Inventory study of plants collection in the Medicinal Thematic Garden, Cibodas Botanic Gardens

M Nikmatullah1,3, D I Junaei1, J R Witoño2 and R. Hendrian2

1Cibodas Botanic Gardens, Research Centre for Plant Conservation and Botanical Garden Indonesian Institute of Sciences (LIPI), Jl. Kebun Raya Cibodas, Cipanas, Cianjur, West Java 43253, Indonesia
2Bogor Botanic Gardens, Research Centre for Plant Conservation and Botanical Garden Indonesian Institute of Sciences, Jl. Ir. H. Juanda 13 Bogor, West Java 16122, Indonesia

E-mail: muhamadnikmatullah@gmail.com

Abstract. CBG’s plant collection managed and displayed in the garden based on the taxonomic classification system and thematic system. Plant collection that managed as a thematic system displayed and managed as a thematic garden. The aim of this study is to conduct an inventory study of CBG medicinal thematic garden collections and to do a literature study about the potential medicinal use of plant collection in CBG medicinal thematic gardens. Data collected through surveyed, checked and validated in the information system of CBG plants data collection from CBG Registration Unit. Recorded medicinal use of surveyed plant collection was identified by the literature study. Data were analyzed descriptively. The result of the study showed that there were 26 species from 23 genera and 22 families of medicinal plant species in CBG medicinal thematic garden. Based on ICD-10-WHO, CBG medicinal plant collections can treat 14 ICD-10-WHO diseases. From these 14 diseases, eight diseases can be treated by five CBG medicinal plant collections. These species were utilized as a medicinal plant by using part of the plant (root, leaves, bark, flowers, fruit, seeds, sap) or the whole plant through pounded or boiled processing, and mixed it with other ingredients.

Keywords: Cibodas Botanic Gardens, inventory, Medicinal Thematic Garden, plants collection

1. Introduction

Many novel diseases have emerged and threatened human health. New medicine can potentially be sourced from various plant chemical compounds. Medicinal plants are important to treat various diseases and most of these diseases can be treated with traditional medicine [1]. Medicinal plants are plants that contain hundreds until thousands of chemical compound [2]. Medicinal plants are plants that contain active substances that contain particular nutrition that have medicinal efficacy to heal diseases [3]. Medicinal plants contain nutritious substances that can cure disease [4] and contain active ingredients which considered as potential ingredients for synthetic medicine [5]. About 80% of the world population is relying on plants and its extract for their health [6]. Despite the important role of medicinal plants for public health, over-utilization of the medicinal plants can lead to plant extinction if not sustainably utilized. Thus, plant conservation (including ex-situ conservation) of medicinal plants is urgently needed.

3 To whom any correspondence should be addressed (muhamadnikmatullah@gmail.com)
Cibodas Botanic Gardens - Indonesian Institute of Sciences LIPI (CBG) conducts plant ex-situ conservation of native highland plants species in the gardens. CBG maintains these conserved plant species as garden plant collections. These plant collections were managed, documented, organized, and displayed based on the taxonomical classification system, bioregion, thematic, or a combination of all of those systems. Apart from plant conservation, CBG also conducts other four taskforces: research, education, tourism, and ecosystem services. According to Jackson and Sutherland botanic garden’s collection in the world was documented scientifically through the management of the thematic system, taxonomical classification system, or geography system [7]. CBG’s plant’s collection was managed based on the taxonomy classification system and thematic system. The taxonomy classification system arranged CBG plants collection based on taxon, while a thematic system based on specific theme, function and consider aesthetic values. The aim of this study is to conduct an inventory study of CBG medicinal thematic garden collections and to do a literature study about the potential medicinal use of plant collection in CBG medicinal thematic gardens. This study expected to provide information of potential medicinal use of plant collection in the CBG’s medicinal thematic gardens.

2. Materials and methods

2.1. Study area
The study area was located on medicinal thematic gardens, Cibodas Botanical Garden, Cianjur District, West Java, Indonesia. CBG located on the feet of Mount Gede-Pangrango at elevation range from 1.250 to 1.425 m above sea level. The total area of CBG is 84.99 hectares. Medicinal thematic garden located at vak IX.A (figure 1) and the total area is 0.3 hectares.

![Figure 1. Study area of Medicinal Thematic Gardens of Cibodas Botanic Gardens](image)

2.2. Methodology
The inventory study and data collection were conducted on registered medicinal thematic garden collections, which have collection registration number in the Registration Unit. After specimen surveyed, we checked and validated it in the CBG collection information system from CBG Registration Unit. Each recorded medicinal use of surveyed plant collection was identified by literature study from
relevant resources, such as *Medicinal Plants in Papua Guinea* (Switzerland: WHO Press) and *Pharmaceutical Biology*. Data that collected from literature includes: the information about scientific name, plant part used for medicinal purposes based on International Statistical Classification of Diseases and Related Health Problem (ICD-10-WHO) [8] by WHO, main use for medicinal purposes, and chemical compounds contained. The correct scientific names were checked and validated in the relevant plant database [9]. After surveyed medicinal plant collection correctly identified, we analyzed it using descriptive approaches.

3. Results and discussion

Based on inventory result, we found 26 medicinal plants species collection in CBG’s medicinal thematic gardens. These medicinal plant species are consist of 23 genus and 22 families. Each species have more than one medicinal use. The summary of the surveyed medicinal plant species is presented in table 1 and species with the most efficacy to treat diseases presented in table 2.

There are 45 diseases can be treated by 26 registered plant of CBG medicinal thematic garden. These 45 diseases can be classified into 14 out of 22 diseases based on ICD-10-WHO [8]. There are eight diseases that can be treated by five medicinal plants with the most efficacy. These eight diseases were common diseases that, often occur in local society. These five medicinal plants collection contain antioxidants, that provide, benefits for body health. The antioxidant can increase body protection from free radical and chronic diseases [10]. Human body needs antioxidants to protect it from free radicals that may continuously damage cells.

The plant collection of CBG medicinal thematic gardens has no efficacy for eight ICD-10-WHO diseases. These diseases are: diseases of the ear and mastoid process, certain conditions originating in the perinatal period, congenital malformations, deformations and chromosomal abnormalities, symptoms, signs and abnormal clinical and laboratory findings, injury, poisoning and certain other consequences of external causes, external causes of morbidity and mortality, factors influencing health status and contact with health services, and codes for special purposes. These diseases are, not common diseases in local society. Based on the literature study conducted, these eight ICD-10-WHO diseases can be treated by medicinal plants. The ear and mastoid process diseases can be treated using *Teucrium polium* L. (for an ear infection and earache [11]). *Bunium persicum* (Boiss.) B. Fedtsch. have efficacy to treat children earache [12]. The diseases of injury, poisoning and certain other consequences of external causes can be treated using *Litsea glutinosa* (to treat bruises and sprain [13]). *Arnebia euchroma* (Royle) I.M.Johnst. and *Alkanna tinctoria* Taush are potential medicinal plants to treat burn [14] [15]. External causes of morbidity and mortality can be treated using *Epipremnum pinnatum* (L.) Engl. and *Bauhinia integrifolia* Roxb. (to treat venomous snake bite [13]). Diseases of codes for special purposes can be treated using *Doratoxylon apetalum* (Poir.) Radlk (to treat zika virus [16]). Furthermore, we recommend CBG to collect those plant species as CBG medicinal thematic gardens to fill the efficacy-gap of ICD-10-WHO diseases that still can be treated by CBG medicinal thematic garden collections.

There are many medicinal plants in CBG medicinal thematic gardens that are not registered yet (without collection number registration). Botanic gardens have responsibility for species identity and origin documentation data and plant collection management based on scientific standards, so that it will have sufficient conservation value [17]. Botanical garden infrastructure development should not only consider aesthetics value but also consider the conservation aspect of the plant garden collections. Thus, garden plant collection data and quality is as important aesthetic aspects and infrastructure development of a thematic garden.
Table 1. List of medicinal plant species in the medicinal thematic garden, its treated diseases based on ICD-10-WHO, and bioactive chemical contained

| Scientific Name          | Families                  | Origin                              | Main use | Plant part used | Chemical compound(s)                                      | Reference |
|--------------------------|---------------------------|-------------------------------------|----------|-----------------|-----------------------------------------------------------|-----------|
| *Alnus japonica* (Thunb.) Steud. | Betulaceae                | Formosa, North East                 | im, dr, ds, tv, mr, mu, ct, bd, at, ca, ar, di bd | leaves, bark, and sap                                     | [18]      |
| *Alstonia scholaris*     | Apocynaceae               | Australia, America, and Africa      |          |                 | diurilheptanoid and flavonoids                            | [19]      |
| *Ardisia paucera* Mez    | Primulaceae               | Lampong                             | mr       | leaves          | alkald, terpenoid and flavonoid                           | [20]      |
| *Bennettia horsfeldii*   | Pandaceae                 | Jambi                               | not mentioned |                 | not mentioned                                             | [21]      |
| *Carallia brasiliensis* (Lour.) Merr. | Rhizophoraceae           | Central Sulawesi                    | wn, ic, ou, it, st | bark | not mentioned                                             | [22]      |
| *Cleidson javanica* Blume | Euphorbiaceae             | East Java                           | cd, sb   | leaves and bark | not mentioned                                             | [23]      |
| *Elaeagnus conferta* Roxb. | Gnetaceae                | West Java                           | bi, mi, ct, bd, at, ca, ar, di | leaves and fruit | Fruit contain Ca, Fe, Mn, P, and protein                 | [24] [25] |
| *Elaeocarpus stipularis* Blume | Lauraceae               | East Java                           | wn       | leaves          | all part plant                                         | [26]      |
| *Endiandra macrophylla* (Blume) Boerl. | Lauraceae               | West Java                           |          |                 | alkaloids, amides, lignans, neolignans, flavonoids, chalcones, terpenoids, and steroids | not mentioned |
| *Euonymus indicus B.Heyne ex Wall.* | Celastraceae             | Jambi                               | it, pk   | bark, leaves, fruit and seeds | xanthon and flavonoids                                   | [27]      |
| *Garcinia parviflora* Benth. | Clusiaceae               | Aceh                                | bi, mr, im, mi, ct, bd, at, ca, ar, di | bark, leaves, fruit and seed | saponins, tannins, fenol gnetosides e and gnetin         | [28]      |
| *Gnetum gnemonoides* Bron. | Gnetaceae                | South Sulawesi                      | bi, mi, ct, bd, at, ca, ar, di | leaves and fruit | alkaloid, flavonoid, saponin, and tannin                 | [29] [30] |
| *Mangifera laurina* Blume | Anacardiaceae            | Aceh                                | mi, ct, bd, at, ca, ar, di | bark, leaves, and fruit | not mentioned                                              | [31] [32] |
| *Mischocarpus pentapetalus* (Roxb.) Radd. | Moraceae                | Sapindaceae                         |    | Stem (wood) | not mentioned                                              |           |
| *Oreopha cornicosa* (Blume) Miq. | Celastraceae             | Jambi                               |          |                 | not mentioned                                             |           |
| *Oreopha hexandra* Blume | Anonaceae                | Aceh                                | ip       | bark            | not mentioned                                             |           |
| *Santhia laevigata* Blume | Burseraceae              | Aceh                                | ip       | leaves and fruits | not mentioned                                             |           |
| *Saurasia pendula* Blume | Actinidiaceae            | Java                                | as, ht   | leaves          | not mentioned                                             |           |
| *Smilax brevifolia* Blume | Smilacaceae              | Aceh                                |          | root and leaves | saponin, and terpenoids                                   |           |
| *Stemonorpus scorpioides* Becc. | Stemonuraceae          | Aceh                                | ed       | bark and leaves | not mentioned                                             | [33] [34] |
| *Stemonorpus grandifolius* Becc. | Stemonuraceae          | Aceh                                | ed       | bark and leaves | not mentioned                                             | [35] [36] |
| *Smilax cynanica* L. | Smilacaceae              | Aceh                                |          | root, leaves, and all of plant | not mentioned                                             | [37]      |
| *Syzygium cf.* dicocophorum* (Koerd. & Vealton) Amshoff | Myrtaceae                | Lampong                             |          | leaves and bark | glycosides, alkaldos, tannins, terpenoids and sterol      |           |
| *Syzygium cf.* malaccense* (L.) Merr. & L.M.Perry | Myrtaceae                | West Java and Kerinci Sehat National Park |          | leaves and bark | theasisin, glukosida, asam ellagat, kaemerol, alkald, jambosine, and glycode jambolin antibiotik   |           |
| *Talinum paniculatum* (Jacq.) Gaertn. | Myrtaceae                | Lampong                             |          | leaves          | saponin, alkaloid, flavonoid, and tannin                  | [46] [47] |
| *Toona sureni* (Blume) Merr. | Meliaceae                | Jambi                               | dr, kd, ds, ge, rp | bark and leaves | tanned substance, sap, bitter substance, and essential oil | [48] [49] |

Explanation: am: antihelminitic; ar: atherosclerosis; as: asthma; at: arthritis; bi: bacterial infectious; bc: blood circulation system disorder; bd: brain dysfunction; ca: cancer; ct: constipation; db: diabetes; dr: diarrhea; ds: dysentery; ed: edema; fv: fever; ft: flatulence; fa: fluor alba; ge: gastroent-eritis; hd: headache; ht: hypertension; hg: hypoglycemic; im: inflammation; it: inflammation of throat; ip: ingredients of postpartum; ic: itch; kd: kidney disorders; lt: laxative; mi: myocardial infarction; mr: malaria; nv: nerves; ou: oral ulcer; pk: pedikulous; rp: repellent; rt: rheumatism; rb: rubella; st: stomatitis; sb: scabies; sp: syphilis; sr: stress; tn: tonic; uc: ulcer; ut: uterine tumor; un: urinaria; wn: wound
| Scientific Name                          | Main use | Diseases (based on ICD-10-WHO) | a | b | d | e | f | g | i | m |
|----------------------------------------|----------|--------------------------------|---|---|---|---|---|---|---|---|
| Alnus japonica (Thunb.) Steud.         | im       | v                              |   |   |   |   |   |   |   |   |
|                                        | dr       | v                              |   |   |   |   |   |   |   |   |
|                                        | ds       | v                              |   |   |   |   |   |   |   |   |
|                                        | fv       | v                              |   |   |   |   |   |   |   |   |
|                                        | mr       | v                              |   |   |   |   |   |   |   |   |
|                                        | mi       | v                              |   |   |   |   |   |   |   |   |
|                                        | ct       | v                              |   |   |   |   |   |   |   |   |
|                                        | bd       | v                              |   |   |   |   |   |   |   |   |
|                                        | at       | v                              |   |   |   |   |   |   |   |   |
|                                        | ca       | v                              |   |   |   |   |   |   |   |   |
|                                        | ar       | v                              |   |   |   |   |   |   |   |   |
|                                        | di       | v                              |   |   |   |   |   |   |   |   |
| Garcinia parviflora Benth.             | bi       | v                              |   |   |   |   |   |   |   |   |
|                                        | mr       | v                              |   |   |   |   |   |   |   |   |
|                                        | im       | v                              |   |   |   |   |   |   |   |   |
|                                        | mi       | v                              |   |   |   |   |   |   |   |   |
|                                        | ct       | v                              |   |   |   |   |   |   |   |   |
|                                        | bd       | v                              |   |   |   |   |   |   |   |   |
|                                        | at       | v                              |   |   |   |   |   |   |   |   |
|                                        | ca       | v                              |   |   |   |   |   |   |   |   |
|                                        | ar       | v                              |   |   |   |   |   |   |   |   |
|                                        | di       | v                              |   |   |   |   |   |   |   |   |
| Gnetum gnemonoides Brongn.             | bi       | v                              |   |   |   |   |   |   |   |   |
|                                        | mi       | v                              |   |   |   |   |   |   |   |   |
|                                        | ct       | v                              |   |   |   |   |   |   |   |   |
|                                        | bd       | v                              |   |   |   |   |   |   |   |   |
|                                        | at       | v                              |   |   |   |   |   |   |   |   |
|                                        | ca       | v                              |   |   |   |   |   |   |   |   |
|                                        | ar       | v                              |   |   |   |   |   |   |   |   |
|                                        | di       | v                              |   |   |   |   |   |   |   |   |
| Syzygium cf. discophorum (Koord. & Valeton) Amshoff | db       | v                              | v |   |   |   |   |   |   |   |
|                                        | hg       | v                              | v |   |   |   |   |   |   |   |
|                                        | ct       | v                              |   |   |   |   |   |   |   |   |
|                                        | nv       | v                              |   |   |   |   |   |   |   |   |
|                                        | sr       | v                              |   |   |   |   |   |   |   |   |
|                                        | im       | v                              |   |   |   |   |   |   |   |   |
|                                        | mi       | v                              |   |   |   |   |   |   |   |   |
|                                        | ct       | v                              |   |   |   |   |   |   |   |   |
|                                        | bd       | v                              |   |   |   |   |   |   |   |   |
|                                        | at       | v                              |   |   |   |   |   |   |   |   |
|                                        | ca       | v                              |   |   |   |   |   |   |   |   |
|                                        | ar       | v                              |   |   |   |   |   |   |   |   |
|                                        | di       | v                              |   |   |   |   |   |   |   |   |
| Talinum paniculatum (Jacq.) Gaertn.    | im       | v                              |   |   |   |   |   |   |   |   |
|                                        | mi       | v                              |   |   |   |   |   |   |   |   |
|                                        | ct       | v                              |   |   |   |   |   |   |   |   |
|                                        | bd       | v                              |   |   |   |   |   |   |   |   |
|                                        | at       | v                              |   |   |   |   |   |   |   |   |
|                                        | ca       | v                              |   |   |   |   |   |   |   |   |
|                                        | ar       | v                              |   |   |   |   |   |   |   |   |
|                                        | di       | v                              |   |   |   |   |   |   |   |   |

Explanation: a: certain infectious and parasitic diseases; b: neoplasms; d: endocrine, nutritional and metabolic diseases; e: mental and behavioural disorders; f: diseases of the nervous system; g: diseases of the eye and adnexa; i: diseases of the circulatory system; m: diseases of the musculoskeletal system and connective tissue
Medicinal plants of CBG medicinal thematic garden collection were utilized by using part of the plant, namely root, leaves, stem, bark, flowers, fruit, seeds, sap or the whole plant through pounded or boiled processing, and mixed it with other ingredients. Most of plant collections in CBG medicinal thematic garden used as medicinal plant by using its leaves. Thus, the use if these species to treat diseases will not significantly decrease its population because the medicinal plant will not be significantly damaged. Leaves also easy to grow back, so that the use of its leaves will not become treat to medicinal plant extinction. The utilization of leaves to treat diseases also founded on the Maybrat society [52] and Dayak Iban [53]. A detail list of CBG medicinal thematic gardens plant species (attachment 1) can be accessed at https://bit.ly/2LZZmlx

4. Conclusion
There are 26 medicinal plant species in the CBG medicinal thematic gardens that, consist of 23 genus and 22 families. Based on 10th revision of ICD-10-WHO, CBG medicinal plants collections can treat 14 ICD-10-WHO diseases. From these 14 diseases, eight diseases can be treated by five CBG medicinal plant collections in medicinal thematic garden. These species were utilised as medicinal plant by using part of the plant or the whole plant.

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