Cellular Models. *Foods* 8(2): 1–12. DOI: 10.3390/foods8020063

Catford, J. A., Wragg, P. D., Clark, A. T., and Cavender-Bares, J. 2019. Traits Linked with Species Invasiveness and Community Invasibility Vary with Time, Stage and Indicator of Invasion in a Long-Term Grassland Experiment. *Ecology Letters* 1(1): 1–12. DOI: 10.1111/ele.13220

Chacón-Morales, P. A., Amaro-Luis, J. M., Beltrán Rojas Fermín, L., Peixoto, P. A., Deffieux, D., Pouységu, L., and Quideau, S. 2019. Preparation and Bactericidal Activity of Oxidation Derivatives of Austroeupatol, An Ent-Nor-Furano Diterpenoid of the Labdane Series from *Austroeupatorium inulifolium*. *Phytochemistry Letters* 29: 47–52. DOI: 10.1016/j.phytol.2018.11.007

Chahal, R., Nanda, A., Akkol, E. K., Sobarzo-Sánchez, E., Arya, A., Kaushik, D., Dutt, R., Bhardwaj, R., Rahman, M. H., and Mittal, V. 2021. *Ageratum conyzoides* L. and Its Secondary Metabolites in the Management of Different Fungal Pathogens. *Molecules* 26(10): 1–28. DOI: 10.3390/molecules26102933

Couto, J., Figueirinha, A., Batista, M. T., Paranhos, A., Nunes, C., Gonçalves, L. M., Marto, J., Fitas, M., Pinto, P., Ribeiro, H. M., and Pina, M. E. 2020. *Fragaria vesca* L. Extract: A Promising Cosmetic Ingredient with Antioxidant Properties. *Antioxidants* 9(2): 1–15. DOI: 10.3390/antiox9020154

Darkwah, W. K., Koomson, D. A., Miwornunyuie, N., Nkoom, M., and Puplampu, J. B. 2020. Review: Phytochemistry and Medicinal Properties of *Solanum torvum* Fruits. *All Life* 13(1): 498–506. DOI: 10.1080/26895293.2020.1817799

De Araújo, E. R. D., Félix-Silva, J., Xavier-Santos, J. B., Fernandes, J. M., Guerra, G. C. B., de Araújo, A. A., Araújo, D. F. de S., de Santis Ferreira, L., da Silva Júnior, A. A., Fernandes-Pedrosa, M. de F., and Zucolotto, S. M. 2019. Local Anti-Inflammatory Activity: Topical Formulation Containing *Kalanchoe brasiliensis* and *Kalanchoe pinnata* Leaf Aqueous Extract. *Biomedicine and Pharmacotherapy* 113(108721): 1–9. DOI: 10.1016/j.biopha.2019.108721

Di Napoli, A., and Zucchetti, P. 2021. A Comprehensive Review of the Benefits of *Taraxacum officinale* on Human Health. *Bulletin of the National Research Centre* 45(110): 1–7. DOI: 10.1186/s42269-021-00567-1

Diep, T., Pook, C., and Yoo, M. 2020. Phenolic and Anthocyanin Compounds and Antioxidant Activity of Tamarillo (*Solanum betaceum* Cav.). *Antioxidants* 9(2): 1–20. DOI: 10.3390/antiox9020169

Diep, T. T., Rush, E. C., and Yoo, M. J. Y. 2022. Tamarillo (*Solanum betaceum* Cav.): A Review of Physicochemical and Bioactive Properties and Potential Applications. *Food Reviews International* 38(7): 1343–1367. DOI: 10.1080/87559129.2020.1804931

Diep, T. T., Yoo, M. J. Y., Pook, C., Sadooghy-Saraby, S., Gite, A., and Rush, E. 2021. Volatile Components and Preliminary Antibacterial Activity of Tamarillo (*Solanum betaceum* cav.). *Foods* 10(9): 1–19. DOI: 10.3390/FOODS10092212

Durofil, A., Radice, M., Blanco-Salas, J., and Ruiz-Téllez, T. 2021. Piper Aduncum Essential Oil: A Promising Insecticide, Acaricide and Antiparasitic. A Review. *Parasite* 28(42): 1–19. DOI: 10.1051/parasite/2021040

Duryat, Santori, Santoso, T., Riniarti, M., and Surya, R. A. 2023. Biomass Productivity of Invasive Mantangan (*Merremia peltata*) under Various Canopy Covers. *Jurnal Sylva Lestari* 11(1):

192–203. DOI: 10.23960/jsl.v11i1.637

Eikert, H., Pajor, J., Klin, P., Rzepiela, A., Slesak, H., and Szopa, A. 2020. Significance of *Artemisia vulgaris* L. (Common Mugwort) in the History of Medicine and Its Possible Contemporary Applications Substantiated by Phytochemical and Pharmacological Studies. *Molecules* 25(4415): 1–32. DOI: 10.3390/molecules25194415

El-Beltagi, H. S., Mohamed, H. I., Safwat, G., Gamal, M., and Megahed, B. M. H. 2019. Chemical Composition and Biological Activity of *Physalis peruviana* L. *Gesunde Pflanzen* 71(2): 113–122. DOI: 10.1007/s10343-019-00456-8

Eskander, D. M., Aziz, W. M., Nassar, M. I., and Hamed, M. A. 2021. Isolation and Characterization of Flavonoid Compounds from *Stachytarpheta jamaicensis* (L.) Vahl and Its Role as Anti-Gastro Ulcerative Agent in Rats. *Biomarkers* 26(7): 606–616. DOI: 10.1080/1354750X.2021.1950210

Fauziana, M., and Susandarini, R. 2019. Species Diversity and Potential Use of Asteraceae in Tawangmangu, Karanganyar Regency, Central Java. *Journal of Tropical Biodiversity and Biotechnology* 4(01): 18–23. DOI: 10.22146/jtbb.36652

Fokam Tagne, M. A., Noubissi, P. A., Fankem, G. O., and Kamgang, R. 2018. Effects of *Oxalis barrelieri* L. (Oxalidaceae) Aqueous Extract on Diarrhea Induced by *Shigella dysenteriae* Type 1 in Rats. *Health Science Reports* 1(e20): 1–8. DOI: 10.1002/hsr2.20

Ganjare, A., and Raut, N. 2019. Nutritional and Medicinal Potential of *Amaranthus spinosus*. *Journal of Pharmacognosy and Phytochemistry* 8(3): 3149–3156.

Garsetiasih, R., Irianto, R., and Sihombing, V. S. 2019. The Utilization of *Merremia Peltata* for Livestock Feed to Control An Invasive Alien Plant Species in Bukit Barisan Selatan National Park. *Indonesian Journal of Forestry Research* 6(2): 85–93. DOI: 10.20886/ijfr.2019.6.2.85-93

Hadidy, D. E., El Sayed, A. M., Tantawy, M. E., Alfy, T. E., Farag, S. M., and Haleem, D. R. A. 2022. Larvicidal and Repellent Potential of *Ageratum houstonianum* against *Culex pipiens*. *Scientific Reports* 12(21410): 1–13. DOI: 10.1038/s41598-022-25939-z

Handayani, A., and Hidayati, S. 2020. Utilization of Invasive Alien Species (IAS) by Communities around Cibodas Biosphere Reserve (CBR): A Recommendation for Invasive Alien Species Management and Policy. *IOP Conference Series: Earth and Environmental* 533: 012017. DOI: 10.1088/1755-1315/533/1/012017

Handayani, A., Junaedi, D. I., and Zuhud, E. A. M. 2021a. Ecological Risk Assessment of Potentially Invasive Alien Plant Species in Cibodas Biosphere Reserve, West Java, Indonesia. *IOP Conference Series: Earth and Environmental Science* 914: 012035. DOI: 10.1088/1755-1315/914/1/012035

Handayani, A., Zuhud, E. A. M., and Junaedi, D. I. 2021b. Assessing the Utilization of Naturalized Alien Plant Species by Community to Inform Its Management Strategy: A Case Study in Cibodas Biosphere Reserve, West Java, Indonesia. *Biodiversitas* 22(7): 2579–2588. DOI: 10.13057/biodiv/d220705

He, X., Luan, F., Yang, Y., Wang, Z., Zhao, Z., Fang, J., Wang, M., Zuo, M., and Li, Y. 2020. *Passiflora edulis*: An Insight into Current Researches on Phytochemistry and Pharmacology. *Frontiers in Pharmacology* 11(617): 1–16. DOI: 10.3389/fphar.2020.00617

Heriyanto, N. M., Samsoedin, I., and Rochmayanto, Y. 2023. Plant Diversity and Carbon Stocks in Urban Green Open Space (Case Study in PT. Gajah Tunggal Tbk., Tangerang, Banten). *Jurnal Sylva Lestari* 11(1): 66–78. DOI: 10.23960/jsl.v11i1.618

Hernández-Caballero, M. E., Sierra-Ramírez, J. A., Villalobos-Valencia, R., and Seseña-Méndez, E. 2022. Potential of *Kalanchoe pinnata* as a Cancer Treatment Adjuvant and an Epigenetic Regulator. *Molecules* 27(19): 1–18. DOI: 10.3390/molecules27196425

Himmi, S. K., Tarmadi, D., Meisyara, D., Fajar, A., Kartika, T., Guswenrivo, I., and Yusuf, S. 2020. Larvicidal Activity of *Brugmansia candid*a against *Aedes aegypti* and *Culex quinquefasciatus* (Diptera: Culicidae). *Biosaintifika: Journal of Biology & Biology Education* 12(3): 363–369. DOI: 10.15294/biosaintifika.v12i3.24634

Holmes, R., Pelser, P., Barcelona, J., Tjitrosoedirdjo, S. S., Wahyuni, I., Kleunen, M. van, Pyšek, P., Essl, F., Kreft, H., Dawson, W., Wijedasa, L., Kortz, A., Hejda, M., Berrio, J. C., Siregar, I., and Williams, M. 2023. The Naturalized Vascular Flora of Malesia. *Biological Invasions* 25(2023): 1339–1357. DOI: 10.1007/s10530-022-02989-y

Hung, N. H., Satyal, P., Hieu, H. V, Chuong, N. T., Dai, D. N., Huong, L. T., Tai, T. A., and Setzer, W. N. 2019. Mosquito Larvicidal Activity of the Essential Oils of Erechtites Species Growing Wild in Vietnam. *Insects* 10(47): 1–14. DOI: 10.3390/insects10020047

Idu, M. D., Edehia, O. O., and Gabriel, B. O. 2021. Anti-Diabetic Effect of *Stachytarpheta jamaicensis* on Low Dose Streptozotocin-Induced Diabetic Rats Fed on a High-Fat Diet. *Clinical Phytoscience* 7(95): 1–12. DOI: 10.1186/s40816-021-00326-9

Irani, M., Tabrizi, M. H., Ardalan, T., and Nosrat, T. 2022. *Artemisia vulgaris* Essential Oil Nanoemulsions (AVEO-NE), A Novel Anti-Angiogenic Agent and Safe Apoptosis Inducer in MCF-7 Human Cancer Cells. *Inorganic and Nano-Metal Chemistry* 52(3): 417–428. DOI: 10.1080/24701556.2021.1980022

Jedrejek, D., Lis, B., Rolnik, A., Stochmal, A., and Olas, B. 2019. Comparative Phytochemical, Cytotoxicity, Antioxidant and Haemostatic Studies of *Taraxacum officinale* Root Preparations. *Food and Chemical Toxicology* 126: 233–247. DOI: 10.1016/j.fct.2019.02.017

Khan, J. A. 2021. Potential of Herbal Medicines Against COVID-19. in: *Herbal Medicine – A Benign and Conventional Medical System* S. K. Agarwal, A. K. Nakkella, and S. Rout, eds. Immortal Publications, India 103–110.

Khan, M. M., Harunsani, M. H., Tan, A. L., Hojamberdiev, M., Poi, Y. A., and Ahmad, N. 2020. Antibacterial Studies of ZnO and Cu-Doped ZnO Nanoparticles Synthesized Using Aqueous Leaf Extract of *Stachytarpheta jamaicensi*s. *BioNanoScience* 10(4): 1037–1048. DOI: 10.1007/s12668-020-00775-5

Khan, R. A., Khan, M. R., Sahreen, S., and Ahmed, M. 2012. Evaluation of Phenolic Contents and Antioxidant Activity of Various Solvent Extracts of *Sonchus asper* (L.) Hill. *Chemistry Central Journal* 6(12): 1–7. DOI: 10.1186/1752-153X-6-12

Khunbutsri, D., Naimon, N., Satchasataporn, K., Inthong, N., Kaewmongkol, S., Sutjarit, S., Setthawongsin, C., and Meekhanon, N. 2022. Antibacterial Activity of *Solanum torvum* Leaf Extract and Its Synergistic Effect with Oxacillin against Methicillin-Resistant Staphyloccoci Isolated from Dogs. *Antibiotics* 11(3): 1–9. DOI: 10.3390/antibiotics11030302

Khursheed, A., Jain, V., and Wani, A. 2022. Euphorbia Hirta as a Gold Mine of High-Value Phytochemicals: A Comprehensive Review of Its Pharmacological Activities and Possible Role against SARS-CoV-2. *Biomedical Research and Therapy* 9(2): 4930–4949. DOI: 10.15419/bmrat.v9i2.728

KLHK. 2016. *Peraturan Menteri Lingkungan Hidup dan Kehutanan Republik Indonesia Nomor P.94/MENLHK/SETJEN/KUM.1/12/2016 tentang Jenis Invasif*. Kementerian Lingkungan Hidup dan Kehutanan Republik Indonesia, Jakarta, Indonesia 1–23.

Kotta, J. C., Lestari, A. B. S., Candrasari, D. S., and Hariono, M. 2020. Medicinal Effect, in Silico Bioactivity Prediction, and Pharmaceutical Formulation of *Ageratum conyzoides* L.: A Review. *Scientifica* Hindawi 2020(6420909): 1–12. DOI: 10.1155/2020/6420909

Kumar, S., Gupta, A., Saini, R. V., Kumar, A., Dhar, K. L., and Mahindroo, N. 2020. Immunomodulation-Mediated Anticancer Activity of a Novel Compound from *Brugmansia suaveolens* Leaves. *Bioorganic and Medicinal Chemistry* 28(12): 1–8. DOI: 10.1016/j.bmc.2020.115552

Kuo, T. F., Yang, G., Chen, T. Y., Wu, Y. C., Tran Nguyen Minh, H., Chen, L. S., Chen, W. C., Huang, M. G., Liang, Y. C., Yang, W. C., and Kuo, A. 2021. *Bidens pilosa*: Nutritional Value and Benefits for Metabolic Syndrome. *Food Frontiers* 2(1): 32–45. DOI: 10.1002/fft2.63

Lian, W., Yang, L., Joseph, S., Shi, W., Bian, R., Zheng, J., Li, L., Shan, S., and Pan, G. 2020. Utilization of Biochar Produced from Invasive Plant Species to Efficiently Adsorb Cd (II) and Pb (II). *Bioresource Technology* 317(124011): 1–9. DOI: 10.1016/j.biortech.2020.124011

Manh, H. D., and Tuyet, O. T. 2020. Larvicidal and Repellent Activity of *Mentha arvensis* L. Essential Oil against *Aedes aegypti*. *Insects* 11(3): 1–9. DOI: 10.3390/insects11030198

Mani, R. K., Paramashree, J. B., Bharathi, D. R., and Ahmed, S. S. 2022. The Traditional and Pharmacological Properties of *Solanum nigrum*: A Review. *International Journal of Indigenous Herbs and Drugs* 7(2): 49–55. DOI: 10.46956/ijihd.v7i2.317

Mardina, V., Ilyas, S., Harmawan, T., Halimatussakdiah, H., and Tanjung, M. 2020. Antioxidant and Cytotoxic Activities of the Ethyl Acetate Extract of *Sphagneticola trilobata* (L.) J.F. Pruski on MCF-7 Breast Cancer Cell. *Journal of Advanced Pharmaceutical Technology & Research* 11(3): 123–127. DOI: 10.4103/japtr.JAPTR_31_20

McCarthy, J. S., and Price, R. N. 2020. Antimalarial Drugs. in: *Mandell, Douglas, and Bennett's Principles and Practice of Infectious Diseases*. J. E. Bennett, R. Dolin, and M. J. Blaser, eds. Elsevier, Philadelphia, PA 685–705.

McGaw, L. J., Omokhua-Uyi, A. G., Finnie, J. F., and Van Staden, J. 2022. Invasive Alien Plants and Weeds in South Africa: A Review of Their Applications in Traditional Medicine and Potential Pharmaceutical Properties. *Journal of Ethnopharmacology* 283(114564): 1–21. DOI: 10.1016/j.jep.2021.114564

Mekam, P. N., Martini, S., Nguefack, J., Tagliazucchi, D., and Stefani, E. 2019. Phenolic Compounds Profile of Water and Ethanol Extracts of *Euphorbia hirta* L. Leaves Showing Antioxidant and Antifungal Properties. *South African Journal of Botany* 127(2019): 319–332. DOI: 10.1016/j.sajb.2019.11.001

Miere (Groza), F., Teușdea, A. C., Laslo, V., Cavalu, S., Fritea, L., Dobjanschi, L., Zdrinca, M., Zdrinca, M., Ganea, M., Pașc, P., Memete, A. R., Antonescu, A., Vlad, A. M., and Vicas, S. I. 2021. Evaluation of In Vitro Wound-Healing Potential, Antioxidant Capacity, and Antimicrobial Activity of *Stellaria media* (L.) Vill. *Applied Sciences* 11(11526): 1–18. DOI: 10.3390/app112311526

Milanović, M., Knapp, S., Pyšek, P., and Kühn, I. 2020. Linking Traits of Invasive Plants with Ecosystem Services and Disservices. *Ecosystem Services* 42(101072): 1–10. DOI: 10.1016/j.ecoser.2020.101072

Nair, K. P. 2021. Home Tree Crops Chapter Cinchona (*Cinchona* sp.). in: *Tree Crops* K. P. Nair, ed. Springer International Publishing, Cham 129–151. DOI: 10.1007/978-3-030-62140-7_4

Nasr, S. M., Elwan, N. M., Abdel-Motagaly, M., Abdel-Aziz, A.-W. A., and Ghareeb, M. 2021. Phytochemical Investigation and Differential Effects of *Cestrum elegans* Isolated Compounds as Antimicrobial and Virucidal Against Hepatitis A Virus. *Egyptian Journal of Chemistry* 64(7): 3729–3738. DOI: 10.21608/ejchem.2021.71934.3581

Navia, Z. I., Adnan, A., Harmawan, T., and Suwardi, A. B. 2022. Ethnobotanical Study of Wild Medicinal Plants in Serbajadi Protected Forest of East Aceh District, Indonesia. *Biodiversitas Journal of Biological Diversity* 23(10): 4959–4970. DOI: 10.13057/biodiv/d231001

Ogundola, A. F., Bvenura, C., Ehigie, A. F., and Afolayan, A. J. 2022. Effects of Soil Types on Phytochemical Constituents and Antioxidant Properties of *Solanum nigrum*. *South African Journal of Botany* 151(2022): 325–333. DOI: 10.1016/j.sajb.2022.09.048

Oktavia, A. I., Indriani, S., and Jati, B. 2017. Ethnobotanical Study of Toxic Plants in Ngadiwono Village, Tosari District, Pasuruan Regency, East Java. *Indonesian Journal of Environment and Sustainable Development* 8(2): 1–6. DOI: 10.21776/ub.jpal.2017.008.02.04

Oladeji, O. S., and Oyebamiji, A. K. 2020. *Stellaria media* (L.) Vill.- A Plant with Immense Therapeutic Potentials: Phytochemistry and Pharmacology. *Heliyon* 6(e04150): 1–7. DOI: 10.1016/j.heliyon.2020.e04150

Omokhua, A., Madikizela, B., Aro, A., VanStaden, J. Van, and McGaw, L. 2019. Antimycobacterial Screening and Safety Evaluation of *Tithonia rotundifolia*, A Southern Africa Alien Invasive Weed. *Planta Medica* 85(18): P-261. DOI: 10.1055/s-0039-3399961

Padmanaba, M., Tomlinson, K. W., Hughes, A. C., and Corlett, R. T. 2017. Alien Plant Invasions of Protected Areas in Java, Indonesia. *Scientific Reports* 7(9334): 1–11. DOI: 10.1038/s41598-017-09768-z

Papadaki, S., Sofia, P., Panagiotis, D., and Magdalini, K. 2022. Isolation and Utilization of Toxins from Marine Invasive Species Towards the Management of Their Population. *European Journal of Sustainable Development* 11(4): 61–71. DOI: 10.14207/ejsd.2022.v11n4p61

Paw, M., Gogoi, R., Sarma, N., Saikia, S., Chanda, S. K., Lekhak, H., and Lal, M. 2022. Antimicrobial, Antioxidant, Antidiabetic study of leaf Essential Oil of Eryngium foetidum L. Along with the Chemical Profiling Collected from North East India. *Journal of Essential Oil Bearing Plants* 25(6): 1229–1241. DOI: 10.1080/0972060X.2022.2158044

Petricevich, V. L., Salinas-Sánchez, D. O., Avilés-Montes, D., Sotelo-Leyva, C., and Abarca-Vargas, R. 2020. Chemical Compounds, Pharmacological and Toxicological Activity of Brugmansia suaveolens: A Review. *Plants* 9(1161): 1–14. DOI: 10.3390/plants9091161

POWO. 2023. Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. Published on the Internet. http://www.plantsoftheworldonline.org

Pratami, M. P., Fendiyanto, M. H., Satrio, R. D., Widana, I. D. K. K., Nikmah, I. A., Sari, N. I. P., Awwanah, M., Farah, N., and Darmadi, D. 2021. Potential of Invasive Alien Species *Clidemia hirta* as Antibacterial against *Salmonella typhi* and *Staphylococcus aureus*. *Biodiversitas* 22(6): 3363–3369. DOI: 10.13057/biodiv/d220643

Puente, L., Nocetti, D., and Espinosa, A. 2019. *Physalis peruviana* Linnaeus, an Update on its Functional Properties and Beneficial Effects in Human Health BT - Wild Fruits: Composition, Nutritional Value and Products. in: *Wild Fruits: Composition, Nutritional Value and Products* A. A. Mariod, ed. Springer International Publishing, Switzerland 447–463. DOI: 10.1007/978-3-030-31885-7_34

Pundir, S., Shukla, M. K., Singh, A., Chauhan, R., Lal, U. R., Ali, A., and Kumar, D. 2022. A

Comprehensive Review on Angel's Trumpet (*Brugmansia suaveolens*). *South African Journal of Botany* 151(2022): 266–274. DOI: 10.1016/j.sajb.2022.02.023

Puspaningtyas, A. R., Sholikhah, E. N., Astuti, P., and Riyanto, S. 2020. Total Flavonoid, Total Phenolic Content and Antioxidant Activity of *Erechtites valerianifolia* Herb Extracts. *Formerly The Philippine Agriculturist* 103(2): 126–131.

Pyšek, P., Hulme, P. E., Simberloff, D., Bacher, S., Blackburn, T. M., Carlton, J. T., and Richardson, D. M. 2020. Scientists' Warning on Invasive Alien Species. *Biological Reviews* 95(6): 1511–1534. DOI: 10.1111/brv.12627

Rai, P. K., and Singh, J. S. 2020. Invasive Alien Plant Species: Their Impact on Environment, Ecosystem Services and Human Health. *Ecological Indicators* 111(106020): 1–20. DOI: 10.1016/j.ecolind.2019.106020

Rambey, R., and Lubis, A. S. J. 2022. Ethnobotany of Plants Used in Traditional Ceremonies in Tanjung Botung Village, North Sumatra, Indonesia. *IOP Conference Series: Earth and Environmental Science* 977: 012098. DOI: 10.1088/1755-1315/977/1/012098

Ramli, A. N. M., Manap, N. W. A., Bhuyar, P., and Azelee, N. I. W. 2020. Passion Fruit (*Passiflora edulis*) Peel Powder Extract and Its Application towards Antibacterial and Antioxidant Activity on the preserved Meat Products. *SN Applied Sciences* 2(1748): 1–11. DOI: 10.1007/s42452-020-03550-z

Ratnayake, R., Bandara, B. M. R., Adikaram, N. K. B., Wijesundara, D. S. A., and Karunaratne, V. 2018. Potential of the Antifungal Activity of *Ageratina riparia* (Regel) RM King and H. Rob. against Banana Anthracnose Disease Caused by the Fungus, *Colletotrichum musae*. *Ceylon Journal of Science* 47(3): 287–291. DOI: 10.4038/cjs.v47i3.7536

Richardson, D. M., and Pyšek, P. 2013. Plant Invasions. in: *Encyclopedia of Biodiversity: Second Edition* Simon A Levin, ed. Elsevier Inc. 90–102. DOI: 10.1016/B978-0-12-384719-5.00319-1

Rohman, F., Juma, Y., Utomo, D. H., Lestari, S. R., Arifah, S. N., and Putra, W. E. 2019. Plants Diversity as a Medicinal Plants by the Tengger Tribe, Bromo Tengger Semeru National Park, East Java, Indonesia. *EurAsian Journal of BioSciences* 13(2): 2293–2298.

Sarfraz, I., Rasul, A., Hussain, G., Shah, M. A., Nageen, B., Jabeen, F., Selamoğlu, Z., Uçak, İ., Asrar, M., and Adem, S. 2022. A Review on Phyto-Pharmacology of *Oxalis corniculata*. *Combinatorial Chemistry and High Throughput Screening* 25(7): 1181–1186. DOI: 10.2174/1386207324666210813121431

Sarkar, T., Ghosh, P., Poddar, S., Choudhury, S., Sarkar, A., and Chatterjee, S. 2020. *Oxalis corniculata* Linn. (Oxalidaceae): A Brief Review. *Journal of Pharmacognosy and Phytochemistry* 9(4): 651–655. DOI: 10.22271/phyto.2020.v9.i4i.11777

Setyawati, T., Sunardi, and Tjitrosoedirdjo, S. 2021. Invasive Alien Plant Species Management in Indonesia. in: *Invasive Alien Species: Observations and Issues from Around the World, Volume 2: Issues and Invasions in Asia and the Pacific Region* T. Pullaiah and M. R. Ielmin, eds. John Wiley & Sons Ltd 73–102. DOI: 10.1002/9781119607045.ch16

Silalahi, M. 2021. Essential Oils and Uses of *Eryngium foetidum* L. *GSC Biological and Pharmaceutical Sciences* 15(3): 289–294. DOI: 10.30574/gscbps.2021.15.3.0175

Sivaraj, B., Vidya, C., Nandini, S., and Sanil, R. 2015. Antimicrobial Activity of *Cestrum aurantiacum* L. *International Journal of Current Microbiology and Applied Sciences* 4(3): 830–834.

Studzińska-Sroka, E., Dudek-Makuch, M., Chanaj-Kaczmarek, J., Czepulis, N., Korybalska, K.,

Rutkowski, R., Łuczak, J., Grabowska, K., Bylka, W., and Witowski, J. 2018. Anti-Inflammatory Activity and Phytochemical Profile of *Galinsoga parviflora* Cav. *Molecules* 23(9): 1–15. DOI: 10.3390/molecules23092133

Sun, L., Wang, Z., Wang, Y., Xu, J., and He, X. 2020. Anti-Proliferative and Anti-Neuroinflammatory Eudesmanolides from Wedelia (*Sphagneticola trilobata* (L.) Pruski). *Fitoterapia* 142(104452): 1–10. DOI: 10.1016/j.fitote.2019.104452

Supiandi, M. I., Mahanal, S., Zubaidah, S., Julung, H., and Ege, B. 2019. Ethnobotany of Traditional Medicinal Plants Used by Dayak Desa Community in Sintang, West Kalimantan, Indonesia. *Biodiversitas* 20(5): 1264–1270. DOI: 10.13057/biodiv/d200516

Tabe-Ojong, M. P. J. 2023. Action against Invasive Species: Charcoal Production, Beekeeping, and *Prosopis eradication* in Kenya. *Ecological Economics* 203(107614): 1–10. DOI: 10.1016/j.ecolecon.2022.107614

Tjitrosoedirdjo, S. S., Mawardi, I., and Tjitrosoedirdjo, S. 2016a. *75 Important Invasive Plant Species in Indonesia*. SEAMEO BIOTROP, Bogor, Indonesia.

Tjitrosoedirdjo, S., Tjitrosoedirdjo, S. S., and Setyawati, T. 2016b. *Tumbuhan Invasif dan Pendekatan Pengelolaannya*. SEAMEO BIOTROP, Bogor, Indonesia.

Tjitrosoedirjo, S., Setyawati, T., Sunardi, Subiakto, A., Irianto, R., and Garsetiasih, R. 2016. *Pedoman Analisis Risiko Tumbuhan Asing Invasif (Post Border)*. (Henry Bastaman, ed.) FORIS Indonesia, Pusat Penelitian dan Pengembangan Hutan, Kementerian Lingkungan Hidup dan Kehutanan Republik Indonesia, Bogor, Indonesia.

Turner, N. J. 1988. The Importance of a Rose: Evaluating the Cultural Significance of Plants in Thompson and Lillooet Interior Salish. *American Anthropologist* 90(2): 272–290. DOI: 10.1525/aa.1988.90.2.02a00020

UNESCO. 2011. *Cibodas: United Nations Educational, Scientific and Cultural Organization. U*NESCO. http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/biosphere-reserves/asia-and-the-pacific/indonesia/cibodas/

Van Etten, E., and Sutomo. 2016. Effect of Fire and Digestion by Herbivores on Seeds of The Exotic Invasive Species "*Acacia nilotica*" in Savanna at Baluran National Park Indonesia. *Australasian Plant Conservation: Journal of the Australian Network for Plant Conservation* 25(3): 20–21. DOI: 10.3316/informit.932056932037616

Van Kleunen, M., Dawson, W., Essl, F., and et al. 2015. Global Exchange and Accumulation of Non-Native Plants. *Nature* 525(2015): 100–103. DOI: 10.1038/nature14910

Vaz, A. S., Kueffer, C., Kull, C. A., Richardson, D. M., Vicente, J. R., Kühn, I., Schröter, M., Hauck, J., Bonn, A., and Honrado, J. P. 2017. Integrating Ecosystem Services and Disservices: Insights from Plant Invasions. *Ecosystem Services* 23(2017): 94–107. DOI: 10.1016/j.ecoser.2016.11.017

Vecchia, C. A. D., Locateli, G., Serpa, P. Z., Bianchin Gomes, D., Ernetti, J., Miorando, D., Zanatta, M. E. D. C., Kaio Silva Nunes, R., Wildner, S. M., and Gutiérrez, M. V. 2022. *Sonchus oleraceus* L. Promotes Gastroprotection in Rodents via Antioxidant, Anti-Inflammatory, and Antisecretory Activities. *Evidence-Based Complementary and Alternative Medicine* Hindawi 2022(7413231): 1–11. DOI: 10.1155/2022/7413231

Wahyuni, D. K., Rahayu, S., Zaidan, A. H., Ekasari, W., Prasongsuk, S., and Purnobasuki, H. 2021. Growth, Secondary Metabolite Production, and In Vitro Antiplasmodial Activity of *Sonchus arvensis* L. Callus Under Dolomite [CaMg(CO3)2] Treatment. *PLOS ONE* 16(8): 1–17. DOI: 10.1371/journal.pone.0254804

WFO. 2023. World Flora Online. Published on the Internet. http://www.worldfloraonline.org

Wiliantari, S., Iswandana, R., and Elya, B. 2022. Total Polyphenols, Total Flavonoids, Antioxidant Activity and Inhibition of Tyrosinase Enzymes from Extract and Fraction of *Passiflora ligularis* Juss. *Pharmacognosy Journal* 14(3): 660–671. DOI: 10.5530/pj.2022.14.86

Yadav, N., Ganie, S. A., Singh, B., Chhillar, A. K., and Yadav, S. S. 2019. Phytochemical Constituents and Ethnopharmacological Properties of *Ageratum conyzoides* L. *Phytotherapy Research* 33(9): 2163–2178. DOI: 10.1002/ptr.6405

Yan, S. H., Song, W., and Guo, J. Y. 2017. Advances in Management and Utilization of Invasive Water Hyacinth (*Eichhornia crassipes*) in Aquatic Ecosystems – A Review. *Critical Reviews in Biotechnology* 37(2): 218–228. DOI: 10.3109/07388551.2015.1132406

Yang, W. C., Yang, C. Y., Liang, Y. C., Yang, C. W., Li, W. Q., Chung, C. Y., Yang, M. T., Kuo, T. F., Lin, C. F., Liang, C. L., and Chang, C. L. T. 2019. Anti-Coccidial Properties and Mechanisms of an Edible Herb, *Bidens pilosa*, and Its Active Compounds for Coccidiosis. *Scientific Reports* 9(2896): 1–11. DOI: 10.1038/s41598-019-39194-2

Yuan, T., Wu, D., Sun, K., Tan, X., Wang, J., Zhao, T., Ren, B., Zhao, B., Liu, Z., and Liu, X. 2019. Anti-Fatigue Activity of Aqueous Extracts of *Sonchus arvensis* L. in Exercise Trained Mice. *Molecules* 24(6): 1–13. DOI: 10.3390/molecules24061168

Zahra, S., Hofstetter, R. W., Waring, K. M., and Gehring, C. 2020. The Invasion of *Acacia nilotica* in Baluran National Park, Indonesia, and Potential Future Control Strategies. *Biodiversitas* 21(1): 104–116. DOI: 10.13057/biodiv/d210115

Zaki, A. G. A., Pertiwi, Y. A. B., Nufus, M., and Sakya, A. T. 2022. The Composition of Undergrowth Vegetation in Forest Area with the Special Purpose of Gunung Bromo, Karangayar, Central Java, Indonesia. *Jurnal Sylva Lestari* 10(1): 127–140. DOI: 10.23960/jsl.v10i1.553