IDENTIFICATION OF MALAYSIAN MEDICINAL PLANT: ILLUSTRATION, DNA BARCODING AND METABOLITE PROFILING OF LOCAL MEDICINAL PLANTS

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ABSTRACT

IDENTIFICATION OF MALAYSIAN MEDICINAL PLANT: ILLUSTRATION, DNA BARCODING AND METABOLITE PROFILING OF LOCAL MEDICINAL PLANTS

Chia Woon Ling

Medicinal plants are become the mainstream of nature source for modern drugs. Nevertheless, the Malaysia community has not been able to fully utilise the knowledge of local medicinal plants as a vast amount of medicinal plant still remained undiscovered. Besides, previous research mainly focused on certain species or plant with specific medicinal values. Therefore, to contribute the existing knowledge system, it is necessary to back up the local medicinal plants knowledge with scientific information. To ensure the success of downstream application of medicinal plants, knowing the plant's identity and their metabolite contents are important. Current study utilises morphological traits and DNA barcoding in plant identification, and untargeted metabolite profiling to access the metabolite compounds. A total of thirty-five medicinal plant samples were collected from state of Selangor, Negeri Sembilan, and Johor Malaysia with each sample were assigned with a voucher code. Three barcode region of ribulose 1,5-biphosphate carboxylase (*rbc*L), maturase K (*mat*K), and internal transcribed spacer (ITS) were tested for their suitability as DNA barcoding regions. Untargeted metabolite profiling was performed via liquid chromatography-

tandem mass spectrometry (LC–MS/MS). Based on morphological traits, all plant samples were identified and verified by a team of taxonomist. Herbarium vouchers of respective plant samples were deposited in Perdana Botanical Garden Kuala Lumpur. Overall, for all the three regions, the identification of genus-level is high, ranging from 74.77-95.45% but the species-level identification is low, ranging from 37.14-46.15%. The result confirmed that single locus is insufficient for DNA barcoding of local medicinal plants. The 'known unknown' putative compounds of all 35 local medicinal plants were recorded with putative 160 Phenolic, 95 Terpenes, 70 Nitrogen containing compounds and 81 others putative compounds. This study supplements the 35 local medicinal plants with proper naming, herbarium voucher, and scientific data of DNA barcoding and metabolite profiling that can become the fundamental for future research works especially in pharmaceutical industry.

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APPROVAL SHEET

This thesis/dissertation entitled "**IDENTIFICATION OF MALAYSIAN MEDICINAL PLANT: ILLUSTRATION, DNA BARCODING AND METABOLITE PROFILING OF LOCAL MEDICINAL PLANTS**" was prepared by CHIA WOON LING and submitted as partial fulfillment of the requirements for the degree of Master of Medical Science at Universiti Tunku Abdul Rahman.

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SUBMISSION OF THESIS / DISSERTATION *

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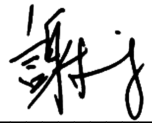

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LIST OF ABBREVIATIONS

BLAST	Basic Local Alignment Search Tool
BRAHMS	Botanical Research and Herbarium Management System
CBOL	Consortium for the Barcode of life
cox1 or COI	Mitochondrial cytochrome C oxidase subunit I gene
DNA	Deoxyribonucleic acid
E	East
FRIM	Forest Research Institute Malaysia
GC-MS	Gas chromatography coupled with mass spectrometry
gDNA	Genomic DNA
GPS	Global Positioning System
ID	Identity
ITS	Internal transcribed spacer
LC	Liquid chromatography
LC-MS	Liquid chromatography- mass spectrometry
LC-MS/MS	Liquid chromatography-tandem mass spectrometry
*Mat*K	maturase K
MS	Mass spectrometry
MS/MS	Tandem mass spectrometry
m/z	Mass to charge ratio
N	North
NaCl	Sodium chloride
NANPDB	Northern African Natural Products Database
NH_4AC	Ammonium acetate

NMR	Nuclear Magnetic Resonance
PCR	Polymerase chain reaction
*Rbc*L	ribulose 1,5-biphosphate carboxylase
UNPD	Universal Natural Products Database

CHAPTER 1

INTRODUCTION

Medicinal plants are an important source of curative and preventive therapeutic for mankind, which has been used to extract important bioactive compounds (Mbuni et al., 2020; Miller, 2001; Lewis and Elvin-lewis, 1995). Its' contribution to healthcare and livelihood makes them one of the most valuable non-timber forest products (Yang et al., 2014). However, it should be aware that using medicinal plants may have some drawbacks that lead to adverse effects. Firstly, is the misidentification of medicinal plants (Ekor, 2014). To cite an example, herbal medicine in Europe comes from traditions all over the world, diversity adds to the challenges of basic naming and validation of the plant identity (Shaw et al., 2012). Secondly, differences in extraction methods or decoctions approach and habitats of medicinal plants may lead to differences in medical efficacy (Wang et al., 2019).

Examining the literature reviews and research studies on Malaysia local medicinal plants, two types of studies are found, namely those that focus on traditional knowledge of medicinal plants (Ong et al., 2011a; Alsarhan et al., 2012; Ong et al., 2011b; Ramli et al., 2021) and those focused on certain medical interest activity (Liew et al., 2020; Jamal et al., 2011; Izzany et al., 2018). Regarding the studies of traditional knowledge of medicinal plants, for example, studies of remedies using local medicinal plants among the Tribe in

Kelantan Malaysia were reported by Zaki et al. (2019). There are fifteen families of medicinal plant species, including those from Zingiberacea, Annonacea, and Umbelifeae were used by aborigines as remedies. The research on local medicinal plants deals with specific medicinal activities; there are studies for examples for the activities of antidiabetic (Ong and Azliza, 2015), anticancer (Mainasara et al., 2018), and anti-inflammatory (Rahim et al., 2021)). As compared to the diverse flora ecosystem in Malaysia which recorded more than 17,631 species of plants in 2016 (Department of Information, 2016), the research on local medicinal plants is still considered scanty.

Plant identification roles should not be taken lightly as they are the most important for all downstream applications (Raime et al., 2020; Tunde and Ogunkunle, 2021). Traditional approaches to identify plants are based on morphological characteristics or organoleptic methods (Friedheim-Sophie, 2016; Ismail et al., 2018). However, these methods require taxonomist to identify the plant species, which is beyond the ability of any layman (Kaur and Kaur, 2019). To meet identification requirements, advances in molecular techniques have promoted the easier identification application of DNA barcoding analysis in the taxonomic field (Hebert et al., 2003). The Consortium for the Barcode of Life (CBOL) approved *ribulose 1,5-biphosphate carboxylase* (rbcL) and *maturase K* (matK), as the official DNA barcode for all land plants in 2009 (CBOL et al., 2009), at the same time internal transcribed spacer (ITS) has also been suggested as supplementary plant barcode by some researchers (Chase et al., 2005; Kress et al., 2005). Integrating DNA barcoding technology with traditional taxonomy gained success in plant identification (Carneiro de

Melo Moura et al., 2019). Numerous studies on molecular identification on medicinal plants but limited to certain families or species such as Piperaceae (Naim and Mahboob, 2019), pineapple (Hidayat et al., 2012), *Clinacanthus nutans* (Ismail et al., 2018). Current study enabled the identification of medicinal plants by integrating the traditional taxonomy with DNA barcoding.

Besides identifying the plant, knowing the chemical constituents of medicinal plants is important for modernising their use (Upton et al., 2020). This is because the metabolites of medicinal plants are varied and complex; clarifying the specific contents and their biological functions is a complicated task (Yi et al., 2018). Mass spectrometry (MS) combined with various types of analytical separation techniques such as Liquid Chromatography (LC) yields highly sensitive results in detecting metabolites contents (Gowda and Djukovic, 2014). Untargeted metabolite profiling gained popularity as it is capable to detect a wide range of metabolites (Bedair and Sumner, 2008). Metabolites from certain medicinal plants were well studied and explored for their medicinal properties, such as *Eurycoma longifolia* (Tongkat Ali) (Chua et al., 2011b; Alias et al., 2020) and *Labisia pumila* (Kacip Fatimah) (Chua et al., 2011a; Karimi et al., 2016). There is still more about local medicinal plants in terms of metabolites yet to be explored. By applying untargeted metabolite profiling in the current study, a wide range of metabolites of the plant sample can be assessed.

Thus, this study embarked with the following objectives:

1. To collect thirty-five medicinal plants for macroscopic photograph identification.
2. To prepare herbarium voucher for thirty-five medicinal plants.
3. To identify the medicinal plant using DNA barcode based on *rbc*L, *mat*K and ITS sequences.
4. To determine the putative metabolites of thirty-five medicinal plants by using untargeted metabolite profiling.

CHAPTER 2

LITERATURE REVIEW

2.1 Medicinal Plants

Medicinal plants have long been utilised in healthcare since time immemorial. It has been used worldwide to treat different types of diseases. The awareness of medicinal plant utilization is a result of numerous long-time battles against illnesses. A medicinal plant is defined as any plant that, in any of its organs either one or more, contains substances that can be used for medicinal purposes, or which can be employed as the antecedents for the synthesis of valuable drugs (Sofowora et al., 2013). The primitive people used the trial-and-error method to distinguish useful plants with toxic or beneficial effects (Folashade et al., 2012). The beneficial use of these plants has been increasingly refined over centuries and generations, and it is now recognised as traditional medicine in different countries.

Plant is a major source of drugs, either in isolated compounds to be dispensed in standardised dosage or crude drugs form (Oladeji, 2016). Herbal medicine derived from plants is chemically complex mixtures consisting of various metabolites with multiple potential targets and mechanisms. In many countries, medicinal plants are consumed daily as food and as a functional food to promote health. Foods are to satisfy hunger and provide physiological

benefits that optimize health conditions and aid in reducing disease (Hasler, 2002). The word 'functional foods' describe those foods that have physiological impacts beyond providing nutrients (Rivera et al., 2010). Numerous research have been done on the role of disease prevention of these medicinal plants.

Carovic-Stanko et al. (2016) presented the beneficial effects of the mint family (*Lamiacea*e species) in the study. Fifty-six species with medicinal properties due to biological activity and edible parts were reported. The review focused on the secondary metabolites encompassing varieties of beneficial functions as antioxidants, antimicrobial, and anti-inflammatory agents.

Amoateng et al. (2018) described their ethnobotanical approach in exploring herbal plants in treating mental and nervous system disorders. The study reported 32 plant species used by the local practitioner, with most of the species belong to Meliaceae, Apocynaceae and Asteraceae family. 50% of the plant reported consists of analgesic properties, with the other having anticonvulsant, antidepressant, and anxiolytic properties.

Salehi et al. (2019) reviewed the potential antidiabetic property of medicinal plants. The reviews include more than 500 plants are used in Asian regions with antidiabetic, antihyperglycemic and hypoglycaemic activities as well as α-glucosidase and α-amylase inhibition. The phytochemistry responsible for antidiabetic properties was reviewed, most of them belongs to alkaloids, flavonoids, and triterpenoids.

In recent years, medicinal plants used among cancer patients illustrated the importance of medicinal herbs as natural anticancer agents. Research has been conducted by Promraksa et al. (2019) on Thai medicinal herbs against cholangiocarcinoma. Medicinal plant *Scoparia dulcis* L. showed an inhibitory effect on cholangiocarcinoma cells by apoptosis induction. Another research reviewed 105 medicinal plant species in Malaysia against breast cancer cells. Those plant species are from 54 different families and 79 genera, such as *Allium cepa*, *Allium sativum*, *Annona muricata*, *Morinda citrifolia*, and *Zingiber officinale*. The review provided a general framework on the type of mechanisms plant extracts inhibit cancer cells and provided therapeutic proof for some anticancer plants (Mainasara, Abu Bakar and Linatoc, 2018).

2.2 Importance of Medicinal Plant Research

2.2.1 Sustained Traditional Knowledge of Community

Traditional knowledge on herbal plants is passed from generation to generation via a verbal form using its vernacular name. New generations are more dependent on Western medicine and are no longer dependent on the traditional ways of utilising the herbal plant. They have little knowledge on identifying and distinguishing the role of plants, which directly erodes the knowledge (Lin, 2005). Previous researchers reported the threatened condition of traditional knowledge of medicinal plants due to a lack of research and documentation (Hong et al., 2015). Documentation of folk medicinal plants is a fundamental point for further research on potentially useful drugs. There has

been a dearth of published data and knowledge of medicinal plants in Malaysia. Documentation of medicinal plants of indigenous tribes in Malaysia is still far from complete (Milow, Malek and Ramli, 2017).

In Malaysia, the documentation on local medicinal plants is still an ongoing process. Most of the data for traditional practices of medicinal plants are done through personal interviews and observations. Othman and Khiruddin (2018) reported Malay Midwifery practices using more than 30 plant species in Kelantan Malaysia. Another group of researchers studied the ethnobotany and phytochemicals of three species of wild Zingiber used by the local communities in Sabah (Kulip et al., 2020), and emphasise the importance of documentation on traditional medicinal plant knowledge on socio-economic upliftment. Documentation and research on medicinal plants are vital in preserving and conserving traditional knowledge, but it too paves the direction for future pharmaceutical and phytochemical research, especially drug discovery.

2.2.2 Ensuring Quality, Safety and Efficacy of Herbs

As the herbal industry grows, consumer safety in utilised medicinal plants is an issue that cannot be neglected. Quality control for testing and identifying raw materials should tighten to ensure all the plant materials used in pharmaceutical products are suitable for their intended use. Many herbal products are launched into the market without prior research, toxicology studies, and safety guidelines (Folashade et al., 2012). Despite that, the community often blindly believes that natural products are safe without knowing that they do

come with risk (Firenzuoli and Gori, 2007). Therefore, the research of medicinal plants must be intensified.

Assuring the quality control of local medicinal plants starts with the correct identification of the plant species. Since Malaysia is a multi-racial country, every race ethnic has its name for the plant and has different ways of using those medicinal plants. Using a common name without a scientific name can mean different things to different communities and languages in distinct geographical locations, and may change over time (Dauncey et al., 2016). Confusion in plant names and terminologies was reported (Sabran, Mohamed and Abu Bakar, 2016). Misidentification of plants may lead to the misuse of unrelated or undesirable species, bringing risks to the consumers (Osathanunkul et al., 2018). De Boer et al. (2014) study revealed the finding of vernacular names of *kelkh* consist of different species, and 68% of traditional medicine unmatched with species in an expected genus. The same conclusion was drawn by Otieno et al. (2015), where the study found that local medicinal plants can be be either under-differentiate or over-differentiate as compared to scientific species. The folk generics could constitute different species related to the same genus or based on morphology characteristics significant in folk classification. Both studies supported relying solely on vernacular names, which can lead to confusion and mistake in species identification.

2.3 Herbarium Voucher

The botanical collection is essential for the plant identification process. Collection of plants serves to provide material in further research and serve as reference material for named taxa. The reference plant collection is known as voucher specimen or herbarium (Simpson, 2019). A voucher can be defined as a representative sample organism identified by an expert and stored at a particular place whereby the researcher may later obtain the voucher for further study (Culley, 2013). In other words, herbarium serves as the storehouse for botanical specimens, for reference and future study (Maden, 2004). Data obtained from herbarium specimens are stable, most specimens include metadata recorded during the time of collection, geographical location, other narrative text written by the collector during label preparation or collection and characteristics of the actual plant that may be observed (Lughadha et al., 2019).

2.3.1 Collection of Voucher Specimens

A well-prepared herbarium voucher is the foundation of research, which verified the plant material that was used and studied; in contrast if a specimen is unavailable, the identity of the materials used may be questioned (Eisenman et al., 2012). There are a few criteria to be emphasised during the collection of voucher specimens. First, the plant material is collected from the same species, simultaneously and at the same location. Second, vital characteristics parts of the plants or all available aboveground of the specimen should be collected to ensure identification accuracy. Third, other refined materials such as powdered

root or other biomass stored in appropriate containers should be attached. These samples are essential for material's organoleptic, microscopic and chemical constituents that may contribute to identification accuracy (Hildreth et al., 2007). All vouchers are assigned with a unique identification number and details label for permanent identification purposes. Data recorded on the data includes collector's name, collection's date, geographical data with latitude and longitude, habitat of the collection site, plant, and other miscellaneous data (Culley, 2013; Carter et al., 2007).

2.3.2 Functions of Herbarium Vouchers

According to Nesbitt (2014), voucher specimens have the function of allowing immediate identification at first glance, allowing the reproducibility of studies, and allowing the work to be updated with new taxonomic concepts. Other researchers in different research work support these viewpoints. Carranza-Rojas et al. (2017) stated that herbarium voucher specimens allowed reproducibility and ensured unambiguous referencing of research results relating to plant species. Lughadha et al. (2019) mentioned the importance of herbarium specimens in providing verifiable and citable evidence of the presence of plants at a particular time and space which is an important criterion in assessing extinction risk of the plant. According to Curtis (2013), species identification alters over time as knowledge towards plants grows, the plant sample and voucher with the same name serve as cross-references for future studies and research. The herbarium is used to study evolutionary change (Wandeler et al., 2007), biogeography and ecology (Kolanowska et al., 2016).

Herbarium provides a window to ancient population histories of plants that may not exist in the current and the past evolutionary process (Bieker and Martin, 2018). Researchers are sampling DNA from these readily-available sources to study those rare, or difficult to obtain taxa or extinct species (Shepherd, 2017). Beyond the benefits mentioned, herbariums, in terms of medicinal plants, have the additional function of providing knowledge on treating health-related issues and providing information for developing new drugs (Narina, 2020). Senchina (2006) proposed using medicinal herbaria in medica botany curricula, emphasizing the information on herbarium in research and societal contexts.

2.4 Plant Identification

Plant identification is defined as associating an unknown with a known entity as mentioned in 'Plant Systematics' (Simpson, 2009) and including the scientific name of the identified entity (Dauncey et al., 2016). The importance of the scientific name was even being stressed in the last decade. The scientific name was described as the crucial link between modern western science and those people with folk knowledge. It becomes the structure for bridging the two different cultures and facilitating the mutually beneficial exchange of data and information (Bye, 1986).

Morphology and DNA barcoding are ideal for plant characterization and identification (Tripathi et al., 2013). In the case of unidentifiable morphology, the molecular method is another better approach. This was supported by Mainasara, Abu Bakar and Linatoc (2017), the research group able to identify

58 plant samples to at least family level that could not be identified based on the morphology approach by using molecular approach. Both approaches can complement each other in identifying sample studies, just as the research was done by Genievskaya et al. (2017) on sand rice collected in Kazakhstan. The finding agrees with a study from Moura et al. (2019), which reported that molecular data complied with morphological identification for the tree diversity in Sumatra, Indonesia. Proper and correct identification of plant species is the vital step that will ensure the success of downstream research.

2.4.1 Traditional Approach: Morphological-Based Identification

Pires and Marinoni (2010) stated that traditional taxonomy is the foundation for biology, researchers would be unable to access the available information and would be unable to report their findings if the identity of the sample cannot be confirmed. Traditionally the identification of plants has been based on external morphology (Nadia, 2011). Plant morphology is defined as the physical appearance of a plant (Wyatt, 2015). Botanical expert answering a series of question about the unknown plant with the criteria of morphology appearance such as leaves, flower, colour, shape, number of petals and other important features to narrow down the set of candidate plant species, and the answered questions eventually reveal the identity of a plant (Wäldchen and Mäder, 2018).

Determination of plant species using a morphology approach required professional experts who mastered a wide range of plant characteristics (Wang,

2017). Four major limitations were documented by Hebert et al. (2003). First, the phenotypic plasticity and genetic variability within the characters utilised for species recognition can lead to erroneous identifications. Second, morphological taxonomy neglected cryptic taxa. Third, many individuals cannot be identified as the morphological keys are usually viable under a particular stage of life or gender. Fourth, misdiagnoses are common as a high level of expertise is needed for the identification and verification.

Among the traits, the leaves are the most common feature for identification (Jamil et al., 2015). Identification of leaves can be done by their distinct shape, texture, and colour (Bhandarkar et al., 2014). Researchers suggest that leaves are easiest to obtain and that they are present for most of their existence as compared to flowers and fruits present in certain seasons (Le et al., 2014). However, studies reported that leaves structures change in response to the environment (Yang et al., 2015). Different studies were conducted on the plasticity of plant morphology affected by the environment. Guo et al. (2017) studied 17 plant species in temperate grassland, and results showed that the leaves thickness increased with heightened aridity, while the vessel diameter and stomatal index decreased with aridity. Another study showed that the leaves have a parallel response to climate rather than geographical variance (Alcántara-Ayala et al., 2020).

The impediments inherent in morphological-based identification systems signal the need for a modern approach to taxon recognition.

2.4.2 Molecular Approach: DNA Barcoding

The molecular method consists of unique genetic diversity, specificity and population differentiation compared to morphological-based identification. Based on the knowledge in molecular biology, Paul Hebert proposed the term of DNA barcode to use in species identification (Hebert et al., 2003). The limitations of morphological-based identification merit the extension of the DNA Barcoding approach to all life.

2.4.2.1 DNA Barcoding

DNA barcoding is a technique that used a species-specific DNA region to identify species (Hebert et al., 2003), where traditional taxonomic identification is not practical (Lahaye et al., 2008). This technique utilised short, standardised DNA sequences to tag for rapid, accurate and automatable species identification (Hebert and Gregory, 2005). The process of applying DNA barcodes for identification purpose entails two vital steps namely building a DNA barcode library of known species, followed by matching the DNA barcode sequence of unknown samples against the library (Kress, 2017). At first sight, taxonomy seems to be the field that gained the most benefits from this technology. In fact, as described by Chase et al. (2005), there are two potential category of DNA barcoding user: taxonomist or systematics and scientist of other fields. The former used it to identify species, while the latter used the information generated by the former to do further research.

The utilisation of DNA barcodes has not been without criticism. Claims for its usage are extravagant, but it should not replace traditional taxonomy, only as a tool that provides information for the unknown species (Ebach and Holdrege, 2005). Tautz et al. (2003) concerned that the minor differences in DNA sequences not particularly useful for differentiating closely related species; in other words, the data can become uninformative. Other researcher was concerned that by replacing traditional taxonomy with DNA barcoding, newly discovered species would be unable to be properly described (Ebach and Holdrege, 2005). Collins and Cruickshank (2013) pointed out that human error and uncertainty in creating reference libraries will be the stumbling block for utilising barcoding as a molecular diagnostic tool.

2.4.2.2 Applications of DNA Barcoding

Contrary to these contretemps, DNA barcoding has received positive feedback from expertise in different fields. DNA barcoding for wildlife forensic aiding the species identification from trace amount of specimen materials (Kumar et al., 2012; Khedkar et al., 2019). The scientist also gains benefits from the technology in identifying fish (Bingpeng et al., 2018; Panprommin et al., 2019) and insect species (Changbunjong et al., 2018; Rasool et al., 2019). DNA barcoding is not limited to identifying species from unknown species, and perhaps it has broader applications for example in archelogy field and study of diversity of animal.

Bilgin et al. (2016) used DNA barcoding to document avian diversity in Eastern Turkey. The data obtained from DNA barcoding can provide a snapshot of the genetic diversity in the region and is possible to document the negative impact of hydraulic works and construction of dam towards the habitat of 264 bird species. The study indicated that the data obtained can be used for phylogeographical comparison at continental scales.

DNA barcoding has gained a place in the field of archelogy and paleoecology. Linseele et al. (2013) utilised DNA barcoding to study the archaeological dung to obtain preliminary information about potential defecators and make it possible to narrow down the genetic screening to genus or species level. The research indicated that dung may be the only evidence for the presence of certain species during certain period that may not represented among the bone remains of certain historical site (Linseele et al., 2013). Another research group utilised the technology to analyse the heavily fragmented bones of animal at historical sites, which cannot determine the species based on morphological characteristics (Dalén et al., 2017).

The technology gained substantial achievement in identifying species responsible for bird-aircraft collision cases, relying on morphological identification for more than 50 years (Dove et al., 2008). González-Varo, Arroyo and Jordano (2014) used DNA barcode to quantify frugivory and seed dispersal interaction networks. In Metro Vancouver, a DNA barcode was applied to a comprehensive seafood market survey study to evaluate the integrity of seafood market (Hu et al., 2018). While Cock, Buddie and Cafa

(2019) use DNA barcoding to assess the host-parasitiod system of banana skippers where the morphological characters of the host cannot be reliably identified.

DNA barcodes can also act as a tool in providing details for diet and food web details. DNA analysis of faeces enable investigation on predator diet and provides different insight towards the diet composition of certain species (Deagle and Tollit, 2007). The research of diet for *Laisurus borealis* identified 127 different species of ingested insect found on guano compared to previous researcher only indicated that these bats prey on moths (Clare et al., 2009). Similar research was done on defecated or regurgitated seed and faeces of frugivore species to study the networks between bird species and seed dispersal (González-Varo et al., 2014).

2.4.2.3 DNA Barcoding in Plant

DNA barcodes were used to evaluate the substituted samples of herbal raw material. Research group from Thailand and Japan utilised DNA barcodes to authenticate *Terminalia* fruit sold in Thai herbal market to monitor safety of drug and adverse drug reactions. The authors found that the use of Internal Transcribed Spacer 2 (ITS2) supplement with psbA-trnH discriminated against all the *Terminalia* species (Intharuksa et al., 2020). Similar research was conducted on *Glehniae Radix* (Beishashen) to differentiate the authentic herbs sample from the seven common adulterants using ITS2 sequences (Zhu et al., 2015). Unnikrishnan et al. (2021) analysed the adulteration of *Coscinium*

fenestratum (Gaertn.) Colebr, widely used ayurvedic herbs with *B. aristate* using ITS, psbA-trnk, *mat*K and *rbc*L.

Besides the authentication of botanical raw materials, different researchers focus on authenticating the botanical raw materials which are in the form of powder or finished formulation or in dietary supplements. Molina et al. (2018) successfully barcoded 20 samples of herbal medicine products sold online and found out four of the products did not match the claimed botanical species. Amritha et al. (2020), in recent research accessed the authenticity of 70 powders and 33 roots of Ashwagandha in the market. Their analysis revealed that 23% of samples were non-authentic, and among the non-authentic samples, 95.6% were in powdered form. The study successfully identified six different plant species from four different families present as substituting or adulterant in those impure powder samples. DNA barcoding enables the validation of botanical adulteration of market samples of Ashwagandha.

DNA barcoding provides new insight for plant community assembly via community phylogenetics. Tan et al. (2018) utilised DNA barcodes to identify both woody and herbaceous species in the plant community at Himalaya-Hengduan Mountain region. With the data obtained from DNA barcoding, a group of researchers analysed the taxonomic structure of plants on Xisha Islands and concluded that barcode's high species identification rate contributed by the far genetic distance among lineages (Li et al., 2018).

2.4.2.4 Universal DNA Barcoding

Standardisation, minimalism, and scalability are the three most important criteria of DNA barcoding. In selecting barcoding regions, it involves choosing only a minimal amount of standard locus that is reproducible and reliable in large or diverse sample sets, resulting from the maximum capacity of species discrimination power (Hollingsworth et al., 2011). In 2003, mitochondrial cytochrome C oxidase subunit I gene (cox1 or COI) was proposed as a universal marker for the animal kingdom (Hebert et al., 2003). However, this locus is incompatible with the plant samples due to its low mutation rate (Fazekas et al., 2008; Kress et al., 2005). The successful utilisation of the CO1 gene in the animal kingdom attracted researcher to find universal DNA barcodes for plant species. In the year 2007, the Alfred P. Sloan Foundation and the Gordon and Betty Moore Foundation (both in the U.S.A.) funded a project to figure out suitable gene regions that could be used as "the universal land plant barcoding protocol". The project involved seven countries researching with more than 100 potential plastid regions for plant barcodes. Based on the reports' finding, no single plastid DNA marker can be used across all the land plants (Chase et al., 2007).

Different researchers have proposed various plastid markers as universal barcodes from the historical view of searching for a suitable plant barcode. A group from Royal Botanic Kew Garden proposed the use of rpoC1, rpoB and maturase K (*mat*K) or rpoC1, *mat*K and psbA-trnH (Chase et al., 2007); ribulose-1,5-biphosphate carboxylase (*rbc*L) complements with trnH-psbA by

Kress and Erickson (Kress and Erickson, 2007); while Lahaye et al. (2008) proposed the use of *mat*K alone.

For shared community resource, there is necessary to have agreement on a common barcode. To facilitate selecting suitable plant gene regions, the Consortium for the Barcode of Life (CBOL) Plant Working group came out with selection criteria of universality, sequence quality, and discriminatory power. Based on the criteria, *rbc*L and *mat*K was proposed as the plant's core barcode (Hollingsworth et al., 2011). Later, Internal Transcribed Spacer (ITS) was recommended by CBOL as a barcode for land plants (Hollingsworth, 2011).

2.4.2.4.1 Ribulose-1,5-Biphosphate Carboxylase

Sen et al. (2011) mentioned that ribulose-1,5-biphosphate carboxylase large subunit (*rbc*L) is famed as the most abundant protein in nature and is important for autotrophy. The *rbc*L gene provides useful information to the barcode dataset because it is easily amplified, sequenced and aligned in most land plants (Hollingsworth, Graham and Little, 2011). Studies by Maloukh et al. (2017) indicate that *rbc*L is a promising barcode locus for 51 plant samples. Modest discriminatory power of *rbc*L was reported in the study on *Fritillariae cirrhosae* bulbus, a type of Chinese herbal medicine to treat coughing (Chen, Wu and Zhang, 2020). However, CBOL reported low discriminatory rate of 26.4% for this gene on 5118 plant samples (China Plant BOL Group et al., 2011).

2.4.2.4.2 Maturase K

The maturase K (*mat*K) gene formerly known as orfK, is a chloroplast gene consisting of 1500 bp (Selvaraj et al., 2008). The *mat*K has emerged as an invaluable locus because of its' high discriminatory ability repeatedly proven by researchers in DNA barcoding and phylogenetic studies. *mat*K was described as high effectiveness and more specific accuracy levels than another barcode region (Probojati et al., 2021; Moura et al., 2019). Using *mat*K, a 100% species resolution rate was achieved in distinguishing 42 individuals plant samples (Parveen et al., 2012). The high discriminatory power of *mat*K was also reported in *Daniellia ogea* and *Daniellia oliveri* (Onefeli, 2021). However, the drawback of *mat*K has been reported as it has low amplification and sequencing rate; it is even being reported as there is no single universal primer of this locus in sequencing the plant kingdom (Yu et al., 2011; Dunning and Savolainen, 2010).

2.4.2.4.3 Internal Transcribed Spacer

Internal Transcribed Spacer (ITS) was described as low functional constraint, universal, and simplicity by the previous researcher (C. T. Wu et al., 2013). It is one of the most frequently used nuclear DNA markers in the study of DNA barcoding and plant phylogenetic (Botany, 2016). The utilisation of ITS for evolution or phylogeny arose between 1995-1996 with paper-reported successful markers in conifer species and angiosperm (Hershkovitz and Zimmer, 1996; Bobola et al., 1992). The high efficiency of ITS was further supported by Abugalieva et al. (2017) in the study of *Allium* species reported variability of

ITS is 6.6 higher than the other tested marker. ITS region possesses the characteristics of difficulty in amplify or sequence and consists of paralogous gene copies, which limit its utility (Hollingsworth, 2011).

2.5 Metabolites

The plant kingdom contains approximately 200,000 to 1 million metabolites compounds (Dixon and Strack, 2003). The presence of metabolites in plant samples are the natural source for traditional medicine, modern medicine, folk medicine, and pharmaceutical industries (Daniel and Krishnakumari, 2015). The research community classified these metabolites into either primary or secondary metabolites based on the functions. However, according to Erb and Kliebenstein (2020), there are no precise biochemical boundaries between the metabolite classifications.

2.5.1 Primary and Secondary Metabolites

Primary metabolites for all living cells are the same, consisting of carbohydrates, amino acid, protein, tricarboxylic acids, nucleic acids and polysaccharides (Hussein and El-Anssary, 2018). Primary metabolites are directly needed for the development and growth of plants (Fernie and Pichersky, 2015). Primary metabolites also serve as signalling molecules to trigger defence response (Kachroo and Robin, 2013). It took decades for researchers to believe that the secondary metabolites of plants are not waste, but the unique set of secondary metabolites is essential for a plant's ecological niche (Hartmann,

2007). According to Wink (2018), plants produce and store mixtures of secondary metabolites, whose main function is for defensive purposes. Compared to known secondary metabolites, only limited number of these metabolites were under thorough study (Wink, 2008). The complex chemical composition of secondary metabolites is present to respond to abiotic or biotic stress of the environment as well as to fulfil certain physiological tasks (Ncube and Van Staden, 2015). The author mentioned that secondary metabolites are dispensable for growth but indispensable for a plant's survival. Importantly, plant secondary metabolites act as natural sources of compounds used in a wide range of industrial applications for healthcare and cosmetic purposes (Tiwari and Rana, 2015). Research showed that ingestion of plant secondary metabolites provides antioxidant and anthelminthic properties towards mammals (Iason, 2005). Secondary metabolites were derived from primary metabolites, and it can be classified into three main classes, terpene, phenolic and nitrogen-containing compounds (Pott et al., 2019).

2.5.1.1 **Terpenes**

Terpenes account for nearly one-third of all compounds characterized in Dictionary of Natural Products. In decade, the existence of terpene recorded an increase from approximately 25,000 to 80,000 in the year 2017 (Gershenzon and Dudareva, 2007; Christianson, 2017). It plays a critical role in plant defence systems, and acts as signalling molecules to attract the insects for pollination (Singh and Sharma, 2015). Besides, terpenes are important for the taste, pigment of plants and fragrance (Cox-Georgian et al., 2019). It was reported

that the terpene contents of five tropical medicinal plant spices are used as flavouring in the packaged tropical foods (Obiloma et al., 2019). Terpenes is reported with various medicinal uses such as antimicrobial, anticancer, antiviral, anti-inflammatory, and antihyperglycemic activities (Brahmkshatriya and Brahmkshatriya, 2013).

2.5.1.2 Phenolics

More than 8000 phenolic compounds have been recorded in different plant species (Pandey and Rizvi, 2009), that contains simple phenolics, phenolic acids, coumarins, flavonoids, stilbenes, hydrolyzable and condensed tannins, lignans and lignin (Naczk and Shahidi, 2006). The phenolic compound is found in non-edible and edible plants; the presence is associated with multiple biological functions (Supritha and Radha, 2018). The function of phenolic compounds in plants are for growth and development (Doberski, 1986; Rasouli et al., 2016), reproduction (Ghasemzadeh and Ghasemzadeh, 2011) and function of both attracting and repelling organisms surrounded the plant (Bhattacharya et al., 2010). Phenolic compounds receiving attention due to their various health benefits such as protective effects against obesity (Turner et al., 2021; Yu et al., 2020), prevent ageing (Grau-Bové et al., 2020), immunomodulatory effects (Shakoor et al., 2021) and anti-inflammatory (Vazquez-Cervantes et al., 2021).

2.5.1.3 Nitrogen-Containing Compounds

Zaman et al. (2020) described nitrogen-containing compounds as the third important category of secondary metabolites. Wink (2011) recorded approximately 24000 known structures of nitrogen-containing secondary metabolites includes alkaloids, amine, non-protein amino acid, alkamides, and lectins reported from higher plants. Among the metabolites, alkaloids are among largest family in this classification with recorded more than 15000 metabolites found in vascular plant species (Nwokeji et al., 2016). Proto-alkaloids and true alkaloids are derived from amino acids, while atypical alkaloids are derived from other sources (Singh, 2018). Alkaloid such as quinine, morphine, and vinblastine play a visible role in modern medicinal drugs (Amirkia and Heinrich, 2014).

2.5.2 Plant Metabolite Analysis

There is currently no best method to identify and quantify the large variety of metabolites (Obata and Fernie, 2012). Analytic strategies for plant metabolite include metabolite fingerprinting, and metabolite profiling. Kopka et al. (2004) described metabolite profiling as the tool to measure hundreds or potentially thousands of metabolites while metabolite fingerprinting is an application to discover the differences between two samples.

Metabolite fingerprinting was used to discriminate between biological samples based on dissimilarity in metabolism caused by factors such as

environment and growth factors (Kruger et al., 2008). It involves sorting datasets into categories rather than identity of the metabolites present in plant samples (Krishnan et al., 2005). It has multiple uses in the interpreting of plant metabolism. Scholz et al. (2004) utilised metabolite fingerprinting in detecting the biological background of *Arabidopsis thaliana*. Another group of researchers detected nine metabolite classes which were accumulated among tissues of accessions from *Arabidopsis thaliana* using the tool (Silveira-Sotelo et al., 2015). The technology gained success comparing *Eleuthrine palmifolia* bulbs by showing differences in the metabolite content of six different plant samples from six different regions (Mutiah et al., 2019).

Metabolite profiling focused on the identification of particular metabolites (Krishnan et al., 2005). It is the study of small molecule metabolites and can be used in various aspects of plant biology such as, environmental stress, nutritional requirement and growth and development (Desai and Alexander, 2013). The technique was used to study the functional metabolite and metabolites for the taste of vegetables (Tamura et al., 2018). Through the data obtained from metabolite profiling, researchers analysed the mineral nutrients of plants (Kim et al., 2018). Besides, metabolite profiling can potentially contribute to data regarding the differences caused by the environment or post-harvest process (Ovesná et al., 2021).

Metabolite fingerprinting is efficient for distinguishing the plant sample from other species, while metabolite profiling enables researchers to gain a broader insight into the biochemical composition of the studied sample, both

identified and unknown compounds (Farag et al., 2012; Roessner and Bowne, 2009). Since the current study aims in detecting the larger set of compounds, metabolite profiling will be a better choice of strategies.

2.5.3 Analytical Platform

Metabolite profiling is a technology-driven discipline, taking advantage of newly developed analytical skills to improve data collection and analysis. Several analysis techniques with distinct advantages but also disadvantages were used for metabolite profiling. Nuclear Magnetic resonance (NMR) and Mass Spectrometry (MS) are the most commonly analytical technologies for compound identification (Gathungu et al., 2020; Sahu et al., 2019). Due to extreme huge and complex chemical diversity, no single analytical platform that able to analyse all the metabolites at the same time (Salem et al., 2020). The preferences of choosing between these two platforms arise from the analytical strength of respective researchers and potential challenges in handling the big dataset obtained from the platform (Krishnan et al., 2005). NMR has been used by researchers to profile the nutritional status, geographical origin characterization and environment perturbation on plant samples (Consonni and Cagliani, 2019). NMR spectroscopy is reported as highly automatable, non-destructive, easily quantifiable, allows the routine identification of novel compounds and is much more feasible as compared to mass spectrometry (Emwas et al., 2019). Kupriyanova et al. (2021) mentioned that the NMR could quantify various chemical nature within seconds or minutes. However, the

sensitivity of NMR is 10 to 100 times less than mass spectrometry, especially Liquid chromatography mass spectrometry (Emwas et al., 2019).

According to Wang et al. (2015), mass spectrometry-based approaches have the advantage of high selectivity, sensitivity, throughput, and depth of coverage. Mass spectrometry is usually coupled with liquid chromatography and gas chromatography for small-molecules analysis (Gowda and Djukovic, 2014). Comparison of gas chromatography-mass spectrometry (GCMS) and liquid chromatography mass spectrometry (LCMS) have been carried out by Perez et al. (2016). The result revealed that sample volatilization is not required by liquid chromatography, and it offers advantages of shorter time needed, and potentially a wider array of compounds can be analysed. Based on Kaal and Janssen (2008), size and polarity should be considered when choosing gas chromatography as an analytical platform because only a limited range of non-polar and small molecules is accessible by GCMS. Besides, GCMS has thermal degradation; research revealed that heating processes could produce significant transformation or degradation of molecules (Fang et al., 2015).

LCMS based metabolite profiling was commonly used to detect secondary metabolites and functional compounds in food and plant samples (Ma et al., 2013; Li et al., 2019). The increases detection capabilities of LCMS in natural products promote its usage by a researcher to analyse a wide range of compounds such as nitrogen-containing compounds, flavonoids and terpenoids (H. Wu et al., 2013). LCMS allowed the identification of 13 metabolite compounds extracted from *Calendula officinalis*, *Hypericum perforatum*,

Galium verum and *Origanum vulgare* (Matei, Gatea and Radu, 2015). In recent years, the emergence of tandem mass spectrometry (MS/MS) technology has added much precision and accuracy to this analytical method (Raju et al., 2015). Tandem mass spectrometry has been used to investigate the chemical composition of medicinal plant samples (Jæger et al., 2017).

2.5.4 Targeted Metabolite Profiling VS Untargeted Metabolite Profiling

Metabolite profiling techniques purposely give an overall picture of metabolites content in a biological living system (Fiehn, 2002). The advance of this technology in providing insight towards the metabolite contents have been proved by lots of researchers from different fields. It is described as the key strategy to identify and analyse the nutrient components at a molecular level. Frank et al. (2009) demonstrated the applicability of these techniques in detecting the metabolic differences of soybean mutants and their wild types. Recently, Yang et al. (2021) utilised the technology to detect approximately 600 metabolites in the corn cultivars, of which 50% of the metabolites detected significantly changed among corn cultivars. Metabolite profiling falls into the categories of either targeted or untargeted metabolite profiling. The targeted and untargeted approach relies on how metabolite identification is executed during the processing of data (Pande and Chanda, 2020).

Targeted metabolite profiling is involved in studying a set of predefined metabolites, while untargeted metabolite profiling deals with the characterization and identification of known and unknown metabolites

(Mukherjee et al., 2016). In most situations, a targeted approach focuses on quantifying and identifying choice of metabolites (Lu et al., 2008). For targeted metabolite profiling, the analysis was undertaken using internal standards for a better understanding of a wide range of metabolic enzymes and the end products as well as their biochemical pathways (Roberts et al., 2012). Its' major disadvantage is that it directly reduced the metabolite coverage (Koal and Deigner, 2010) especially in the case of difficulty to obtain the required chemical standards for the metabolites of interest (L. Chen et al., 2020).

If targeted metabolite profiling acts as a cornerstone, then non-targeted metabolite profiling should be considered the stepping stone for metabolite contents. The non-targeted metabolite profiling technique was suggested by some researchers as an additional or supportive tool for targeted metabolite profiling as it can increase the possibility to detect some changes of metabolic from studied sample (Davies, 2010). It is usually done to explore hypothesis generation research, followed by a targeted approach for more accurately quantify of interested metabolites (Xiao et al., 2012; Schrimpe-Rutledge et al., 2016). Non-targeted metabolite profiling aims to detect a vast range of unknown metabolites with varying chemical and physical properties (L. Chen et al., 2020). This property becomes its main advantage; however, collecting data without pre-existing knowledge may accompany the uncertainty in sample preparation and analytical methods, which then further impact the qualitative result obtained from the studies (Schrimpe-Rutledge et al., 2016).

CHAPTER 3

MATERIALS AND METHODS

3.1 Selection and Collection of Plant Materials

A list of 153 local medicinal plants on the basis of ethnobotanical research studies led by Prof. Dr. Lim Yang Mooi previously was provided to the herbalist prior to the field trip. Collection sites were selected based on the prior survey done by the herbalist. All the plants were collected from State of Selangor, Negeri Sembilan and Johor. Field walks with the herbalist were employed to collect specimens of each medicinal plant species. The goal of the field trip was to collect a total of 35 plant species out of 153 from the list. Thus, in the field collection process, plant species that had already been collected were avoided. All the equipment and tools needed during the field trip was recorded in Table 3.1.

Plant collection was conducted from August 2016 to April 2017. Methods for collection of plant specimens were based on the research work of herbarium voucher specimen, DNA barcoding and metabolite profiling. Field work consisted of plant collection, data documentation and photograph. During field work, all the specimens were initially identified taxonomically (leaves, stem, seed, flower, and whole plant) with the help of herbalist, Mr, Haw Ming Hock. The identity of the plant specimens was later confirmed by Dr. Richard

Chung, Senior Research Officer, Floral Biodiversity Programme. Thirty-five local medicinal plants were first assigned with a collection number and field data like their habitats (latitude, longitude), plant morphology (plant height, colour of flower, and size of leaves), medicinal importance and the date of collection was noted in the field notebook. Fresh samples were then individually collected in different sterile plastic bags for the purpose of DNA isolation and LCMS-MS extraction. Due to time constrain for field work, all the cleaning process were done in the laboratory. All the equipment and tools used for the collection of plant sample were recorded in Table 3.1. Details including the family name, scientific name, plant parts used for LCMS-MS analysis and the GPS location for the 35 plants were recorded in Table 3.2.

Table 3.1: Equipment and tools for collection of plant sample

Item	Quantity	Purpose
Field notebook	2	Record field characters of specimens
Specimen tags	1 box	Tag all specimens with field numbers
Pencil	2	To write on tags and field books
Old newspapers	1 bundle	To cover and separate specimens
Plastic bag	1 bundle	To store and preserved specimens
Wooden board and straps	2 set	To press the plant sample
Bush knife	1	To slash the bark of trees to view the texture and get the sample
Camera	1	To take photograph of plant
GPS	1	To record longitude, latitude and elevation of field site
Tape measures	1	To measure the plant samples
Hand gloves	3	Use for collecting all the plants
Secateur	1	To trim and cut the plant

Table 3.2: List of 35 local medicinal plants, plant parts used for LCMS-MS analysis and the GPS location of plant collection.

Family Name	Scientific Name	Plant Parts	GPS Location
Amaranthaceae	*Althernanthera sessilis*	Whole plants	N03° 31' 03.9" E101° 05' 51.5" 9m
Amaranthaceae	*Celosia argentea* L.	Flower	N1°50'12.4" E102°56'00.6"
Amaranthaceae	*Gomphrena globosa* L.	Leaves	N03° 30' 54.3" E101° 05' 51.1" 9m
Annonaceae	*Annona muricata* L.	Leaves	N02° 55' 40.7" E101° 55' 40.8" 94m
Araliaceae	*Eleutherococcus trifoliatus* (L.) S.Y. Hu	Leaves	N03° 01' 15.3" E101° 41' 15.9" 115m
Cactaceae	*Epiphyllum oxypetalum*	Leaves	N1°50'12.4" E102°56'00.6"
Cactaceae	*Pereskia bleo*	Leaves	N02° 55' 53.8" E101° 55' 30.6" 124m
Campanulaceae	*Laurentia longiflora* (L.) Peterm.	Leaves	N03° 01' 19.8" E101° 41' 32.9" 89m
Campanulaceae	*Lobelia chinensis* Lour.	Whole plants	N03° 00'56.3" E101° 41' 15.9" 104m
Compositae	*Ageratum conyzoides* L.	Leaves	N02° 46' 33.3" E101° 45' 11.9" 18m
Compositae	*Artemisia vulgaris* L.	Leaves	N03° 01' 22.4" E101° 41 '33.6" 106m
Compositae	*Blumea balsamifera* (L.) DC.	Leaves	N02° 55' 39.8" E101° 55' 40.4" 107m
Compositae	*Cosmos sulphureus*	Leaves	N1°50'12.4" E102°56'00.6"
Compositae	*Elephantopus scaber* L.	Leaves	N1°50'12.4" E102°56'00.6"
Compositae	*Elephantopus tomentosus* L.	Leaves	N03° 46' 33.2" E101° 45' 10.8" 22m
Compositae	*Mikania cordata* (Burm.f) B.L. Rob	Leaves	N03° 00' 58.8" E101° 41' 13.7" 97m
Compositae	*Vernonia esculenta* Hemsl. Ex Hemsl	Leaves	N03° 01' 21.0" E101° 41' 33.4" 81m

Table 3.2 (continued)

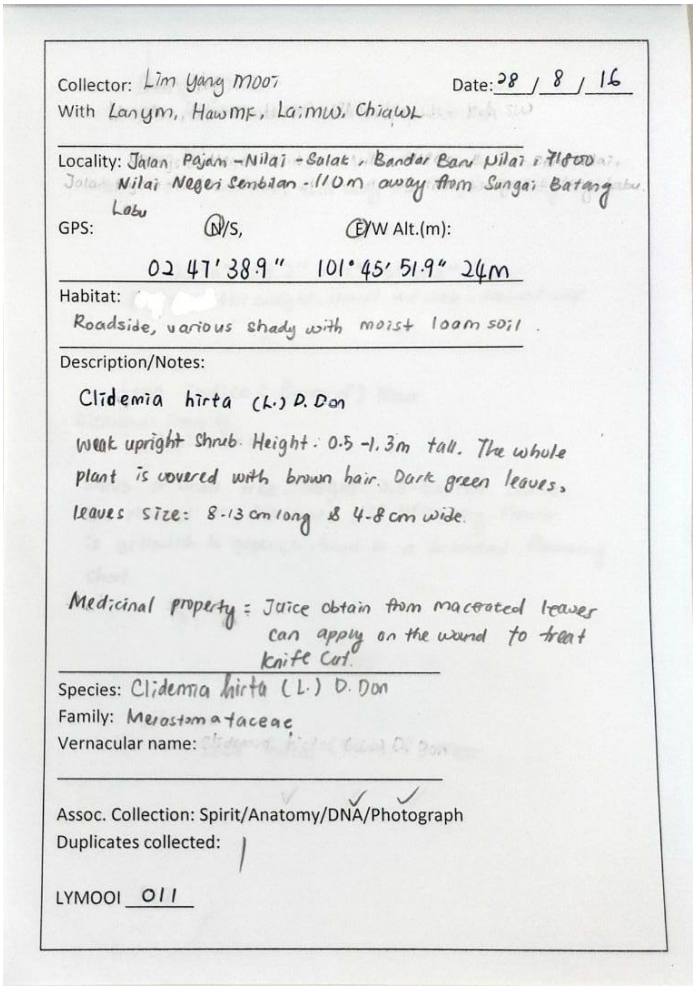
Family Name	Scientific Name	Plant Parts	GPS Location
Euphorbiaceae	*Jatropha podagrica*	Stem	N02° 55' 39.7" E101° 55' 40.6" 103m
Euphorbiaceae	*Ricinus communis*	Leaves	N03° 01' 22.6" E101° 41' 24.8" 89m
Leguminosae	*Senna occidentalis* (L.) Link	Leaves	N03° 30' 59.5" E101° 08' 08.7" 9m
Leguminosae	*Senna tora* (L.) Roxb	Whole plant	N02° 47 '38.9" E101° 45 '51.9" 24m
Malpighiaceae	*Malpighia coccigera*	Leaves	N02° 55' 39.2" E101° 55' 39.6" 103m
Meliaceae	*Melia azedarach* L.	Leaves	N02° 48' 01.9" E101° 46 '07.7" 30m
Meliaceae	*Toona sinensis*	Leaves	N02° 55' 40.7" E101° 55' 40.5" 92m
Moraceae	*Morus alba* Y.B. Wu	Leaves	N02° 55' 40.0" E101° 55' 39.4" 101m
Phyllanthaceae	*Sauropus spatulifolius* Beilla	Leaves	N02° 55' 39.3" E101° 55' 39.6" 103m
Piperaceae	*Peperomia pellucida*	Whole plant	N02° 55' 39.8" E101° 55 '39.7" 99m
Piperaceae	*Piper sarmentosum* Roxb	Leaves	N02° 55' 39.9" E101° 55' 40.4" 97m
Polygonaceae	*Persicaria chinensis* (L.) H. Gross var chinensis	Leaves	N02° 55' 38.9" E101° 55' 40.6" 98m
Simaroubaceae	*Brucea javanica* (L.) Merr.	Leaves	N02° 46' 31.6" E101° 45' 17.2" 25m
Solanaceae	*Solanum nigrum* L.	Leaves	N02° 55' 53.8" E101° 55' 30.6" 124m
Solanaceae	*Solanum torvum* Sw.	Root	N02°47' 38.2" E101°45 '51.8" 16m
Umbelliferae	*Centella asiatica* (L.) Urb	Leaves	N02° 55' 40.0" E101° 55' 40.6" 110m
Umbelliferae	*Eryngium foetidum* L.	Leaves	N02° 55' 39.0" E101° 55' 40.4" 97m
Umbelliferae	*Hydrocotyle sibthorpioides* Lam.	Whole plant	N1°58'54.1" E102°56'21.8"

3.2 Macroscopic Photography

All the assigned plants were photographed in the field prior to preparation as specimens. Most of the photographs were taken by the principal investigator Prof. Dr. Lim Yang Mooi. To make the identification job easier, most of the significant parts of the plant parts were photographed. They were then sorted and matched to the collection number of specimens.

3.3 Herbarium Voucher

Specimen collection for herbarium voucher was prepared according to the methods acquired by Forest Research Institute Malaysia (FRIM). After specimen collection, a paper tag on string was attached to the specimen and all other related data was recorded in A5 fieldtrip notebook in accordance with the template from FRIM (Figure 3.1). The plant samples were cleaned of adhering dust and soil carefully before being processed as herbarium voucher. Plants were put on a newspaper, placed between corrugated board ventilators to enable air flow through the press, and then tight up with wooden board covering both up and bottom sides. The whole stack of herbarium samples was placed in the oven for drying. The dried plant specimens were sent to Perdana Botanical Garden, Kuala Lumpur for mounting, verification, and deposition. The data noted in the field work notebook was transferred to a label and pasted on the right bottom of the respective herbarium sheet. The taxonomy data collection was recorded in the database BRAHMS (Botanical Research and Herbarium Management System).



Collector: Lim Yang Moot Date: 28 / 8 / 16
With Lanym, HawMF, LaiMW, ChiaWL

Locality: Jalan Pajam - Nilai - Solak, Bandar Baru Nilai 71800 Nilai Negeri Sembilan - 110m away from Sungai Batang Labu

GPS: (N)/S, (E)/W Alt.(m):
02 47' 38.9" 101° 45' 51.9" 24m

Habitat:
Roadside, various shady with moist loam soil.

Description/Notes:
Clidemia hirta (L.) D. Don
Weak upright shrub. Height: 0.5 - 1.3m tall. The whole plant is covered with brown hair. Dark green leaves, leaves size: 8-13 cm long & 4-8 cm wide.

Medicinal property: Juice obtain from macerated leaves can apply on the wound to treat knife cut.

Species: Clidemia hirta (L.) D. Don
Family: Merostomataceae
Vernacular name:

Assoc. Collection: Spirit/Anatomy/DNA/Photograph
Duplicates collected: 1

LYMOOI 011

Figure 3.1: Sample of field note

3.4 DNA Extraction

Plant samples were cleaned with 75% alcohol before the extraction process. Extraction was then carried out using the GeneJET Plant Genomic DNA Purification Kit (Thermo Scientific). Leaves samples collected from above mentioned local medicinal plants were ground in mortar and pestle by adding liquid nitrogen. Lysis Buffer A, Lysis Buffer B and RNase A was added into grounded tissues. The extracted samples were then incubated for 10 min at 65°C. Then, 130 µl of precipitation solution was added and mixed by inverting the tubes for few times before incubate on ice for 5 min. Tubes were kept in the centrifuge for 5 min at 14,000 rpm. The aqueous later was transferred into a new tube and 400 µl of Plant gDNA Binding Solution and 400 µl of 96% ethanol was added. The well mixed samples were transferred to a spin column, centrifuged at a minute time at 8000 rpm. Wash Buffer I and II was then added followed by elute genomic DNA using Elution Buffer. The extracted DNA was kept in -20°C for polymerase chain reaction (PCR).

3.4.1 Polymerase Chain Reaction Amplification

Polymerase chain reaction (PCR) was performed using Veriti 96 Well Thermal Cycle (Applied Biosystems). Three genes region, which are two plastid genome (*rbc*L and *mat*K) and a nuclear gene (ITS) were screened for species identification in this study (Table 3.3). For those without or weak bands, repetitions of PCR were performed. The PCR products were verified by electrophoresis in 1.5% agarose gels stained with Midori Green Advance DNA

Stain. DNA ladder of DM2100 ExcelBand 100 bp (SMOBIO) was used to estimate the size of amplification products. The PCR band of the expected size was excised prior being sent to Apical Scientific for sequencing.

3.4.2 DNA Sequence Analysis

DNA sequencing was performed using the same primer used in amplification. Bidirectional sequences for each gene region were separately aligned using MEGA 7.0 software. All the consensus nucleotides were queried using default setting of megablast online at National Centre for Biotechnology Information (NCBI) nucleotide Basic Local Alignment Search Tool (BLAST) (McGinnis and Madden, 2004) against the nucleotide database. Identifications were assigned based on the top matching hit of maximum identity >95% in a single species. If the BLAST result indicated the sample did not belong to a priori assigned taxon, it was then compared with the herbarium specimens authenticated by Perdana Botanical Garden. Morphological characteristics are used to confirm whether an error had been made.

Table 3.3: Primer sequences and thermocycling condition

Region	Primer	Sequence (5'-3')	Thermocycling condition	Reference
*rbc*L	rbcla_F	ATG TCA CCA CAA ACA GAG ACT AAA GC	94°C for 4 min; 35 cycles of 94°C for 30 s, 55°C for 30 s, 72°C for 1 min; final extension 72°C for 10 min.	(Fazekas et al., 2012)
	rbcLajf634R	GAA ACG GTC TCT CCA ACG CAT		
*mat*K	matK_390f	CGA TCT ATT CAT TCA ATA TTT C	94°C for 3 min, 35 cycles of 94°C for 30 s, 48°C for 40 s, 72°C for 1 min, and a final extension at 72°C for 10 min.	(Fazekas et al., 2012)
	matK_1326r	TCT AGC ACA CGA AAG TCG AAG T		
ITS	ITS_5P	GGA AGG AGA AGT CGT AAC AAG G	94°C for 5 min, 35 cycles of 94°C for 30 s, 55°C for 40 s, 72°C for 1 min, and a final extension at 72°C for 10 min.	(Moller and Cronk, 1997)
	ITS_8P	CAC GCT TCT CCA GAC TAC A		

3.5 LC MS/MS Metabolite Profiling

3.5.1 Sample Preparation and Extraction

Thirty-five plant samples were dried using Oven Model UF450 with temperature of 40˚C for 5 days. Dried specimen was ground into powder by using mortar and pestle. Approximately 5 ± 0.5 mg of plant powder was extracted using modified folch extraction protocol (Ling et al., 2014; Puah et al., 2019; Lee et al., 2018). Methanol (MeOH) / Chloroform (1:1 v/v) mixture was added into powder plants. Then, mixtures were mixed thoroughly with 0.05 M NaCl solution. Then, 35 samples were centrifuged at 500 g, 4°C for 30 min and formed two layers, upper layer (hydrophilic metabolites) and lower layer (hydrophobic metabolites). Both layers were transferred, vaporized, and stored at -80°C. Before proceeding to LC-MS/MS analysis, plant extracts were re-dissolved in 1.5 mL methanol.

3.5.2 Liquid Chromatography-Tandem Mass Spectrometry

Briefly, 10 µL and 30 µL extract was introduced to Vanquish UHPLC system (Thermo Scientific, Waltham, MA, USA) coupled to ultra-high-resolution Q-Time-of-flight Impact II (Bruker, Billerica, MA, USA) at positive and negative electrospray ionization modes, respectively. Pentaflurophenyl column, Kinetex F5 (2.1 mm x 100 mm x 2.6 µm; Phenomenex, Torrance, California, USA) was utilised to perform chromatographic separation and maintained at 35°C while mobile phase flow rate was maintained at 0.6 mL/min.

During chromatographic separation, mobile phase A, mixture of deionized water with 0.1% formic acid and 1% ammonium acetate (NH_4AC) added while mobile phase B, consist of mixture of acetonitrile and methanol [6:4 v/v] with 0.1% formic acid and 1% NH_4AC added. The gradient elution was programmed to increase linearly from 1% to 70% of solvent B in 7 min, followed by 100% solvent B from 7.1 to 10 min and maintained for 3 min. Later, the column was conditioned with initial gradient for 1 min before the next sample injection. The data acquisition was set between *m/z* 50 and 1500. Positive and negative electrospray ionization voltage was set as 3.5 kV and -3.5 kV, respectively. Ion source gas temperature was set at 325°C along with 10 L/min drying gas flow and nebulizer flow at 3 Bar. Mass spectrometer was calibrated with Tune Mix (Sigma-Aldrich, St Louis, MO, USA) before each batch analysis. Mass calibrant, sodium formate was introduced between 0.1-0.3 min during each acquisition. Post-acquisition, acquired analytes *m/z* were calibrated against introduced sodium formate. For plant metabolome identification, similar chromatographic separation gradient was applied. Different collision energies were employed during molecule fragmentation was carried out as manufacturer's guidelines where molecules < *m/z* 200, 201-500, 501-750, and > 751 was predetermined as 10, 20 30 and 35 eV respectively.

3.5.3 Metabolite Identification

During the compound matching, signal threshold was applied where compounds spectra above 1×10^3 intensity were selected for identification. The identification of extracted plant metabolome are based on metabolite

fragmentation spectra matching using MS-Finder (Lai et al., 2017) referencing to UNPD (Nature product), Pubchem (Biomolecule), KNApSAcK (nature product), NANPDB (Nature product) and PlantCyc (plant) database. Mass-to-charge ratio compliment with the fragmented spectral and acceptable mass tolerance (at 5 ppm) allow us to reveal the plant metabolome identity. All the known unknown metabolites were recorded. Known unknown metabolites are described as metabolites that have been previously described in literature of databases but yet to been discovered in the sample of interest (Wishart, 2009; Garcia-Perez et al., 2020).

CHAPTER 4

RESULTS

The studies of 35 local medicinal plants have been done at University Tunku Abdul Rahman, Sungai Long Campus. The objective of the study was to identify the local medicinal plants used by the traditional healers or local citizen and perform metabolite profiling for all the studied plant sample. The results of various aspects are presented in this chapter.

4.1 Plant Collection, Photograph and Herbarium Voucher

In total, 35 medicinal plant species belonging to 32 genera and 17 families were documented (Table 3.2). The macroscopic photography and herbarium voucher of 35 species are presented from Figures 4.1.1 to 4.1.35 and Tables 4.1.1 to 4.1.35.

4.1.1 *Althernanthera sessilis* LYMOOI 067

Representative photographs dataset of morphology characteristic for *Althernanthera sessilis* are shown in Figure 4.1.1 A-B. Data obtained from the field notebook as shown in Table 4.1.1 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.1 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.1.1: Specimen of *Althernanthera sessilis* (A) Habitat (B) Whole plant (C) Herbarium voucher LYMOOI 067

Table 4.1.1: Information relating to vouchered specimen of *Althernanthera sessilis* LYMOOI 067

Voucher	LYMOOI 067
Family	Amaranthaceae
Scientific Name	*Althernanthera sessilis*
Date of Collection	17th February 2017
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Jalan Aman 1, Taman Aman, 45400 Sekinchan Selangor
Location	N03° 31' 03.9" E101° 05' 51.5" 9 m
Habitat	Home cultivated residential area, require high humidity.
Description	Perennial herbs with prostrate stem, often rooting at the nodes. Cylindrical stem with brownish colour. Leaves oblate to broadly elliptic, 1-1.5 cm long and 0.2-2.5 cm wide. Flower in small axillary sessile heads, white often tinged with pink, bracteoles about 1 cm long.
Medicinal Property	Diuretic property.

4.1.2 *Celosia argentea* L. LYMOOI 072

Representative photographs dataset of morphology characteristic for *Celosia argentea* are shown in Figure 4.1.2 A-B. Data obtained from the field notebook as shown in Table 4.1.2 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.2 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

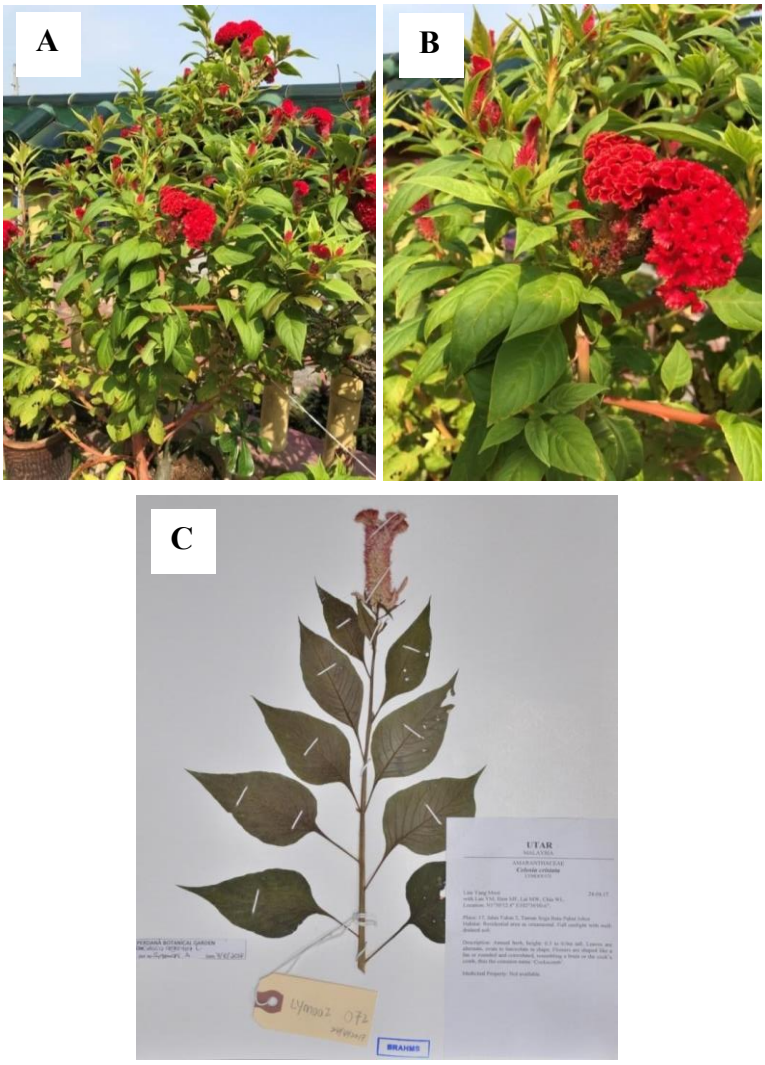


Figure 4.1.2: Specimen of *Celosia argentea* L. (A) Habitat (B) Leaves and flower position (C) Herbarium voucher LYMOOI 072

Table 4.1.2: Information relating to vouchered specimen of *Celosia argentea* L. LYMOOI 072

Voucher	LYMOOI 072
Family	Amaranthaceae
Scientific Name	*Celosia argentea* L.
Date of Collection	24th April 2017
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	17, Jalan Tukas 2, Taman Soga Batu Pahat Johor
Location	N1°50'12.4" E102°56'00.6"
Habitat	Residential area as ornamental. Full sunlight with well-drained soil.
Description	Annual herb, height: 0.3-0.9 m tall. Leaves are alternate, ovate to lanceolate in shape. Flowers are shaped like a fan or rounded and convoluted, resembling a brain or the cock's comb, thus the common name 'Cockscomb'.
Medicinal Property	Not available

4.1.3 *Gomphrena globosa* L. LYMOOI 032

Representative photographs dataset of morphology characteristic for *Gomphrena globosa* are shown in Figure 4.1.3 A-B. Data obtained from the field notebook as shown in Table 4.1.3 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.3 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.1.3: Specimen of *Gomphrena globosa* L. (A) Flowers (B) Leaves from top view (C) Herbarium voucher LYMOOI 032

Table 4.1.3: Information relating to vouchered specimen of *Gomphrena globosa* L. LYMOOI 032

Voucher	LYMOOI 032
Family	Amaranthaceae
Scientific Name	*Gomphrena globosa* L.
Date of Collection	11th November 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Jalan Aman Jaya 3, Taman Aman Jaya, 45400 Sekinchan, Selangor
Location	N03° 30' 54.3" E101° 05' 51.1" 9 m
Habitat	Beside the drain of the residential area. Full sunlight. Garden ornamental.
Description	Height 10-45 cm. Narrow oblong to elliptic green leaves, leaves arrange in opposite. Long lasting fresh cut purple flower. Excellent dried flower (an everlasting) that retains colour well.
Medicinal Property	Not available

4.1.4 *Annona muricata* L. LYMOOI 048

Representative photographs dataset of morphology characteristic for *Annona muricata* are shown in Figure 4.1.4 A-B. Data obtained from the field notebook as shown in Table 4.1.4 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.4 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.1.4: Specimen of *Annona muricata* L (A) Habitat (B) Fruit (C) Herbarium voucher of LYMOOI 048

Table 4.1.4: Information relating to vouchered specimen of *Annona muricata* L. LYMOOI 048

Voucher	LYMOOI 048
Family	Annonaceae
Scientific Name	*Annona muricata* L.
Date of Collection	27th November 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Lebuhraya Wilayah Persekutuan & Jalan Broga
Location	N02° 55' 40.7" E101° 55' 40.8" 94 m
Habitat	Growing on slope, full sunlight and well-drained moist soil.
Description	Shrub or small tree grows up to 3.0-5.0 m in height. Leaves size: 4.2-13.4 cm long and 2.4-5.2 cm wide. Normally evergreen, the leaves have an offensive smell, smooth and are dark green on the surface, lighter beneath. Leaves are oblong, elliptic or narrow obovate, pointed at both ends.
Medicinal Property	Anticancer property.

4.1.5 *Eleutherococcus trifoliatus* (L.) S.Y. Hu LYMOOI 014

Representative photographs dataset of morphology characteristic for *Eleutherococcus trifoliatus* are shown in Figure 4.1.5 A-B. Data obtained from the field notebook as shown in Table 4.1.5 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.5 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

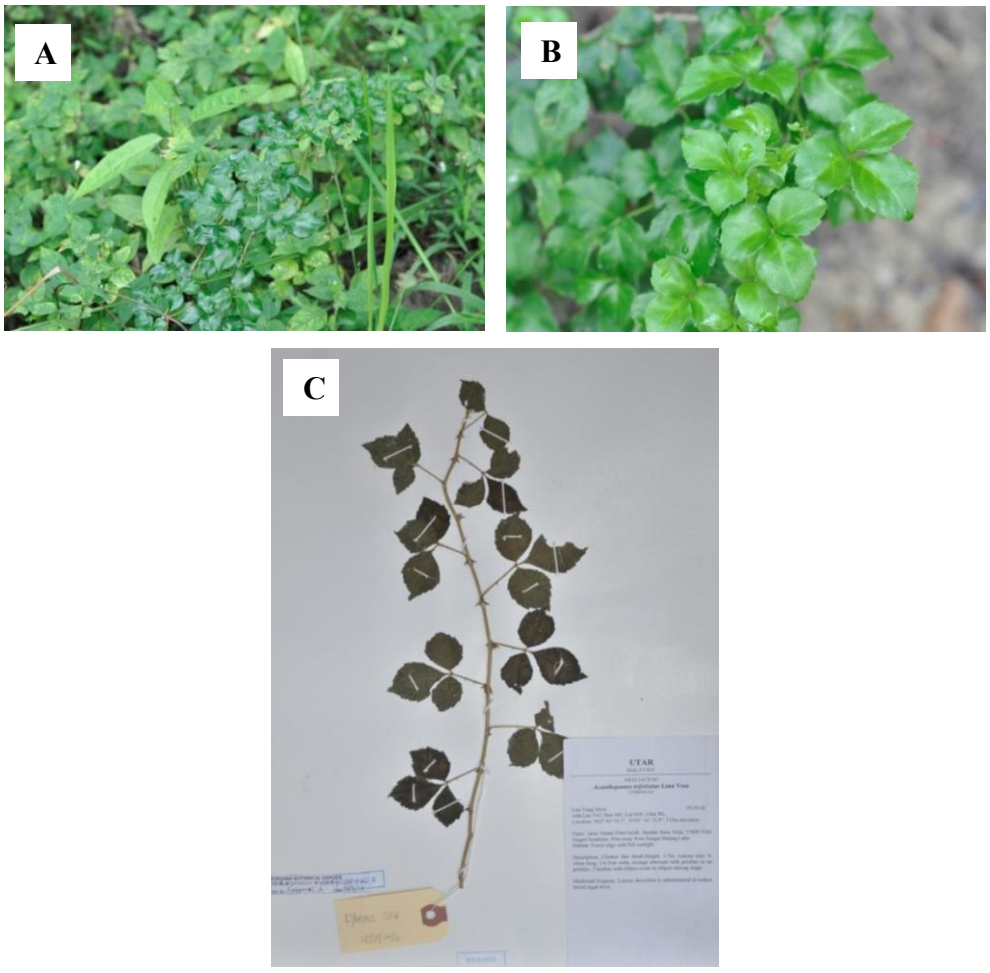


Figure 4.1.5: Specimen of *Eleutherococcus trifoliatus* (L.) S.Y.Hu. (A) Habitat (B) Top view of leaves (C) Herbarium voucher of LYMOOI 014

Table 4.1.5: Information relating to vouchered specimen of *Eleutherococcus trifoliatus* (L.) S.Y. Hu LYMOOI 014

Voucher	LYMOOI 014
Family	Araliaceae
Scientific Name	*Eleutherococcus trifoliatus* (L.) S.Y. Hu
Date of Collection	30th October 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Jalan Pajam-Nilai-Salak, Bandar Baru Nilai, 71800 Nilai Negeri Sembilan. 95 m away from Sungai Batang Labu.
Location	N03° 01' 15.3" E101° 41' 15.9" 115 m
Habitat	Forest edge with full sunlight.
Description	Climber like shrub. Height: 1-7 m. Leaves size: 4-10 cm long, 3-6.5 cm wide, arranges alternate with prickles or no prickles. Three leaflets with ellipse-ovate to ellipse-oblong shaped.
Medicinal Property	Leaves decoction is administered to reduce blood sugar level.

4.1.6 *Epiphyllum oxypetalum* LYMOOI 071

Representative photographs dataset of morphology characteristic for *Epiphyllum oxypetalum* are shown in Figure 4.1.6 A-B. Data obtained from the field notebook as shown in Table 4.1.6 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.6 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.1.6: Specimen of *Epiphyllum oxypetalum* (A) Habitat (B) Leaves (C) Voucher herbarium of LYMOOI 071

Table 4.1.6: Information relating to vouchered specimen of *Epiphyllum oxypetalum* LYMOOI 071

Voucher	LYMOOI 071
Family	Cactaceae
Scientific Name	*Epiphyllum oxypetalum*
Date of Collection	24th April 2017
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	17, Jalan Tukas 2, Taman Soga Batu Pahat Johor
Location	N1°50'12.4" E102°56'00.6"
Habitat	Residential area as ornamental. Full sunlight, prefer moist with well-drained soil.
Description	Epiphytic cactus that grows up to 2 m tall. No leaves but have modified stems that look like leaves and serve similar functions. Flower buds are produced at the end of modified stems that look like leaves.
Medicinal Property	Not available

4.1.7 *Pereskia bleo* LYMOOI 059

Representative photographs dataset of morphology characteristic for *Pereskia bleo* are shown in Figure 4.1.7 A-B. Data obtained from the field notebook as shown in Table 4.1.7 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.7 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.1.7: Specimen of *Pereskia bleo* (A) Leaves (B) Thorns (C) Herbarium voucher of LYMOOI 059

Table 4.1.7: Information relating to vouchered specimen of *Pereskia bleo* LYMOOI 059

Voucher	LYMOOI 059
Family	Cactaceae
Scientific Name	*Pereskia bleo*
Date of Collection	15th January 2017
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Broga Lenggeng, Negeri Sembilan
Location	N02° 55' 53.8" E101° 55' 30.6" 124 m
Habitat	Growing on slope, loam soil with full sunlight.
Description	Perennial leafy cactus grows as a shrub or small tree reaches height of 1.2-1.8 m tall. Leaves are thin, oblong to oblanceolate, glossy, and succulent. Woody stem with thorns is parallel in bundles.
Medicinal Property	Not available

4.1.8 *Laurentia longiflora* (L.) Peterm. LYMOOI 026

Representative photographs dataset of morphology characteristic for *Laurentia longiflora* are shown in Figure 4.1.8 A-B. Data obtained from the field notebook as shown in Table 4.1.8 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.8 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

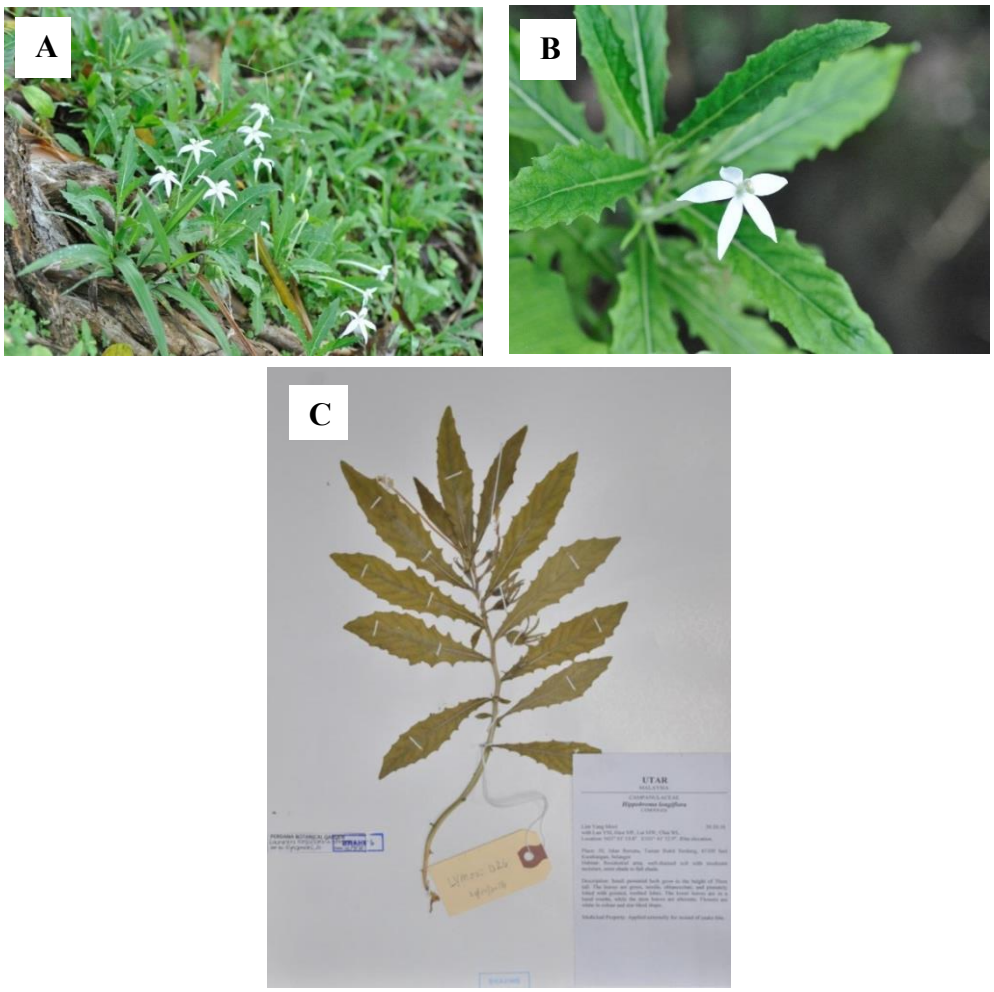


Figure 4.1.8: Specimen of *Laurentia longiflora* (L.) Peterm. (A) Habitat (B) Leaves and flower (C) Herbarium voucher of LYMOOI 026

Table 4.1.8: Information relating to vouchered specimen of *Laurentia longiflora* (L.) Peterm. LYMOOI 026

Voucher	LYMOOI 026
Family	Campanulaceae
Scientific Name	*Laurentia longiflora* (L.) Peterm.
Date of Collection	30th October 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	50, Jalan Bersatu, Taman Bukit Serdang, 43300 Seri Kembangan, Selangor
Location	N03° 01' 19.8" E101° 41' 32.9" 89 m
Habitat	Residential area, well-drained soil with moderate moisture, semi-shade to full shade.
Description	Small perennial herb grows to the height of 70 cm tall. The leaves are green, sessile, oblanceolate, and pinnately lobed with pointed, toothed lobes. The lower leaves are in a basal rosette, while the stem leaves are alternate. Flowers are white in colour and star-liked shape.
Medicinal Property	Applied externally for wound of snake bite.

4.1.9 *Lobelia chinensis* Lour. LYMOOI 023

Representative photographs dataset of morphology characteristic for *Lobelia chinensis* are shown in Figure 4.1.9 A-B. Data obtained from the field notebook as shown in Table 4.1.9 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.9 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.1.9: Specimen of *Lobelia chinensis* Lour (A) Habitat (B) Flower (C) Herbarium voucher of LYMOOI 023

Table 4.1.9: Information relating to vouchered specimen of *Lobelia chinensis* Lour LYMOOI 023

Voucher	LYMOOI 023
Family	Campanulaceae
Scientific Name	*Lobelia chinensis* Lour
Date of Collection	30th October 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Rizab Melayu Sungai Kuyoh, 43300 Seri Kembangan, Selangor.
Location	N03° 00'56.3" E101° 41' 15.9" 104 m
Habitat	Planted on secondary forest, found in slope, well-drained soil with semi-shade to full sunlight.
Description	Small perennial plant grows up to 15-35 cm tall. Creeping and low growing herbaceous plant which gives an attractive ground cover. It has a long, thin, branching stem that is olive green and green-brown crumpled narrow leaves. Flower is white in colour.
Medicinal Property	Promote diuresis, traditionally used to treat liver ascites.

4.1.10 *Ageratum conyzoides* L. LYMOOI 016

Representative photographs dataset of morphology characteristic for *Ageratum conyzoides* are shown in Figure 4.1.10 A-D. Data obtained from the field notebook as shown in Table 4.1.10 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.10 E) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

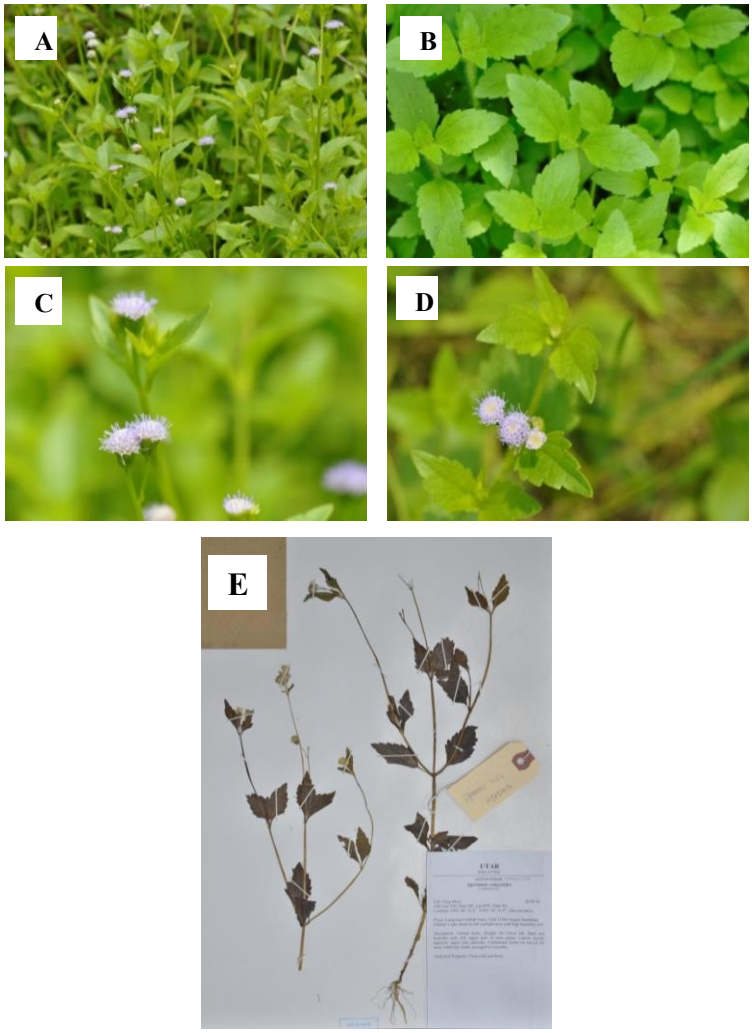


Figure 4.1.10: Specimen of *Ageratum conyzoides* L. (A) Habitat (B) Leaves (C) Lateral view of flower (D) Top view of flower (E) Herbarium voucher of LYMOOI 016

Table 4.1.10: Information relating to vouchered specimen of *Ageratum conyzoides* L. LYMOOI 016

Voucher	LYMOOI 016
Family	Compositae
Scientific Name	*Ageratum conyzoides* L.
Date of Collection	28th August 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Kampung Lembah Paya, Nilai 71800 Negeri Sembilan
Location	N02° 46' 33.3" E101° 45' 11.9" 18 m
Habitat	Light shade to full sunlight area with high humidity soil.
Description	Annual herbs. Height: 20-110 cm tall. Stem and branches pale red, upper part of stem green. Leaves mostly opposite, upper part alternate. Capitulum borne on top of the stem, relatively small, arranged to corymbs.
Medicinal Property	Treatment for cold and fever.

4.1.11 *Artemisia vulgaris* L. LYMOOI 028

Representative photographs dataset of morphology characteristic for *Artemisia vulgaris* are shown in Figure 4.1.11 A-B. Data obtained from the field notebook as shown in Table 4.1.11 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.11 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.1.11: Specimen of *Artemisia vulgaris* L. (A) Habitat (B) Leaves (C) Herbarium voucher of LYMOOI 028

Table 4.1.11: Information relating to vouchered specimen of *Artemisia vulgaris* L. LYMOOI 028

Voucher	LYMOOI 028
Family	Compositae
Scientific Name	*Artemisia vulgaris* L.
Date of Collection	30th October 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	1-11, Jalan BS 5/21, Taman Bukit Serdang, 43300 Seri Kembangan, Selangor
Location	N03° 01' 22.4" E101° 41 '33.6" 106 m
Habitat	Roadside, beside the drain of residential area. Prefer semi-shade, sandy and loam soil.
Description	Perennial herbs grow to the height of 0.6-1.2 m tall. The lower stems of mature plant often become reddish or woody in appearance. The upper surface of these leaves is green and hairless, while their lower surface is white from fine pubescent hairs.
Medicinal Property	Not available

4.1.12 *Blumea balsamifera* (L.) DC. LYMOOI 043

Representative photographs dataset of morphology characteristic for *Blumea balsamifera* are shown in Figure 4.1.12 A-B. Data obtained from the field notebook as shown in Table 4.1.12 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.12 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.1.12: Specimen of *Blumea balsamifera* (L.) DC (A) Habitat (B) Leaves (C) Herbarium voucher of LYMOOI 043

Table 4.1.12: Information relating to vouchered specimen of *Blumea balsamifera* (L.) DC LYMOOI 043

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Voucher	LYMOOI 043
Family	Compositae
Scientific Name	*Blumea balsamifera* (L.) DC
Date of Collection	27th November 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Lebuhraya Wilayah Persekutuan & Jalan Broga
Location	N02° 55' 39.8" E101° 55' 40.4" 107 m
Habitat	Growing on slope, well-drained loam soil with full sunlight.
Description	Perennial evergreen, strong aromatic shrub grows to the height of 2.3-3.2 m tall. Simple, alternate, broadly elongated leaves with tooth margin. The lower surface is densely hairy while the upper surface is pilose.
Medicinal Property	Used in Traditional Chinese Medicine to expel wind pathogens.

4.1.13 *Cosmos sulphureus* LYMOOI 075

Representative photographs dataset of morphology characteristic for *Cosmos sulphureus* are shown in Figure 4.1.13 A-B. Data obtained from the field notebook as shown in Table 4.1.13 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.13 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.1.13: Specimen of *Cosmos sulphureus*. (A) Habitat (B) Flower (C) Herbarium voucher of LYMOOI 075

Table 4.1.13: Information relating to vouchered specimen of Cosmos sulphurous LYMOOI 075

Voucher	LYMOOI 075
Family	Asteraceae
Scientific Name	*Cosmos sulphureus*
Date of Collection	24th April 2017
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	17, Jalan Tukas 2, Taman Soga Batu Pahat Johor
Location	N1°50'12.4" E102°56'00.6"
Habitat	Residential area as ornamental. Full sunlight with well-drained soil.
Description	Herbaceous annual plant growing up to 1.3 m tall. Leaves opposite, deeply dissected with ultimate segments narrowly oblong. Daisy like flower with yellow disc.
Medicinal Property	Not available

4.1.14 *Elephantopus scaber* L. LYMOOI 074

Representative photographs dataset of morphology characteristic *Elephantopus scaber* are shown in Figure 4.1.14 A-B. Data obtained from the field notebook as shown in Table 4.1.14 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.14 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.1.14: Specimen of *Elephantopus scaber* L. (A) Habitat (B) Flower (C) Herbarium voucher of LYMOOI 074

Table 4.1.14: Information relating to vouchered specimen of *Elephantopus scaber* L. LYMOOI 074

Voucher	LYMOOI 074
Family	Compositae
Scientific Name	*Elephantopus scaber* L.
Date of Collection	24th April 2017
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	17, Jalan Tukas 2, Taman Soga Batu Pahat Johor
Location	N1°50'12.4" E102°56'00.6"
Habitat	Found in semi-shade grassland with dry or moist soil, easy to grow.
Description	Herbaceous plant with short root stock that can reach the height of 48 cm tall. Leaves: obovate-oblong, radical forming a spreading rosette on the ground, hairy on both surfaces. Leaves size 5-18 cm long, 2-4 cm wide. Flowers: purple in heads, heads numerous, closely packed.
Medicinal Property	Not available

4.1.15 *Elephantopus tomentosus* L. LYMOOI 021

Representative photographs dataset of morphology characteristic *Elephantopus tomentosus* are shown in Figure 4.1.15 A-B. Data obtained from the field notebook as shown in Table 4.1.15 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.15 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.1.15: Specimen of *Elephantopus tomentosus* L. (A) Habitat (B) Flower (C) Herbarium voucher LYMOOI 021

Table 4.1.15: Information relating to vouchered specimen of *Elephantopus tomentosus* L. LYMOOI 021

Voucher	LYMOOI 021
Family	Compositae
Scientific Name	*Elephantopus tomentosus* L.
Date of Collection	30th October 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Rizab Melayu Sungai Kuyoh, 43300 Seri Kembangan, Selangor.
Location	N03° 46' 33.2" E101° 45' 10.8" 22 m
Habitat	Growing on slope, light shade to full sunlight, dry to moderate moist soil.
Description	Perennial herbaceous plant with height of 20-60 cm. Leaves size: 8-18 cm long, 3-6 cm wide. Stems erect, multi-branched, angled, white villous. Leaves shape from oval to elongated oval and are surrounded by three leaf-like bracts.
Medicinal Property	Leaves decoction has anticancer properties.

4.1.16 *Mikania cordata* (Burm.f) B.L. Rob LYMOOI 022

Representative photographs dataset of morphology characteristic *Mikania cordata* are shown in Figure 4.1.16 A-B. Data obtained from the field notebook as shown in Table 4.1.16 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.16 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.1.16: Specimen of *Mikania cordata* (Burm. f) B.L. Rob. (A) Leaves (B) Flower (C) Herbarium voucher of LYMOOI 022

Table 4.1.16: Information relating to vouchered specimen of *Mikania cordata* (Burm.f) B.L. Rob LYMOOI 022

Voucher	LYMOOI 022
Family	Compositae
Scientific Name	*Mikania cordata* (Burm. f) B.L. Rob
Date of Collection	30th October 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Rizab Melayu Sungai Kuyoh, 43300 Seri Kembangan, Selangor.
Location	N03° 00' 58.8" E101° 41' 13.7" 97 m
Habitat	Growing on slope, grows best in full sunlight but tolerates light shade, damp loam soil.
Description	Scandent herb. Stem is nearly cylinder or irregular angular. Leaves are long-petioled, deltoid-ovoid or ovate heart-shaped with pointed tip, rounded, heart-shaped, or truncate base, and toothed margins. Heads are 4-flowered, corolla white or yellowish white in colour.
Medicinal Property	Not available

4.1.17 *Vernonia esculenta* Hemsl. Ex Hemsl LYMOOI 024

Representative photographs dataset of morphology characteristic *Vernonia esculenta* are shown in Figure 4.1.17 A-B. Data obtained from the field notebook as shown in Table 4.1.17 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.17 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.1.17: Specimen of *Vernonia esculenta* Hems. Ex. Hemsl. (A) Habitat (B) Leaves (C) Herbarium voucher of LYMOOI 024

Table 4.1.17: Information relating to vouchered specimen of *Vernonia esculenta* Hems. Ex. Hemsl LYMOOI 024

Voucher	LYMOOI 024
Family	Asteraceae
Scientific Name	*Vernonia esculenta* Hems. Ex. Hemsl
Date of Collection	30th October 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	56, Jalan Bersatu, Taman Bukit Serdang, 43300 Seri Kembangan, Selangor
Location	N03° 01' 21.0" E101° 41' 33.4" 81m
Habitat	Growing on slope with full sunlight, secondary forest.
Description	Shrub or small tree grows up to 1-6 m tall. Leaves size: 10-23 cm long, 3-8 cm wide. Leaf blade oblong-lanceolate or lanceolate, uniformly densely grey pilose to sparsely tomentulose on veins only, adaxially dark green, rather scabrid.
Medicinal Property	Act as a cooling agent to alleviate fever, antihypertensive and anti-inflammatory.

4.1.18 *Jatropha podagrica* LYMOOI 042

Representative photographs dataset of morphology characteristic *Vernonia esculenta* are shown in Figure 4.1.18 A-D. Data obtained from the field notebook as shown in Table 4.1.18 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.18 E) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

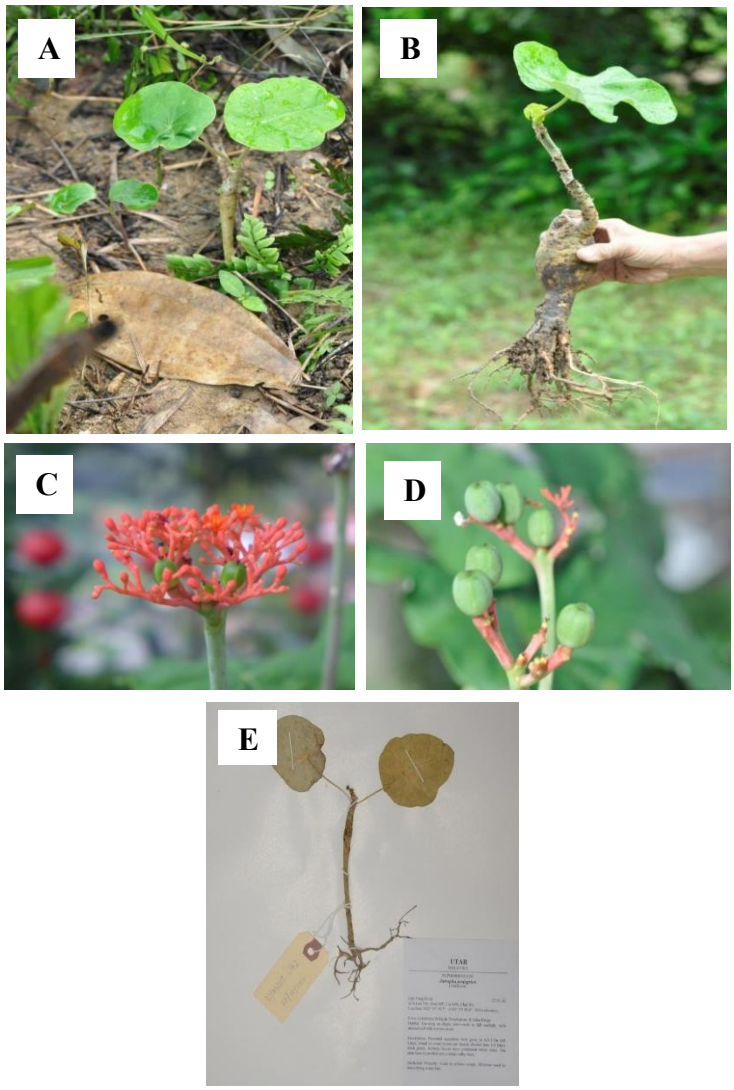

Figure 4.1.18: Specimen of *Jatropha podagrica* (A) Habitat (B) Caudex and roots (C) Flowers (D) Fruits (E) Herbarium voucher of LYMOOI 042

Table 4.1.18: Information relating to vouchered specimen of *Jatropha podagrica* LYMOOI 042

Voucher	LYMOOI 042
Family	Euphorbiaceae
Scientific Name	*Jatropha podagrica*
Date of Collection	27th November 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Lebuhraya Wilayah Persekutuan & Jalan Broga
Location	N02° 55' 39.7" E101° 55' 40.6" 103 m
Habitat	Growing on slope, semi-shade to full sunlight, well-drained soil with low moisture.
Description	Perennial succulent herb grows to 0.3-1.2 m tall. Large, round to ovate leaves is deeply divided into 3-5 lobes. Dark green, leathery leaves have prominent white veins. The stem base is swollen and contains milky latex.
Medicinal Property	Used to relieve cough. Rhizomes used to detoxify snake bite.

4.1.19 *Ricinus communis* LYMOOI 027

Representative photographs dataset of morphology characteristic *Ricinus communis* are shown in Figure 4.1.19 A-D. Data obtained from the field notebook as shown in Table 4.1.19 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.19 E) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

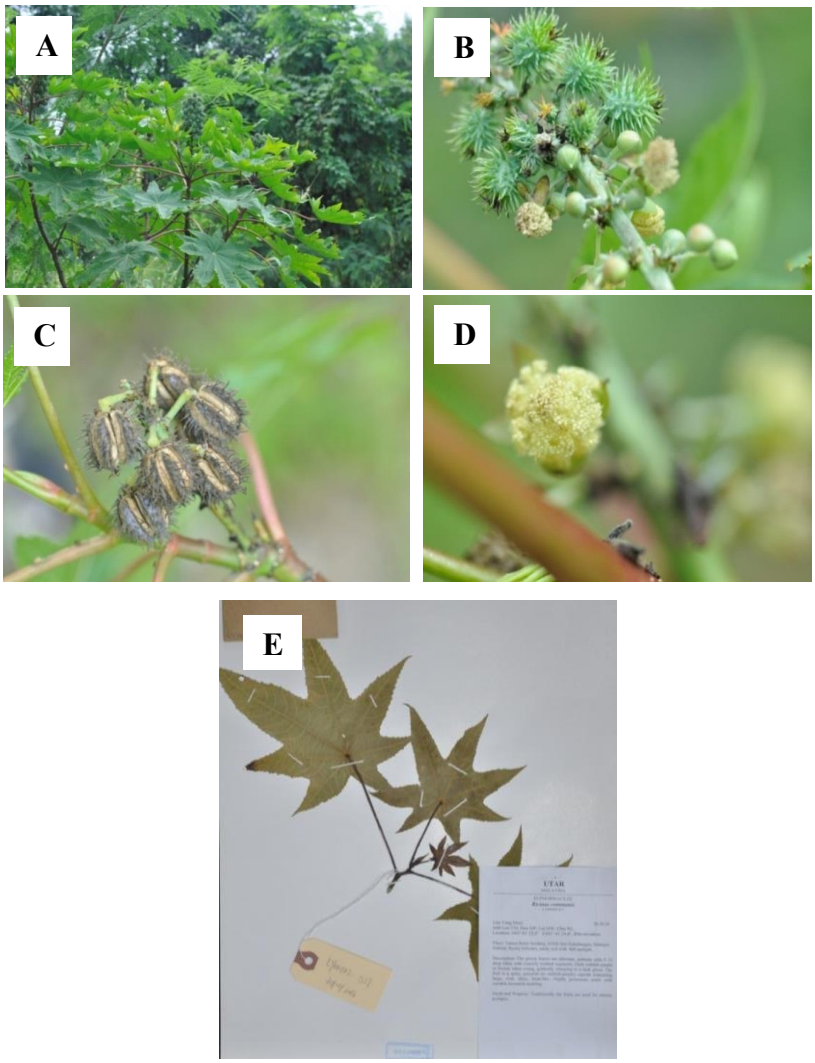

Figure 4.1.19: Specimen of *Ricinus communis* L. (A) Habitat (B) Unripe fruits (C) Ripe fruits (D) Flower (E) Herbarium voucher of LYMOOI 027

Table 4.1.19: Information relating to vouchered specimen of *Ricinus communis* L. LYMOOI 027

Voucher	LYMOOI 027
Family	Euphorbiaceae
Scientific Name	*Ricinus communis* L.
Date of Collection	30th October 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Taman Bukit Serdang, 43300 Seri Kembangan, Selangor
Location	N03° 01' 22.6" E101° 41' 24.8" 89 m
Habitat	Rocky hillsides, sandy soil with full sunlight.
Description	The glossy leaves are alternate, palmate with 5–12 deep lobes with coarsely toothed segments. Dark reddish purple or bronze when young, gradually changing the colour to a dark green. The fruit is a spiny, greenish (to reddish-purple) capsule containing large, oval, shiny, bean-like. Have highly poisonous seeds with variable brownish mottling.
Medicinal Property	Traditionally the fruits are used for uterine prolapse.

4.1.20 *Senna occidentalis* (L.) Link LYMOOI 030

Representative photographs dataset of morphology characteristic *Senna occidentalis* are shown in Figure 4.1.20 A-C. Data obtained from the field notebook as shown in Table 4.1.20 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.20 D) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

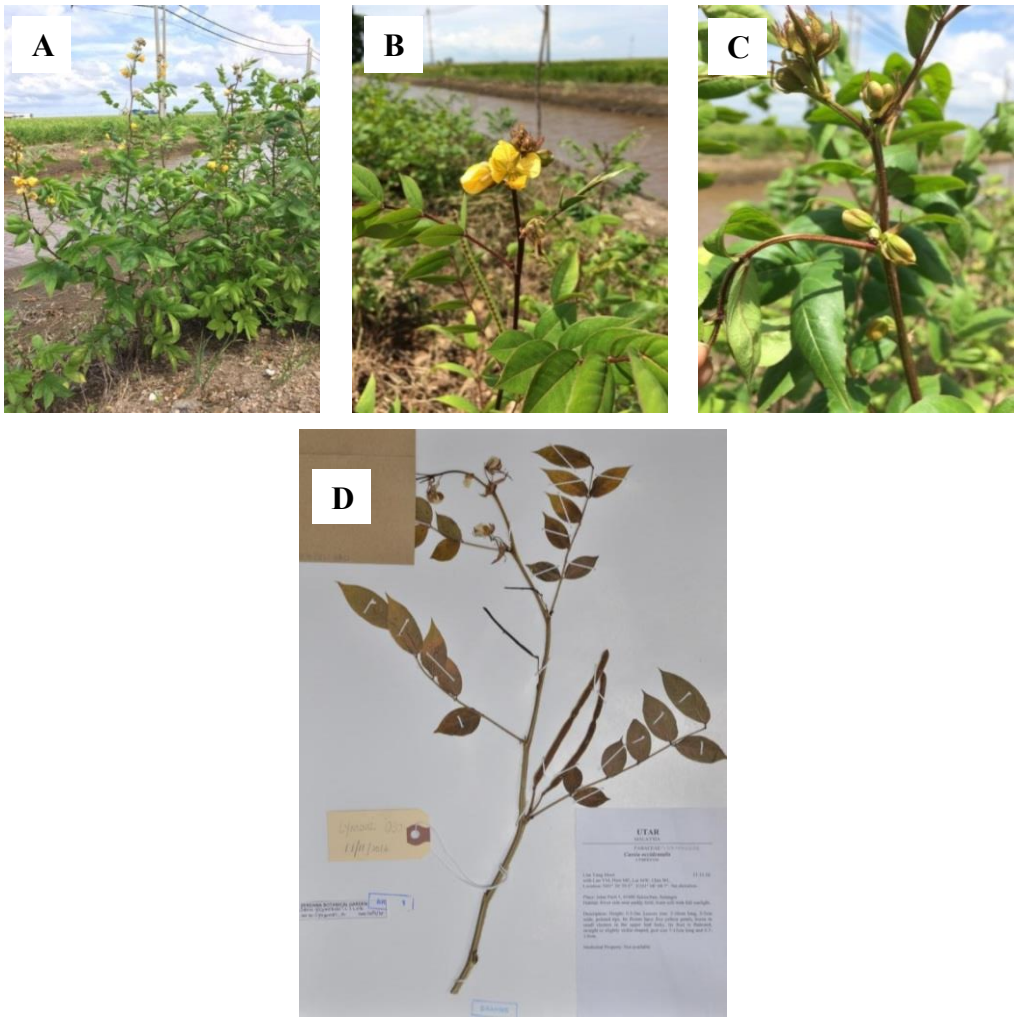

Figure 4.1.20: Specimen of *Senna occidentalis* (L.) (A) Habitat (B) Leaves and flower (C) Buds (D) Herbarium voucher of LYMOOI 030

Table 4.1.20: Information relating to vouchered specimen of *Senna occidentalis* (L.) Link LYMOOI 030

Voucher	LYMOOI 030
Family	Leguminosae
Scientific Name	*Senna occidentalis* (L.) Link
Date of Collection	11th November 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Jalan Parit 5, 45400 Sekinchan
Location	N03° 30' 59.5" E101° 08' 08.7" 9 m
Habitat	River side near paddy field, loam soil with full sunlight.
Description	Height: 0.5-2 m. Leaves size: 2-10 cm long, 2-3 cm wide, pointed tips. Its flower has five yellow petals, borne in small clusters in the upper leaf forks. Its fruit is flattened, straight or slightly sickle-shaped, pod size 7-12 cm long and 0.7-1.0 cm.
Medicinal Property	Not available

4.1.21 *Senna tora* (L.) Roxb LYMOOI 010

Representative photographs dataset of morphology characteristic *Senna tora* are shown in Figure 4.1.21 A-C. Data obtained from the field notebook as shown in Table 4.1.21 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.1.21 D) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

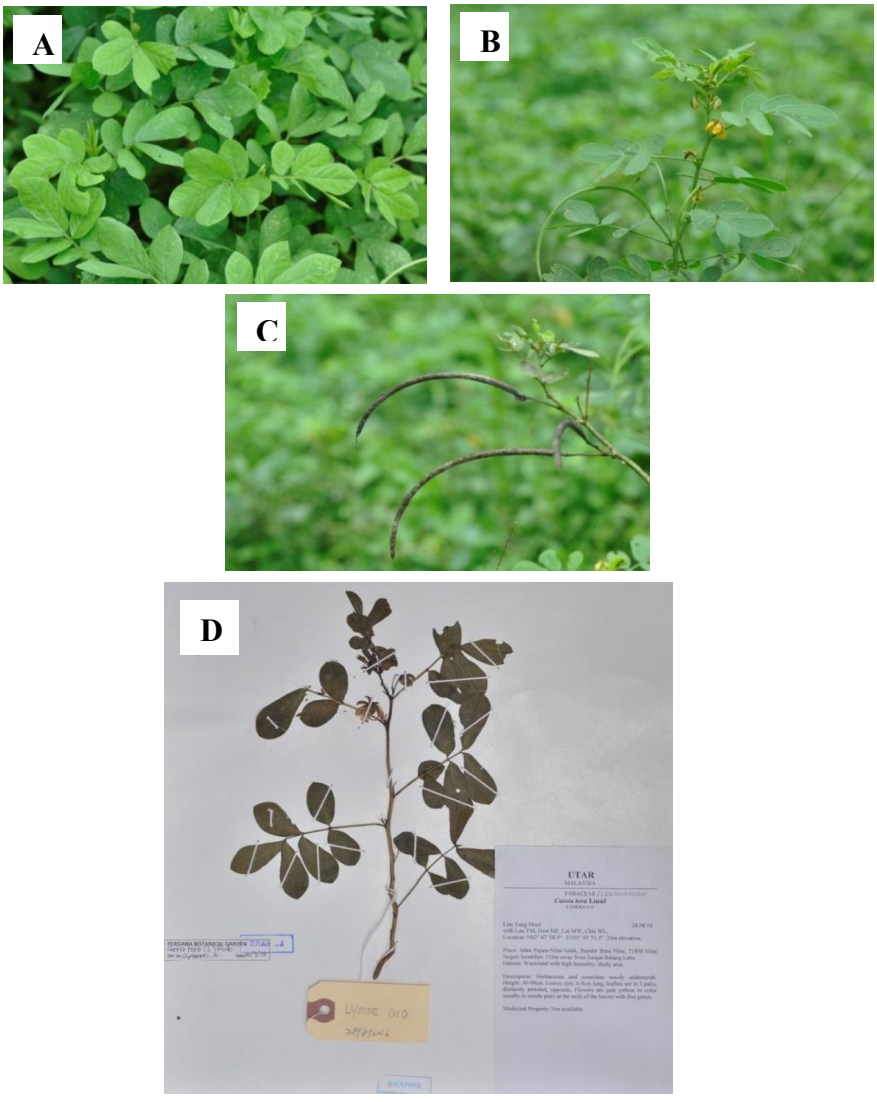

Figure 4.1.21: Specimen of *Senna tora* (L.) Roxb (A) Top view (B) Lateral view (C) Fruit (D) Herbarium voucher of LYMOOI 010

Table 4.1.21: Information relating to vouchered specimen of *Senna tora* (L.) Roxb LYMOOI 010

Voucher	LYMOOI 010
Family	Leguminosae
Scientific Name	*Senna tora* (L.) Roxb
Date of Collection	28th August 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Jalan Pajam-Nilai-Salak, Bandar Baru Nilai, 71800 Nilai Negeri Sembilan. 110m away from Sungai Batang Labu.
Location	N02° 47 '38.9" E101° 45 '51.9" 24 m
Habitat	Wasteland with high humidity, shady area.
Description	Herbaceous and sometime woody undershrub. Height: 30-90 cm. Leaves size: 6-8 cm long, leaflets are in three pairs, distinctly petiole, opposite. Flowers are pale yellow in colour usually in sessile pairs at the axils of the leaves with five petals.
Medicinal Property	Not available

4.1.22 *Malpighia coccigera* LYMOOI 052

Representative photographs dataset of morphology characteristic *Malpighia coccigera* are shown in Figure 4.1.22 A-B. Data obtained from the field notebook as shown in Table 4.1.22 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.22 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.1.22: Specimen of *Malpighia coccigera* (A) Habitat (B) Leaves (C) Herbarium voucher of LYMOOI 052

Table 4.1.22: Information relating to vouchered specimen of *Malpighia coccigera* LYMOOI 052

Voucher	LYMOOI 052
Family	Malpighiaceae
Scientific Name	*Malpighia coccigera*
Date of Collection	27th November 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Lebuhraya Wilayah Persekutuan & Jalan Broga
Location	N02° 55' 39.2" E101° 55' 39.6" 103m
Habitat	Growing on slope of secondary forest.
Description	Evergreen shrub or small tree grows up to 1.5-2 m tall. Leaves size: 0.5-1.3 cm long, 0.5-1.0 cm wide. Leaves are small and thorny which are oppositely arranged, and initial leaves are glossy and round shaped. Leaves become dark green and thorny at leaf margin at later stage.
Medicinal Property	Treat hepatitis. Traditionally used it to clear heat eliminate toxin and promote diuresis.

4.1.23 *Melia azedarach* L. LYMOOI 002

Representative photographs dataset of morphology characteristic *Melia azedarach* are shown in Figure 4.1.23 A-D. Data obtained from the field notebook as shown in Table 4.1.23 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.23 E) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.1.23: Specimen of *Melia azedarach* L (A) Habitat (B) Leaves and flower (C) Upper side of leaf (D) Bark (E) Herbarium voucher of LYMOOI 002

Table 4.1.23: Information relating to vouchered specimen of *Melia azedarach* L. LYMOOI 002

Voucher	LYMOOI 002
Family	Meliaceae
Scientific Name	*Melia azedarach* L.
Date of Collection	28th August 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Jalan BBN 6/2f, 71800 Nilai Negeri Sembilan
Location	N02° 48' 01.9" E101° 46 '07.7" 30 m
Habitat	Resident area with loam soil; planted
Description	Shrub tree, 6-12 m tall. Leaves size: 2-7 cm long, arrange in alternate. Leaves type are bipinnately compound and odd-pinnately compound. Fruit is light yellow at maturity; size is less than 1.5 cm.
Medicinal Property	Leaves used to ease the itching and rashes of chicken pox. Chinese used the fruit to expel worms.

4.1.24 *Toona sinensis* LYMOOI 047

Representative photographs dataset of morphology characteristic *Toona sinensis* are shown in Figure 4.1.24 A-B. Data obtained from the field notebook as shown in Table 4.1.24 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.24 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.1.24: Specimen of *Toona sinensis* (A. Juss.) (A) Habitat (B) Front view of leaves (C) Lateral view of leaves (D) Herbarium voucher of LYMOOI 047

Table 4.1.24: Information relating to vouchered specimen of *Toona sinensis* (A. Juss.) LYMOOI047

Voucher	LYMOOI 047
Family	Meliaceae
Scientific Name	*Toona sinensis* (A. Juss.)
Date of Collection	27th November 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Lebuhraya Wilayah Persekutuan & Jalan Broga
Location	N02° 55' 40.7" E101° 55' 40.5" 92m
Habitat	Sandy and fertile soil, moderate moist and well-drained soil, full sunlight.
Description	Deciduous plant grows up to 6m height. Leaves size: 3.3-13.2 cm long and 0.3-3.6 cm wide. Leaves are pinnate with an entire or weakly serrated margin.
Medicinal Property	Traditionally used to strengthen the spleen and stomach.

4.1.25 *Morus alba* Y.B. Wu LYMOOI 050

Representative photographs dataset of morphology characteristic *Morus alba* are shown in Figure 4.1.25 A-B. Data obtained from the field notebook as shown in Table 4.1.25 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.25 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

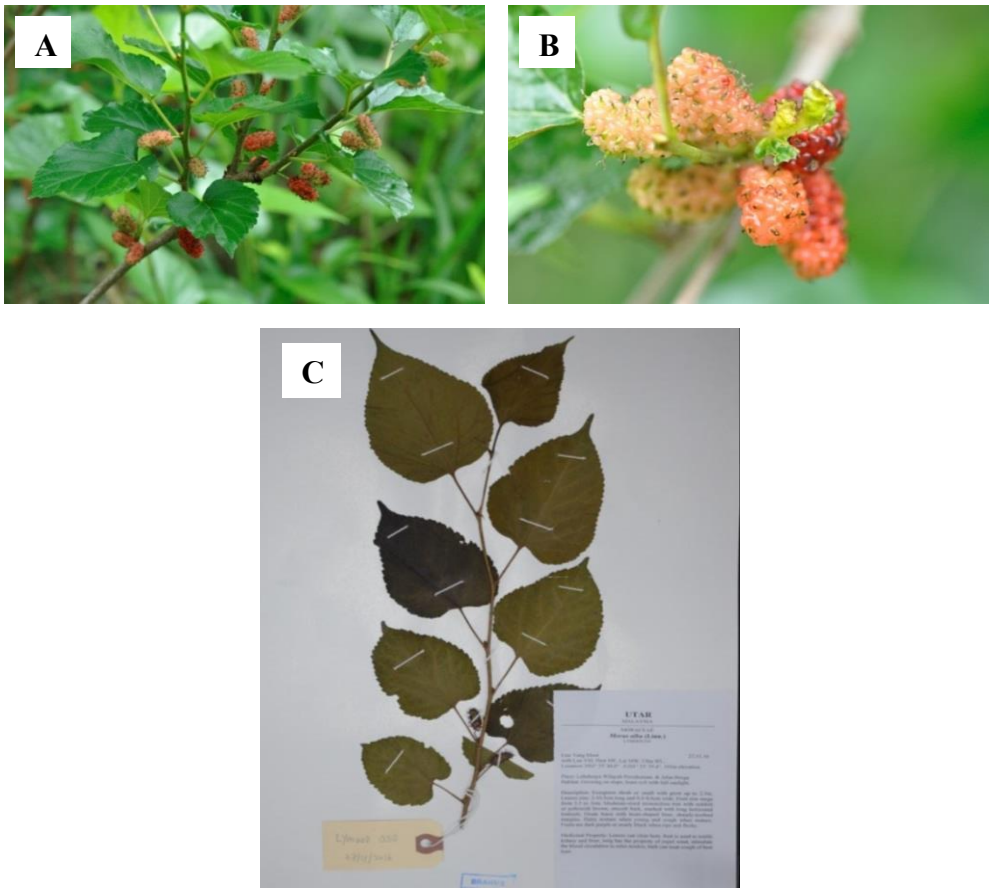

Figure 4.1.25: Specimen of *Morus alba* Y.B Wu. (A) Leaves and fruits (B) Unripe fruits (C) Herbarium voucher of LYMOOI 050

Table 4.1.25: Information relating to vouchered specimen of *Morus alba* Y.B Wu LYMOOI 050

Voucher	LYMOOI 050
Family	Moraceae
Scientific Name	*Morus alba* Y.B Wu
Date of Collection	27th November 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Lebuhraya Wilayah Persekutuan & Jalan Broga
Location	N02° 55' 40.0" E101° 55' 39.4" 101 m
Habitat	Growing on slope, loam soil with full sunlight.
Description	Evergreen shrub or small with grow up to 2.5 m. Leaves size: 3-10.5 cm long and 0.4-8.0 cm wide. Fruit size range from 1.5-3.0 cm. Moderate-sized monoecious tree with reddish or yellowish brown, smooth bark, marked with long horizontal lenticels. Ovate leaves with heart-shaped base, sharply-toothed margins. Hairy texture leaves when young and rough when mature. Fruits are dark purple or nearly black when ripe and fleshy.
Medicinal Property	Leaves can clear heat, fruit is used to tonify kidney and liver, twig has the property of expel wind, stimulate the blood circulation to relax tendon, bark can treat cough of heat type.

4.1.26 *Sauropus spatulifolius* Beilla LYMOOI 054

Representative photographs dataset of morphology characteristic *Sauropus spatulifolius* are shown in Figure 4.1.26 A-B. Data obtained from the field notebook as shown in Table 4.1.26 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.26 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

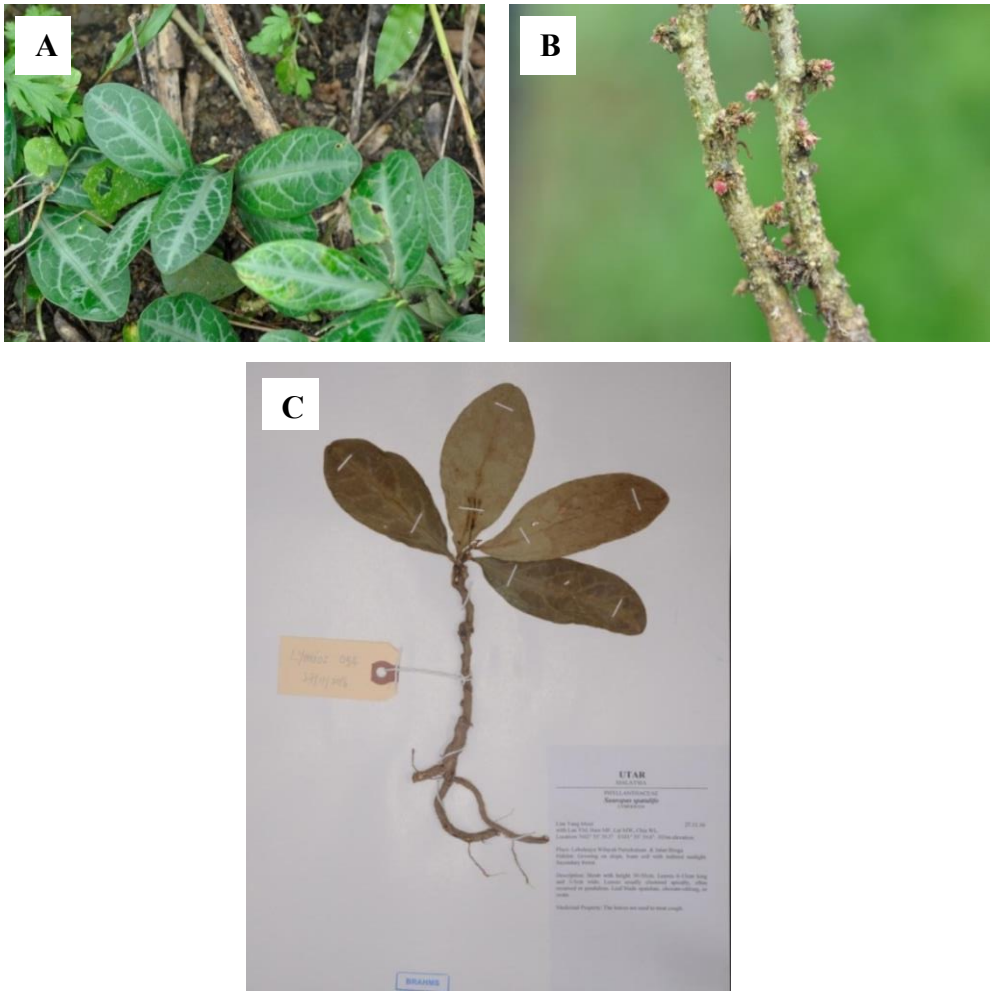

Figure 4.1.26: Specimen of *Sauropus spatulifolius* Beilla (A) Habitat (B) Stem (C) Herbarium voucher of LYMOOI 054

Table 4.1.26: Information relating to vouchered specimen of *Sauropus spatulifolius* Beilla LYMOOI 054

Voucher	LYMOOI 054
Family	Phyllanthaceae
Scientific Name	*Sauropus spatulifolius* Beilla
Date of Collection	27th November 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Lebuhraya Wilayah Persekutuan & Jalan Broga
Location	N02° 55' 39.3" E101° 55' 39.6" 103m
Habitat	Growing on slope, loam soil with indirect sunlight of secondary forest.
Description	Shrub with height 30-50 cm. Leaves 6-13 cm long and 3-5 cm wide. Leaves usually clustered apically, often recurved or pendulous. Leaf blade spatulate, obovate-oblong, or ovate.
Medicinal Property	The leaves are used to treat cough.

4.1.27 *Peperomia pellucida* LYMOOI 051

Representative photographs dataset of morphology characteristic *Peperomia pellucida* are shown in Figure 4.1.27 A-B. Data obtained from the field notebook as shown in Table 4.1.27 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.27 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

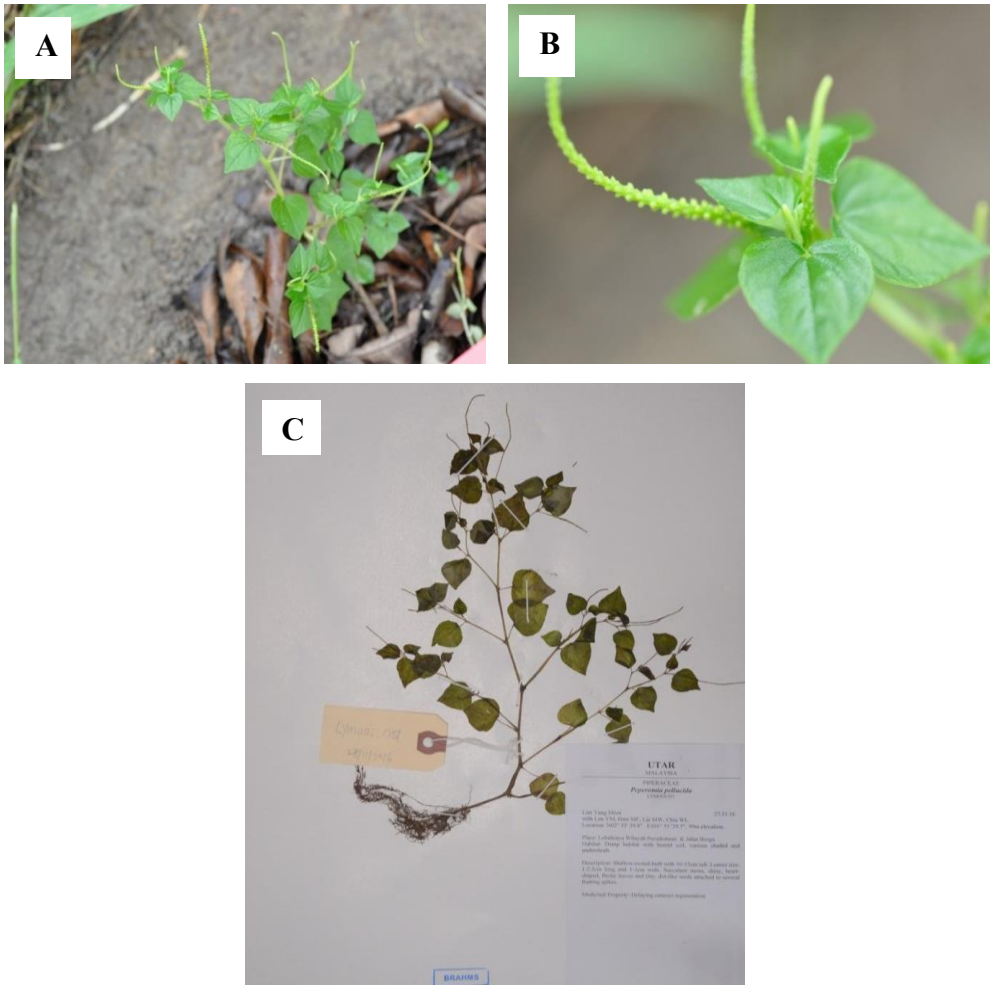

Figure 4.1.27: Specimen of *Peperomia pellucida* (A) Habitat (B) Leaves and spike (C) Herbarium voucher of LYMOOI 050

Table 4.1.27: Information relating to vouchered specimen of *Peperomia pellucida* LYMOOI051

Voucher	LYMOOI 051
Family	Piperaceae
Scientific Name	*Peperomia pellucida*
Date of Collection	27th November 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Lebuhraya Wilayah Persekutuan & Jalan Broga
Location	N02° 55' 39.8" E101° 55 '39.7" 99m
Habitat	Damp habitat with humid soil, various shaded and undershrub.
Description	Shallow-rooted herb with 10-15 cm tall. Leaves size: 1-2.5 cm long and 1-2 cm wide. Succulent stems, shiny, heart-shaped, fleshy leaves and tiny, dot-like seeds attached to several fruiting spikes. .
Medicinal Property	Delaying cataract regeneration.

4.1.28 *Piper sarmentosum* Roxb LYMOOI 044

Representative photographs dataset of morphology characteristic *Piper sarmentosum* are shown in Figure 4.1.28 A-B. Data obtained from the field notebook as shown in Table 4.1.28 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.28 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.1.28: Specimen of *Piper sarmentosum* Roxb. (A) Habitat (B) Flower (C) Herbarium voucher of LYMOOI 044

Table 4.1.28: Information relating to vouchered specimen of *Piper sarmentosum* Roxb LYMOOI 044

Voucher	LYMOOI 044
Family	Piperaceae
Scientific Name	*Piper sarmentosum* Roxb
Date of Collection	27th November 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Lebuhraya Wilayah Persekutuan & Jalan Broga
Location	N02° 55' 39.9" E101° 55' 40.4" 97 m
Habitat	Moist and well-drained soil with semi-shade.
Description	Sprawling herbaceous creeper, growing close to the ground up to the height of 0.3-0.5 m. Leaves size: 8.4-14 cm long, 8-10.6 cm wide. Leaves are alternate, stalked leaves and have leaf blades that are heart-shaped, glossy dark green with waxy surface. The stem is slightly hairy.
Medicinal Property	Has culinary and medicinal property. Used to regulate stomach qi, treat indigestion and stomach distension.

4.1.29 *Persicaria chinensis* (L.) H. Gross var chinensis LYMOOI 037

Representative photographs dataset of morphology characteristic *Persicaria chinensis* are shown in Figure 4.1.29 A-B. Data obtained from the field notebook as shown in Table 4.1.29 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.29 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

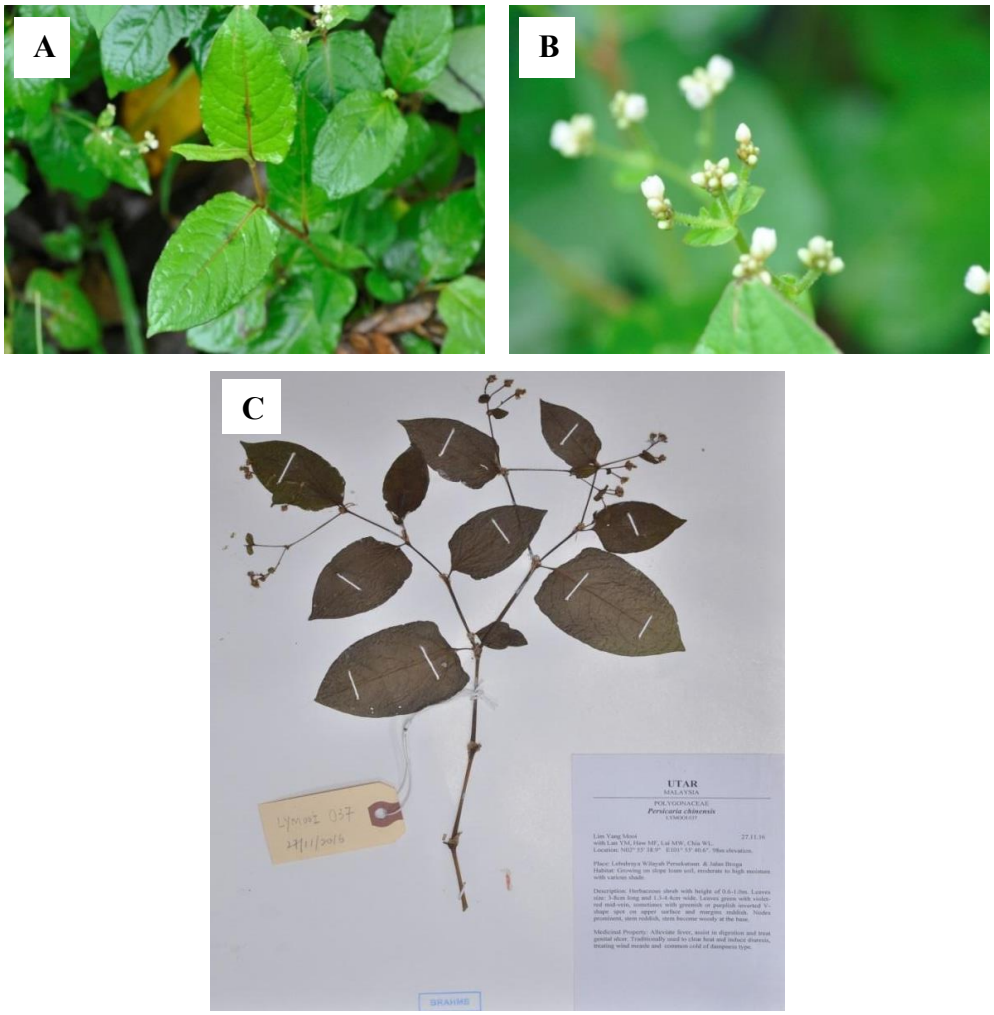

Figure 4.1.29: Specimen of *Persicaria chinensis* (L.) H. Gross var. chinensis (A) Leaves (B) Flower (C) Herbarium voucher of LYMOOI 037

Table 4.1.29: Information relating to vouchered specimen of *Persicaria chinensis* (L.) H. Gross var. chinensis LYMOOI 037

Voucher	LYMOOI 037
Family	Polygonaceae
Scientific Name	*Persicaria chinensis* (L.) H. Gross var. chinensis
Date of Collection	27th November 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Lebuhraya Wilayah Persekutuan & Jalan Broga
Location	N02° 55' 38.9" E101° 55' 40.6" 98 m
Habitat	Growing on slope loam soil, moderate to high moisture with various shade.
Description	Herbaceous shrub with height of 0.6-1.0 m. Leaves size: 3-8 cm long and 1.3-4.4 cm wide. Leaves green with violet-red mid-vein, sometimes with greenish or purplish inverted V-shape spot on upper surface and margins reddish. Nodes prominent, stem reddish, stem become woody at the base.
Medicinal Property	Alleviate fever, assist in digestion, and treat genital ulcer. Traditionally used to clear heat and induce diuresis, treating wind measles and common cold of dampness type.

4.1.30 *Brucea javanica* (L.) Merr. LYMOOI 020

Representative photographs dataset of morphology characteristic *Brucea javanica* are shown in Figure 4.1.30 A-B. Data obtained from the field notebook as shown in Table 4.1.30 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.30 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.1.30: Specimen of *Brucea javanica* (Linn) Merr. (A) Habitat (B) Top view of leaves (C) Herbarium voucher of LYMOOI 020

Table 4.1.30: Information relating to vouchered specimen of *Brucea javanica* (Linn) Merr. LYMOOI 020

Voucher	LYMOOI 020
Family	Simaroubaceae
Scientific Name	*Brucea javanica* (Linn) Merr.
Date of Collection	30th October 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Kampung Lembah Paya, Nilai 71800 Negeri Sembilan
Location	N02° 46' 31.6" E101° 45' 17.2" 25 m
Habitat	Growing on slope, secondary forest with moderate moist lump soil, partial to full sunlight.
Description	Shrub grows to the height of 5 m tall. Leaves arrange alternately, compound leaves. Leaflets are opposite, ovate to ovate-lanceolate with serrate margins. The leaves are covered with fine hairs that are most prominent at the veins and on the undersides of the leave.
Medicinal Property	Seed can be used to treats corns while the root is normally used to treat herpes zoster.

4.1.31 *Solanum nigrum* L. LYMOOI 003

Representative photographs dataset of morphology characteristic *Solanum nigrum* are shown in Figure 4.1.31 A-B. Data obtained from the field notebook as shown in Table 4.1.31 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.31 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

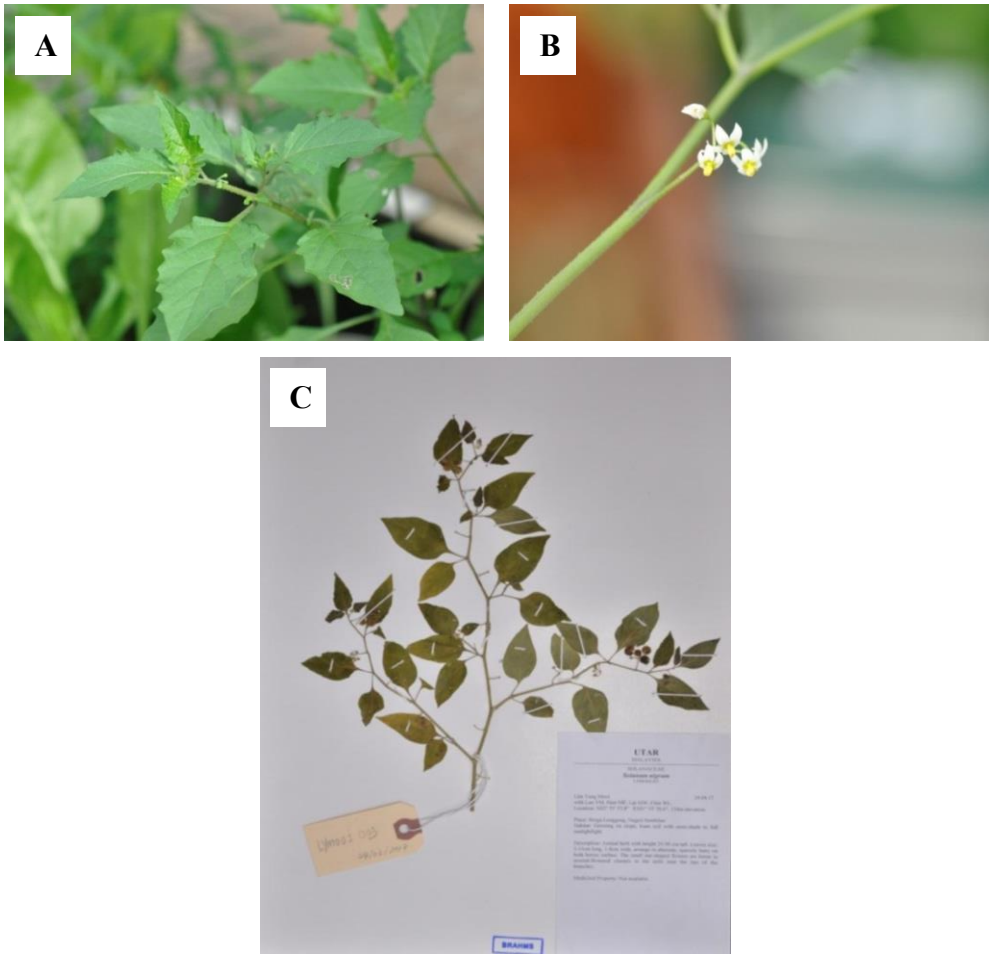

Figure 4.1.31: Specimen of *Solanum nigrum* L. (A) Upper surface of leaf (B) Flower (C) Herbarium voucher of LYMOOI 003

Table 4.1.31: Information relating to vouchered specimen of *Solanum nigrum* L. LYMOOI 003

Voucher	LYMOOI 003
Family	Solanaceae
Scientific Name	*Solanum nigrum* L.
Date of Collection	24th April 2017
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Broga Lenggeng, Negeri Sembilan
Location	N02° 55' 53.8" E101° 55' 30.6" 124 m
Habitat	Growing on slope, loam soil with semi-shade to full sunlight.
Description	Annual herb with height 25-90 cm tall. Leaves size: 2-13 cm long, 1-8 cm wide, arrange in alternate, sparsely hairy on both leaves surface. The small star-shaped flowers are borne in several-flowered clusters in the axils near the tips of the branches.
Medicinal Property	Not available

4.1.32 *Solanum torvum* Sw. LYMOOI 013

Representative photographs dataset of morphology characteristic *Solanum torvum* are shown in Figure 4.1.32 A-C. Data obtained from the field notebook as shown in Table 4.1.32 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.32 D) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

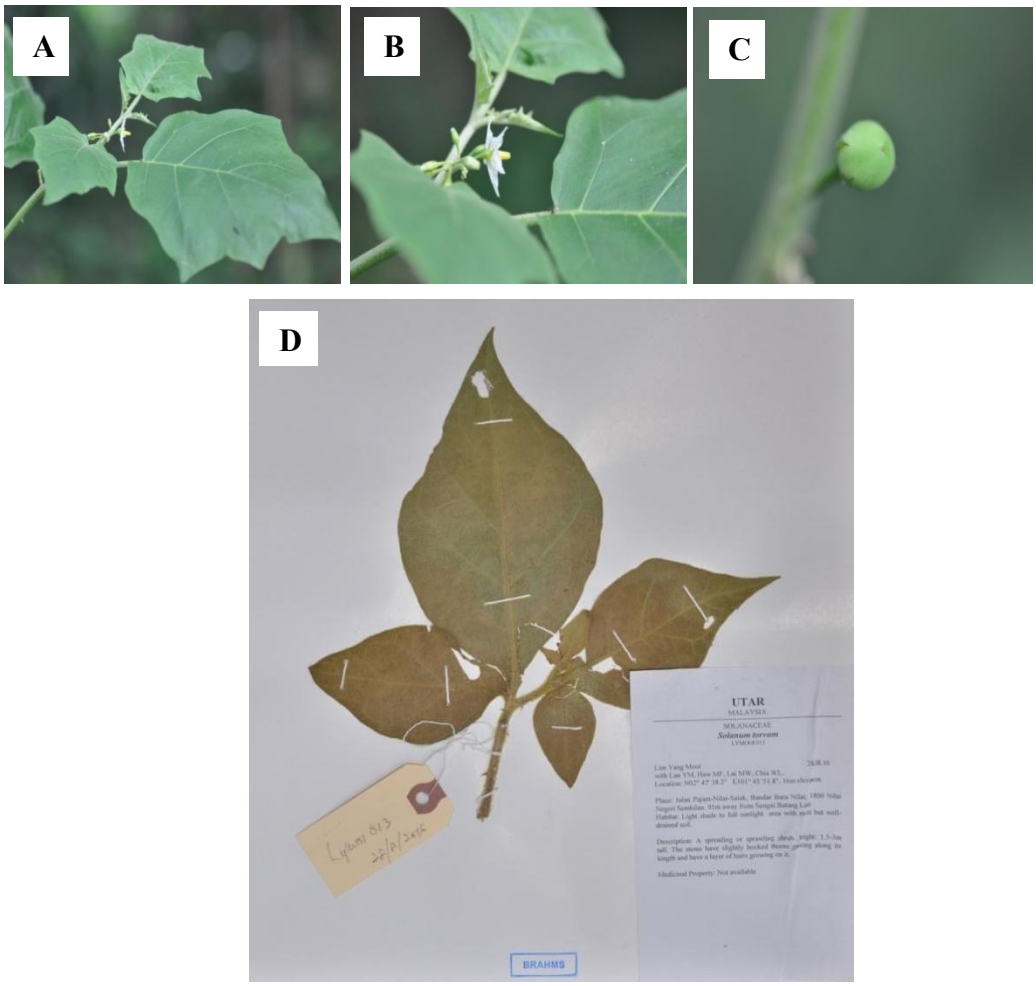

Figure 4.1.32: Specimen of *Solanum torvum* Sw. (A) Leaves (B) Lateral view of flower (C) Fruit (D) Herbarium voucher of LYMOOI 013

Table 4.1.32: Information relating to vouchered specimen of *Solanum torvum* Sw. LYMOOI 013

Voucher	LYMOOI 013
Family	Solanaceae
Scientific Name	*Solanum torvum* Sw.
Date of Collection	28th August 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Jalan Pajam-Nilai-Salak, Bandar Baru Nilai, 71800 Nilai Negeri Sembilan. 95 m away from Sungai Batang Labu
Location	N02°47' 38.2" E101°45 '51.8" 16 m
Habitat	Light shade to full sunlight area with moist but well-drained soil.
Description	A spreading or sprawling shrub. Height: 1.5-3 m tall. The stems have slightly hooked thorns growing along its length and have a layer of hairs growing on it.
Medicinal Property	Not available

4.1.33 *Centella asiatica* (L.) Urb LYMOOI 046

Representative photographs dataset of morphology characteristic *Centella asiatica* are shown in Figure 4.1.33 A-B. Data obtained from the field notebook as shown in Table 4.1.33 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.33 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

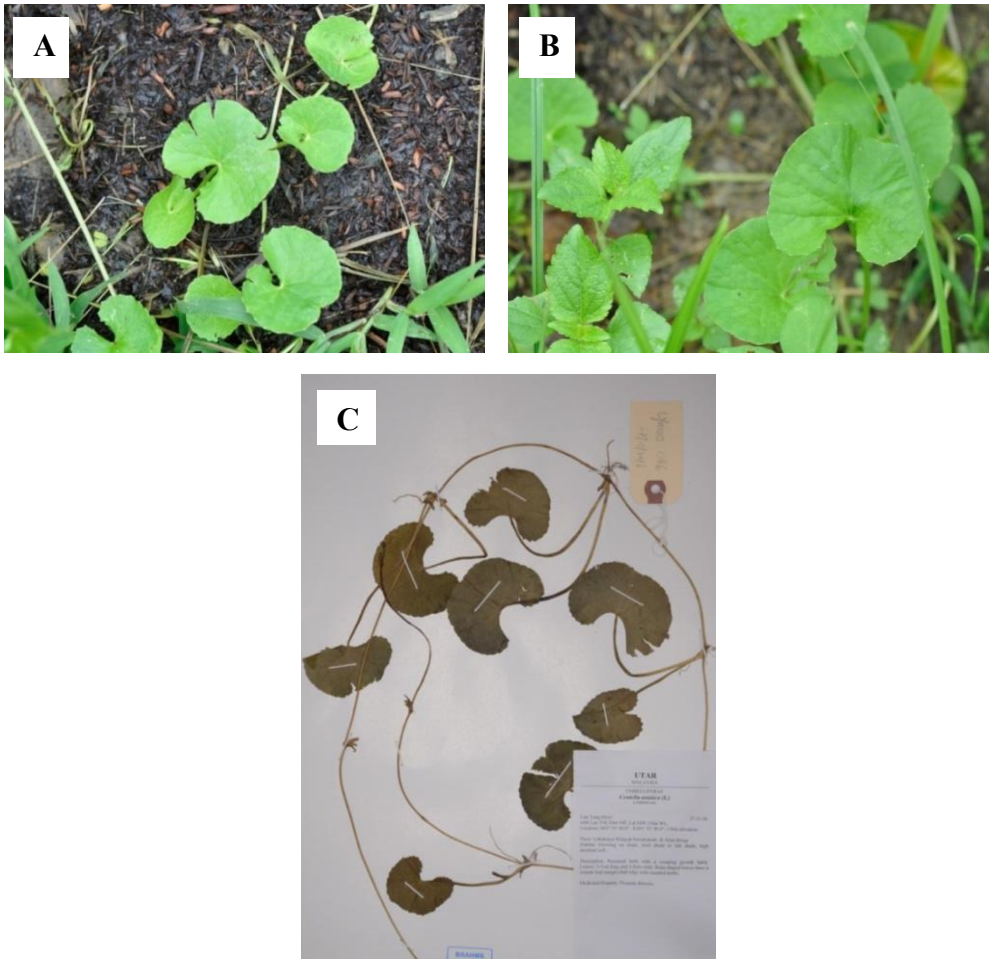

Figure 4.1.33: Specimen of *Centella asiatica* (L.) Urb (A) Habitat (B) Leaves (C) Herbarium voucher of LYMOOI 046

Table 4.1.33: Information relating to vouchered specimen of *Centella asiatica* (L.) Urb LYMOOI 046

Voucher	LYMOOI 046
Family	Umbelliferae
Scientific Name	*Centella asiatica* (L.) Urb
Date of Collection	27th November 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Lebuhraya Wilayah Persekutuan & Jalan Broga
Location	N02° 55' 40.0" E101° 55' 40.6" 110 m
Habitat	Growing on slope, semi shade to full shade, high moisture soil.
Description	Perennial herb with a creeping growth habitat. Leaves: 3-5 cm long and 2-4 cm wide. Bean-shaped leaves have a crenate leaf margin (leaf edge with rounded teeth).
Medicinal Property	Promote diuresis.

4.1.34 *Eryngium foetidum* L. LYMOOI 038

Representative photographs dataset of morphology characteristic *Eryngium foetidum* are shown in Figure 4.1.34 A-B. Data obtained from the field notebook as shown in Table 4.1.34 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.34 C-D) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.1.34: Specimen of *Eryngium foetidum* L. (A) Leaves (B) Flower (C) and (D) Herbarium voucher of LYMOOI 038

Table 4.1.34: Information relating to vouchered specimen of *Eryngium foetidum* L LYMOOI 038

Voucher	LYMOOI 038
Family	Umbelliferae
Scientific Name	*Eryngium foetidum* L
Date of Collection	27th November 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Lebuhraya Wilayah Persekutuan & Jalan Broga
Location	N02° 55' 39.0" E101° 55' 40.4" 97 m
Habitat	Well-drained fertile loam soil with moderate moisture, semi-shade to full sunlight.
Description	Perennial shrub grows up to the height of 0.3-0.6 m tall. Leaves size: 4.5-15 cm long and 2.0-3.8 cm wide, arranged in a basal rosette. Leaf margin is finely toothed. Leaf edges and tips may be sharp, especially those of leaves on the floral stalk. Flowers arranged in a reduced umbel inflorescence that is cylindrical with a dome-shaped top.
Medicinal Property	Used in Traditional Chinese Medicine to regulate middle burner qi, regulating the stomach qi. Used for the symptoms of stomach distension and bloating.

4.1.35 *Hydrocotyle sibthorpioides* Lam. LYMOOI 069

Representative photographs dataset of morphology characteristic *Hydrocotyle sibthorpioides* are shown in Figure 4.1.35 A-B. Data obtained from the field notebook as shown in Table 4.1.35 were used to prepare labels for the voucher specimen. The mounted voucher herbarium specimen (Figure 4.1.35 C) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

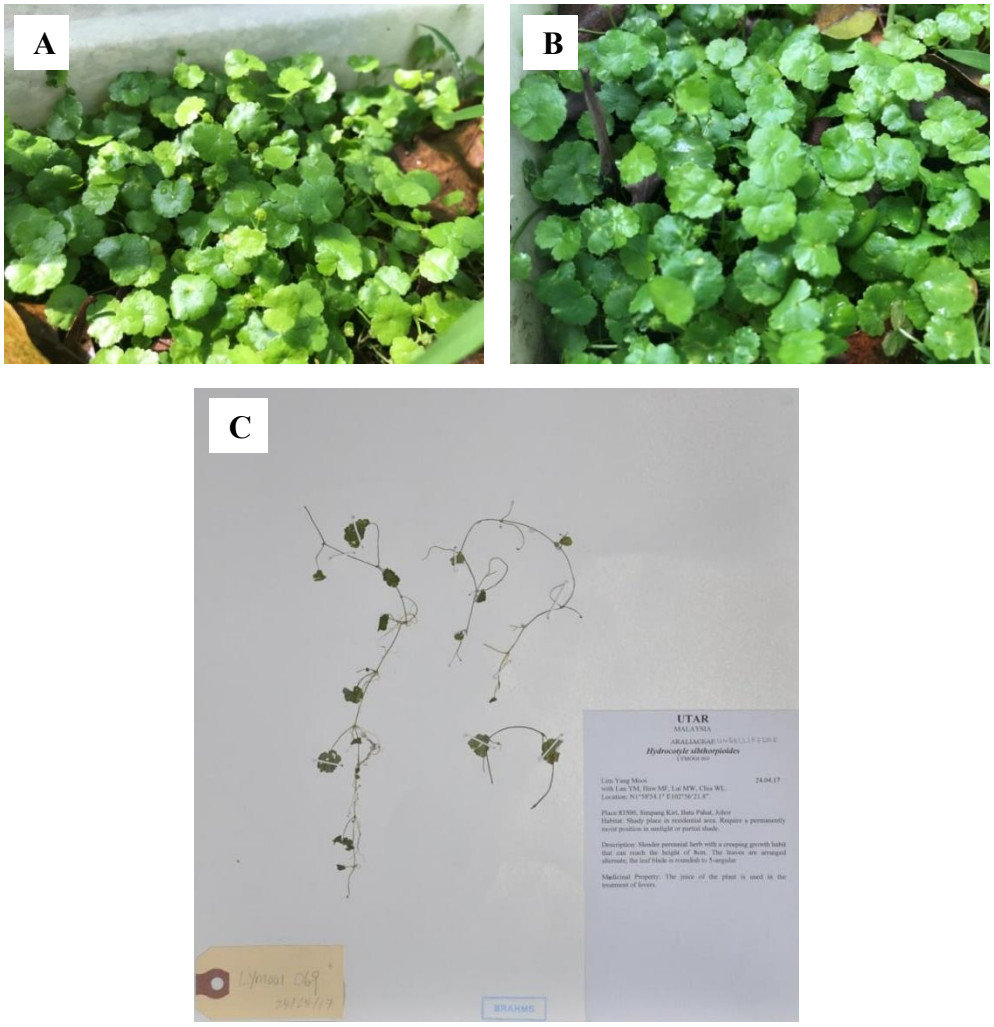

Figure 4.1.35: Specimen of *Hydrocotyle sibthorpioides* Lam. (A) Habitat (B) Top view of leaves (C) Herbarium voucher of LYMOOI 069

Table 4.1.35: Information relating to vouchered specimen of *Hydrocotyle sibthorpioides* Lam. LYMOOI 069

Voucher	LYMOOI 069
Family	Umbelliferae
Scientific Name	*Hydrocotyle sibthorpioides* Lam.
Date of Collection	24th April 2017
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	83500, Simpang Kiri, Batu Pahat, Johore
Location	N1°58'54.1" E102°56‘21.8”
Habitat	Shady place in residential area. Require a permanently moist position in sunlight or partial shade.
Description	Slender perennial herb with a creeping growth Habitat that can reach the height of 8 cm. The leaves are arranged alternate; the leaf blade is roundish to 5-angular.
Medicinal Property	The juice of the plant is used in the treatment of fevers.

4.2 DNA barcoding

4.2.1 Universality of Primer Sequences

In the 35 local medicinal plants, samples of a total of 35 individuals were collected and 84 sequences were available for the three DNA fragments (Table 4.2.1). Among these fragments, *rbc*L had gain 100% success rate of PCR amplification, followed by ITS (88.57%) and the success rate of PCR amplification for *mat*K was the lowest (74.29%). By comparison, the sequencing success rate in percentage were *rbc*L> ITS> *mat*K.

4.2.2 Identification Efficiency

In order to select the most suitable barcode, the identification efficiency of the three regions were compared. Identification efficiency of three loci is shown in Table 4.2.2. Based on BLAST analysis methods, the correct identification efficiency of *rbc*L was significantly lower than that of *mat*K and ITS. ITS had the highest identification rate in both the species-level and genus level. By comparison, the correct identification efficiency values were *mat*K>ITS>*rbc*L at genus level and ITS>*mat*K>*rbc*L species level.

Based on the BLAST result, the three regions successfully amplified 13 plant samples using *rbc*L, 9 using *mat*K and 12 using ITS region, respectively. For those plant that successfully identified to species level by using *rbc*L are, *Alternanthera sessilis*, *Celosia argentea*, *Annona muricata*, *Laurentia*

longiflora, *Lobelia chinensis*, *Blumea balsamifera*, *Elephantopus scaber*, *Ricinus communis*, *Senna tora*, *Peperomia pellucida*, *Piper sarmentosum*, *Solanum torvum* and *Centella asiatica*. For *mat*K are *Alternanthera sessilis*, *Annona muricata*, *Pereskia bleo*, *Ricinus communis*, *Malpighia coccigera*, *Sauropus spatulifolius*, *Brucea javanica*, *Solanum torvum* and *Hydrocotyle sibthorpioides*. For ITS are *Blumea balsamifera*, *Cosmos sulphureus*, *Jatropha podagrica*, *Ricinus communis*, *Senna occidentalis*, *Senna tora*, *Morus alba*, *Peperomia pellucida*, *Persicaria chinensis*, *Centella asiatica*, *Eryngium foetidum*, and *Hydrocotyle sibthorpioides*. BLAST results for three loci are shown in Table 4.2.3

Table 4.2.1: Amplification and sequencing success rate of the three candidate loci for 35 local medicinal plants

Locus	Sample for PCR amplification	Amplicons obtained	Amplification success (%)	No. of finished sequences generated	Sequencing success (%)
*rbc*L	35	35	100.00	35	100.00
*mat*K	35	26	74.29	22	84.62
ITS	35	30	85.71	27	87.10

Table 4.2.2: Identification efficiency for three loci of 35 local medicinal plants using BLAST

Locus	Plant taxa level	Sample size	Correct identification (%)	Ambiguous identification (%)	Incorrect identification or no match (%)
*rbc*L	Genus	35	74.77	5.70	20.00
	Species	35	37.14	42.85	
*mat*K	Genus	22	95.45	0.00	4.55
	Species	22	40.90	54.54	
ITS	Genus	26	92.30	0.00	7.70
	Species	26	46.15	46.15	

Table 4.2.3: BLAST result for 35 species of local medicinal plants

Scientific Name	*rbc*L	ID (%)	*mat*K	ID (%)	ITS	ID (%)
Althernanthera sessilis	*Alternanthera sessilis*	100	*Alternanthera sessilis*	99	*Alternanthera* sp.	97
					Alternanthera sessilis	98
Celosia argentea L.	*Celosia argentea*	100	*Celosia cristata*	100	*Celosia cristata*	99
Gomphrena globosa L.	*Froelichia drummondii*	99	*Gomphrena ferruginea*	99	*Gomphrena celosioides*	93
	Gomphrena serrata	100	*Gomphrena* sp. C	100		
Annona muricata L.	*Annona muricata*	99	*Annona muricata*	100	-	
Eleutherococcus trifoliatus (L.) S.Y. Hu	*Eleutherococcus senticosus*	99	*Eleutherococcus trichodon*	99	*Eleutherococcus sessiliflorus*	98
			Eleutherococcus senticosus	99	*Eleutherococcus divaricatus*	99
Epiphyllum oxypetalum (DC. Haw)	*Neobuxbaumia scoparia*	99	-		-	
Pereskia bleo	*Maihuenia poeppigii*	99	*Pereskia bleo*	100	-	

Table 4.2.3 (continued)

Scientific Name	*rbc*L	ID (%)	*mat*K	ID (%)	ITS	ID (%)
Laurentia longiflora (L.) Peterm.	*Hippobroma longiflora*	100	-	-		
Lobelia chinensis Lour	*Lobelia chinensis*	100	-		-	
Ageratum conyzoides L.	*Praxelis clematidea*	99	-		*Praxelis clematidea*	98
Artemisia vulgaris L.	*Artemisia argyi*	100	*Artemisia argyi*	99	*Artemisia* sp.	99
Blumea balsamifera (L.) DC	*Blumea balsamifera*	100	*Alocasia cucullata*	99	*Blumea balsamifera*	100
Cosmos sulphureus	*Cosmos bipinnatus*	99	-		*Cosmos sulphureus*	99
Elephantopus scaber L.	*Elephantopus scaber*	99	-		*Elephantopus mollis*	100
Elephantopus tomentosus L.	*Elephantopus scaber*	99	-		*Elephantopus sp.*	100
Mikania cordata (Burm.f) B.L. Rob	*Mikania micrantha*	100	-		*Mikania micrantha*	99

Table 4.2.3 (continued)

Scientific Name	*rbc*L	ID (%)	*mat*K	ID (%)	ITS	ID (%)
Vernonia esculenta Hems.Ex. Hemsl	*Oldenburgia grandis*	99	-		*Gymnanthemum amygdalinum*	99
Jatropha podagrica	*Jatropha capensis*	99	*Jatropha gossypiifolia*	99	*Jatropha podagrica*	97
	Jatropha curcas	99	*Jatropha podagrica*	99	-	
	Jatropha podagrica	100				
Ricinus communis L.	*Ricinus communis*	99	*Ricinus communis*	100	*Ricinus communis*	99
Senna occidentalis (L.) Link	*Senna marilandica*	99	*Senna hirsuta*	99	*Senna occidentalis*	100
	Senna tora	99	*Senna occidentalis*	99		
Senna tora (L.) Roxb	*Senna tora*	100	*Senna obtusifolia*	100	*Senna tora*	100
			Senna tora	100		
Malpighia coccigera	*Mascagnia anisopetala*	99	*Malpighia coccigera*	100	*Malpighia emarginata*	94
	Tetrapterys ambigua	99			*Malpighia stevensi*	94

Table 4.2.3 (continued)

Scientific Name	*rbc*L	ID (%)	*mat*K	ID (%)	ITS	ID (%)
Melia azedarach L.	*Azadirachta indica*	100	-		-	
Toona sinensis (A. Juss.)	*Cedrela odorata*	99	-		*Toona sinensis*	99.59
	Toona sinensis	100	-			
Morus alba Y.B Wu	*Morus australis*	100	*Morus australis*	100	*Morus alba*	100
	Morus alba	100	*Morus alba*	100		
Sauropus spatulifolius Beilla	*Phyllanthus urinaria*	99	*Sauropus saptulifolius*	100	-	
	Breynia cernua	100				
	Sauropus racemosus	100				
Peperomia pellucida	*Peperomia pellucida*	99	-		*Peperomia pellucida*	100
Piper sarmentosum Roxb.	*Piper sarmentosum*	99	-		-	
Persicaria chinensis (L.) H. Gross var. chinensis	*Persicaria capitata*	99	*Persicaria sieboldii*	100	*Polygonum chinense*	100
	Polygonum chinense	99	*Polygonum chinense*	100		

Table 4.2.3 (continued)

Scientific Name	*rbc*L	ID (%)	*mat*K	ID (%)	ITS	ID (%)
Brucea javanica (Linn) Merr.	*Brucea mollis*	99	*Brucea javanica*	99	*Brucea mollis*	97
	Brucea javanica	99			*Brucea javanica*	98
Solanum nigrum L.	*Solanum sp*	99	*Solanum americanum*	99	*Solanum americanum*	100
	Solanum nigrum	99	*Solanum nigrum*	99	*Solanum nigrum*	99
Solanum torvum Sw.	*Solanum torvum*	100	*Solanum torvum*	100	-	
Centella asiatica (L.) Urb	*Centella asiatica*	100	*Centella virgata*	99	*Centella asiatica*	99
			Centella asiatica	100		
Eryngium foetidum L.	*Eryngium vesiculosum*	99	*Eryngium vaseyi*	99	*Eryngium foetidum*	85
			Eryngium foetidum	100		
Hydrocotyle sibthorpioides Lam.	*Hydrocotyle sibthorpioides*	100	*Hydrocotyle sibthorpioides*	100	*Centella asiatica*	99
	Hydrocotyle verticillata	99			*Hydrocotyle ramiflora*	99

4.3 Untargeted Metabolite Profiling

Untargeted metabolomic profiling was done on 35 collected plant sample with different plant parts were used (Chapter 3 Table 3.1). Among the plant parts used for preparation of crude extraction (Figure 4.3), leaves were 27 (77%) most frequently used individually. It was followed by the whole plant 5 (14%), root, flower, and stem 1 for each (3%).

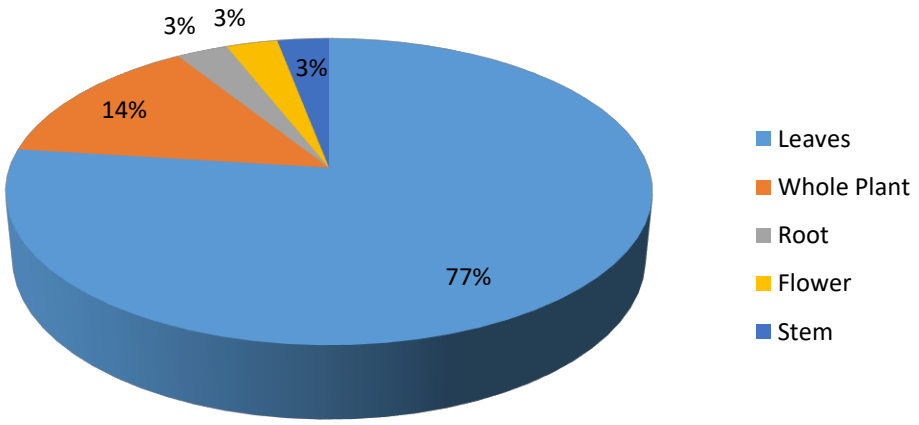

Figure 4.3: Plant parts used in untargeted metabolite profiling

Putative identification of compounds detected were made by referring to several databases in MS-Finder software such as UNPD (Nature product), PubChem (Biomolecule), KNApSAcK (nature product), NANPDB (Nature product) and PlantCyc (plant) databases. Extracts from 35 local medicinal plants led to the identification of known unknown metabolites in chloroform/methanol and aqueous extracts (Tables 4.3.1 to 4.3.35). Both primary and secondary metabolites were detected but the latter is more abundant in terms of number of

metabolites. Regarding secondary metabolites, it can be divided into four main categories, namely, nitrogen-containing compounds, phenolics, terpenes and others. A total of 70 nitrogen-containing compounds, 160 phenolic compounds and 95 terpenes putative compounds were identified.

Ageratum conyzoides recorded 38 secondary metabolites, the highest secondary metabolites among 35 plants. *Peperomia pellucida* has the highest nitrogen-containing compounds, *Ageratum conyzoides* has the highest phenolic compounds while *Elephantopus tomentosus* has the highest terpene compounds, recorded the amount of 16, 19, and 15 respectively.

4.3.1 *Alternanthera sessilis* LYMOOI 067

LCMSMS analysis of extract from *Alternanthera sessilis* enabled the identification of 27 putative compounds (Table 4.3.1) belonging to different chemical families. It contains 3 putative primary metabolites and 24 putative secondary metabolites.

Table 4.3.1: List of putative compounds in LYMOOOI 067, consist of 27 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	268.1046	1.09	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
Pigments	535.2708	9.18	Chlorins	Chlorins
	607.2924	9.36	Methyl pheophorbide a	Chlorins

Table 4.3.1 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Secondary metabolites				
Nitrogen containing compounds	118.0863	0.82	3-(dimethylamino)propanoic acid	Trialkylamines
	205.0971	1.80	L-tryptophan	L-tryptophan
	344.1492	3.97	7-amino-10-hydroxy-1,2,3-trimethoxy-6,7-dihydro-5H-benzo[a]heptalen-9-one	Tropolones
	314.1396	4.17	(1S,9R)-3-hydroxy-4,13-dimethoxy-17-azatetracyclo[7.5.3.01,10.02,7]heptadeca-2(7),3,5,10,13-pentaen-12-one	Phenanthrenes and derivatives
Phenolic	195.0651	2.63	(2E)-3-(3-hydroxy-2-methoxyphenyl)prop-2-enoic acid	Hydroxycinnamic acids
	433.1138	3.22	Resokaempferol 7-glucoside	Flavonoid-7-O-glycosides
	431.0977	3.35	(2S,3S,4S,5R,6S)-3,4,5-trihydroxy-6-{[3-(4-hydroxyphenyl)-4-oxo-4H-chromen-7-yl]oxy}oxane-2-carboxylic acid	Isoflavonoid O-glycosides
	463.1238	3.65	8-beta-D-Glucopyranosyl-5,7-dihydroxy-2-(3-hydroxy-4-methoxyphenyl)-4H-1-benzopyran-4-one	Flavonoid 8-C-glycosides

Table 4.3.1 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolic	221.1171	6.15	2-(1-hydroxycyclopentyl)-2-phenylacetic acid	Benzene and substituted derivatives
Terpenes	551.4253	9.01	3,5,5-trimethyl-4-[(1E,3E,5E,7E,9E,11E,13E,15E,17E)-3,7,12,16-tetramethyl-18-[(1S)-2,6,6-trimethylcyclohexa-2,4-dien-1-yl]octadeca-1,3,5,7,9,11,13,15,17-nonaenyl]cyclohex-3-en-1-ol	Xanthophylls
Others	166.0863	0.96	2-hydroxy-2-phenylpropanamide	Phenylacetamides
	229.1552	1.00	Fatty acid methyl esters	Fatty acid methyl esters
	238.1077	1.35	(3-hydroxy-2,2-dimethyl-3H-1-benzofuran-7-yl) N-methylcarbamate	Coumarans
	209.1174	2.58	2-[3-oxo-2-[(E)-pent-2-enyl]cyclopenten-1-yl]acetic acid	Cyclic ketones
	227.1281	2.70	2-[(1R,2R)-2-[(Z,4S)-4-hydroxypent-2-enyl]-3-oxocyclopentyl]acetic acid	Jasmonic acids
	179.1066	3.31	(4S)-4-hydroxy-3-methyl-2-[(2Z)-penta-2,4-dienyl]cyclopent-2-en-1-one	Secondary alcohols

Table 4.3.1 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Others	181.1217	4.51	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols
	277.2159	5.72	9,12,15,17-octadecatetraenoic acid	Lineolic acids and derivatives
	277.2161	5.98	octadeca-9,11,13,15-tetraenoic acid	Lineolic acids and derivatives
	282.2794	7.25	octadec-9-enamide	Fatty amides
	613.4824	8.96	(2S)-1-hydroxy-3-[(9Z,12Z)-octadeca-9,12-dienoyloxy]propan-2-yl (6Z,9Z,12Z,15Z)-octadeca-6,9,12,15-tetraenoate	Lineolic acids and derivatives
	429.3731	9.28	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols
	760.5853	11.60	[2-(methylamino)ethoxy]({2-[(9Z)-octadec-9-enoyloxy]-3-(octadecanoyloxy)propoxy})phosphinic acid	Monomethylphosphatidyl ethanolamines

4.3.2 *Celosia argentea* L. LYMOOI 072

LCMSMS analysis of extract from *Celosia argentea* enabled the identification of 25 putative compounds (Table 4.3.2) belonging to different chemical families. It contains 1 putative primary metabolite and 24 putative secondary metabolites.

Table 4.3.2: List of putative compounds in LYMOOOI 072, consist of 25 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	268.1047	1.61	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
Secondary metabolites				
Nitrogen containing compounds	104.1071	0.79	3-(dimethylamino)propan-1-ol	1,3-aminoalcohols
	118.0864	0.82	3-(dimethylamino)propanoic acid	Trialkylamines
	138.0550	0.83	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids
	188.0709	1.60	3-(1*H*-indol-3-yl)prop-2-enoic acid	Indoles

Table 4.3.2 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	205.0981	1.98	L-tryptophan	L-tryptophan
	217.0978	2.41	3-(1-phenylethyl)imidazole-4-carboxylic acid	Carbonylimidazoles
	344.1495	3.98	7-amino-10-hydroxy-1,2,3-trimethoxy-6,7-dihydro-5H-benzo[a]heptalen-9-one	Tropolones
	314.1385	4.18	Phenanthrenes and derivatives	Phenanthrenes and derivatives
Phenolic	151.0757	1.66	5-ethenyl-2-methoxyphenol	Methoxyphenols
	421.1349	1.96	Methyl (1S,2S,4S,5S,6S,7S)-5-hydroxy-5-(hydroxymethyl)-7-[(2S,3R,4S,5S,6R)-3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxy-3,8-dioxatricyclo[4.4.0.02,4]dec-9-ene-10-carboxylate	O-glycosyl compounds
	287.0555	2.56	3,7,8-trihydroxy-2-(4-hydroxyphenyl)chromen-4-one	Flavonols
	535.1080	3.09	Kaempferol 7-O-β-D-(6"-O-malonyl)-glucoside	Flavonoid-7-O-glycosides
	287.0556	3.37	3,5,7-trihydroxy-2-(3-hydroxyphenyl)-4H-chromen-4-one	Flavonols

Table 4.3.2 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolic	147.0444	4.15	3-phenylprop-2-ynoic acid	Benzene and substituted derivatives
	327.0862	5.22	9-methoxy-7-(2-methoxyphenyl)-[1,3]dioxolo[4,5-g]chromen-8-one	Isoflavones
	343.1174	5.57	3-(1,3-benzodioxol-5-ylmethyl)-5,7-dihydroxy-6,8-dimethyl-2,3-dihydrochromen-4-one	Homoisoflavanones
	313.1069	5.67	3-(3,4-dimethoxyphenyl)-7-methoxychromen-4-one	7-O-methylisoflavones
Others	166.0865	0.96	2-hydroxy-2-phenylpropanamide	Phenylacetamides
	229.1551	1.10	Fatty acid methyl esters	Fatty acid methyl esters
	177.0553	4.24	3-(1,3-benzodioxol-5-yl)prop-2-enal	Benzodioxoles
	353.2314	4.77	(5Z,8Z,10E,12S)-12-hydroperoxy-13-[(2R,3S)-3-pentyloxiran-2-yl]trideca-5,8,10-trienoate	Long-chain fatty acids
	293.2107	5.47	10-methoxyheptadec-1-en-4,6-diyne-3,9-diol	Long-chain fatty alcohols
	277.2169	5.92	Octadeca-6,9,12,15-tetraenoic acid	Lineolic acids and derivatives
	351.2534	7.53	8-HPETE methyl ester	Other hydroperoxyeicosapolyenoic acids

4.3.3 *Gomphrena globosa* L LYMOOI 032

LCMSMS analysis of extract from *Gomphrena globosa* enabled the identification of 32 putative compounds (Table 4.3.3) belonging to different chemical families. It contains 2 putative primary metabolites and 30 putative secondary metabolites.

Table 4.3.3: List of putative compounds in LYMOOOI 032, consist of 32 putative compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	268.1039	1.24	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
Proteins	175.1189	0.94	(3~{S})-3-azaniumyl-5-(diaminomethylideneazaniumyl)pentanoate	Beta amino acids and derivatives
Secondary metabolites				
Nitrogen containing compounds	138.0546	0.65	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids
	104.1068	0.81	3-(dimethylamino)propan-1-ol	1,3-aminoalcohols

Table 4.3.3 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitogen containing compounds	118.0862	0.81	3-(dimethylamino)propanoic acid	Trialkylamines
	217.0975	2.41	3-(1-phenylethyl)imidazole-4-carboxylic acid	Carbonylimidazoles
	312.1237	3.55	Velucryptine	Benzylisoquinolines
	314.1394	4.17	4~{a}-hydroxy-9-methoxy-3-methyl-2,4,7~{a},13-tetrahydro-1~{H}-4,12-methanobenzofuro[3,2-e]isoquinolin-7-one	Morphinans
	206.1406	9.40	N-(3-methylbut-2-enyl)-1,4,5,7-tetrahydropurin-6-imine	Imidazopyrimidines
	124.0872	14.03	Benzene-1,2,4-triamine	Aniline and substituted anilines
Phenolic	435.1286	3.75	5,7-dihydroxy-2-(4-hydroxyphenyl)-3-[(3,4,5-trihydroxy-6-methyloxan-2-yl)oxy]-3,4-dihydro-2H-1-benzopyran-4-one	Flavonoid-3-O-glycosides
	331.0454	4.19	2,3-Dimethylellagic acid	Hydrolyzable tannins
	477.1036	4.37	Luteolin 7-methylglucuronide	Flavonoid-7-O-glucuronides

Table 4.3.3 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolic	315.0505	4.38	2-(5,7-dihydroxy-4-oxochromen-3-yl)-5-methoxycyclohexa-2,5-diene-1,4-dione	Chromones
	625.1558	4.67	(2~{R},3~{S})-2-(3,5-dihydroxy-4-methoxyphenyl)-8-[(2~{R},3~{R},4~{R})-3,5,7-trihydroxy-2-(3,4,5-trihydroxyphenyl)-3,4-dihydro-2~{H}-chromen-4-yl]-3,4-dihydro-2~{H}-chromene-3,5,7-triol	Biflavonoids and polyflavonoids
	315.0506	4.78	11,14-dihydroxy-6,8,19-trioxapentacyclo[10.7.0.0^{2},^{9}.0^{3},^{7}.0^{13},^{17}]nonadeca-1(12),2(9),4,10,13(17)-pentaene-16,18-dione	Angular furanocoumarins
Others	156.0420	0.77	2-(methylamino)ethyl dihydrogen phosphate	Phosphoethanolamines
	229.1550	1.09	Fatty acid methyl esters	Fatty acid methyl esters
	181.1229	4.50	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols
	291.1964	5.08	Deoxy phytoprostane J1	Prostaglandins and related compounds
	279.2325	6.19	9,12,14-octadecatrienoic acid	Lineolic acids and derivatives

4.3.4 *Annona Muricata* L LYMOOI 048

LCMSMS analysis of extract from *Annona Muricata* enabled the identification of 32 putative compounds (Table 4.3.4) belonging to different chemical families. It contains 1 putative primary metabolite and 31 putative secondary metabolites.

Table 4.3.4: List of putative compounds in LYMOOOI 048, consist of 32 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	268.1042	1.64	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
Secondary metabolites				
Nitrogen containing compounds	146.0813	0.63	trans-4-Hydroxy-N-methyl-L-proline	Proline and derivatives
	138.0549	0.70	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids
	208.1332	1.89	7-methoxy-1,2-dimethyl-3,4-dihydro-1H-isoquinolin-6-ol	Tetrahydroisoquinolines

Table 4.3.4 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	188.0705	1.97	3-(1*H*-indol-3-yl)prop-2-enoic acid	Indoles
	330.1699	2.18	4-[[(1S)-6,7-dimethoxy-1,2,3,4-tetrahydroisoquinolin-2-ium-1-yl]methyl]-2-methoxyphenol	Benzylisoquinolines
	272.1283	2.62	Norhydromorphone	Morphinans
	314.1388	2.68	(1S,9R)-3-hydroxy-4,13-dimethoxy-17-azatetracyclo[7.5.3.01,10.02,7] heptadeca-2(7),3,5,10,13-pentaen-12-one	Phenanthrenes and derivatives
	298.1445	2.70	Homolinearisine	Proaporphines
	286.1443	2.73	Isococlaurine	Benzylisoquinolines
	300.1596	3.11	4-[(6,7-dimethoxy-1,2,3,4-tetrahydroisoquinolin-1-yl)methyl]phenol	Benzylisoquinolines
	342.1697	3.43	(9-methoxy-3-methyl-2,4,4a,7,7a,13-hexahydro-1H-4,12-methanobenzofuro[3,2-e]isoquinolin-7-yl) acetate	Morphinans
	284.1280	3.76	Crotsparine	Proaporphines
	282.1122	3.97	Cissaglaberrimine	Aporphines

Table 4.3.4 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	300.1593	4.17	(-)-4'-O-Methylcoclaurine	Benzylisoquinolines
	296.1278	4.67	Pachypodanthine	Aporphines
	124.0863	13.97	benzene-1,2,4-triamine	Aniline and substituted anilines
Phenolic	147.0435	2.33	3-phenylprop-2-ynoic acid	Benzene and substituted derivatives
	303.0864	2.82	(3R,4R)-3-(6-hydroxy-1,3-benzodioxol-5-yl)-3,4-dihydro-2H-chromene-4,7-diol	Isoflavanols
	449.1079	3.46	6-beta-D-Glucopyranosyl-3,5,7-trihydroxy-2-(4-hydroxyphenyl)-4H-1-benzopyran-4-one	Flavonoid C-glycosides
	287.0547	3.47	3,7,8-trihydroxy-2-(4-hydroxyphenyl)chromen-4-one	Flavonols
	611.1608	3.57	7-{[(2S,3R,4S,5S,6R)-4,5-dihydroxy-6-(hydroxymethyl)-3-{[(2S,3R,4R,5R,6S)-3,4,5-trihydroxy-6-methyloxan-2-yl]oxy}oxan-2-yl]oxy}-2-(3,4-dihydroxyphenyl)-3,5-dihydroxy-4H-chromen-4-one	Flavonoid-7-O-glycosides
	449.1079	3.59	Quercetin 3-O-L-rhamnoside	Flavonoid-3-O-glycosides

Table 4.3.4 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolics	283.1336	3.70	5-prop-2-enyl-3-(4-prop-2-enylphenoxy)benzene-1,2-diol	Diphenylethers
	595.1659	3.76	5,7-dihydroxy-2-(4-hydroxyphenyl)-3-[(3,4,5-trihydroxy-6-{[(3,4,5-trihydroxy-6-methyloxan-2-yl)oxy]methyl}oxan-2-yl)oxy]-4H-chromen-4-one	Flavonoid-3-O-glycosides
Terpenes	163.0752	1.19	2-hydroxy-6-prop-1-en-2-ylcyclohepta-2,4,6-trien-1-one	Tropolones
Others	166.0862	0.96	2-hydroxy-2-phenylpropanamide	Phenylacetamides
	180.1019	1.20	3,4-Methylenedioxyamphetamine	Benzodioxoles
	174.1489	1.25	9-aminononanoic acid	Medium-chain fatty acids
	291.0866	1.60	6-[3-(2H-1,3-benzodioxol-5-yl)oxiran-2-yl]-4-methoxy-5,6-dihydro-2H-pyran-2-one	Benzodioxoles
	286.1443	2.14	Strobolamine	Dihydropyranones
	295.1019	2.71	6-tuliposide B	Saccharolipids

4.3.5 *Eleutherococcus trifoliatus* (L.) S.Y. Hu LYMOOI 014

LCMSMS analysis of extract from *Eleutherococcus trifoliatus* enabled the identification of 32 putative compounds (Table 4.3.5) belonging to different chemical families. It contains 1 putative primary metabolite and 31 putative secondary metabolites.

Table 4.3.5: List of putative compounds in LYMOOOI 014, consist of 32 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	136.0613	0.96	7H-purin-6-amine	Adenine
Secondary metabolites				
Nitrogen containing compounds	144.1022	0.66	1-aminocyclohexane-1-carboxylic acid	L-alpha-amino acids
	104.1072	0.68	3-(dimethylamino)propan-1-ol	1,3-aminoalcohols

Table 4.3.5 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	205.0976	1.98	L-tryptophan	L-tryptophan
	217.0977	2.42	3-(1-phenylethyl)imidazole-4-carboxylic acid	Carbonylimidazoles
Phenolics	163.0388	1.20	4-hydroxychromen-2-one	4-hydroxycoumarins
	355.1026	2.04	1-[3-(3,4-dihydroxyphenyl)prop-2-enoyloxy]-3,4,5-trihydroxycyclohexane-1-carboxylic acid	Quinic acids and derivatives
	303.0502	2.64	2-(3,4-dihydroxyphenyl)-3,6,7-trihydroxychromen-4-one	Flavonols
	303.0502	2.67	3,5,7,8-tetrahydroxy-2-(4-hydroxyphenyl)chromen-4-one	Flavonols
	147.0440	2.99	3-phenylprop-2-ynoic acid	Benzene and substituted derivatives
	611.1613	3.05	7-{[(2S,3R,4S,5S,6R)-4,5-dihydroxy-6-(hydroxymethyl)-3-{[(2S,3R,4R,5R,6S)-3,4,5-trihydroxy-6-methyloxan-2-yl]oxy}oxan-2-yl]oxy}-2-(3,4-dihydroxyphenyl)-3,5-dihydroxy-4H-chromen-4-one	Flavonoid-7-O-glycosides

Table 4.3.5 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolics	303.0505	3.11	2-(3,4-dihydroxyphenyl)-3,7,8-trihydroxychromen-4-one	Flavonols
	177.0547	3.25	7-hydroxy-6-methyl-2H-chromen-2-one	7-hydroxycoumarins
	389.1236	5.93	5-hydroxy-2-(4-hydroxy-3-methoxyphenyl)-3,6,7-trimethoxy-8-methylchromen-4-one	7-o-methylated flavonoids
Terpenes	433.3105	4.20	(2Z,4Z,6E,8Z,10E,12E,14Z,16E)-17-(4-hydroxy-2,6,6-trimethylcyclohex-2-en-1-yl)-2,6,11,15-tetramethylheptadeca-2,4,6,8,10,12,14,16-octaenal	Triterpenoids
	455.3525	4.52	Eucalyptanoic acid	Triterpenoids
	487.3421	4.78	(3*S*,4*S*,4*ar*,6*ar*,6*bs*,8*as*,12*as*,14*ar*,14*br*)-3-hydroxy-4,6*a*,6*b*,11,11,14*b*-hexamethyl-1,2,3,4*a*,5,6,7,8,9,10,12,12*a*,14,14*a*-tetradecahydropicene-4,8*a*-dicarboxylic acid	Triterpenoids
	441.3366	4.81	(2R)-2-[(3Z,7E,11Z)-13-hydroxy-4,8,12-trimethyltrideca-3,7,11-trien-1-yl]-2,5,7,8-tetramethyl-3,4-dihydro-2H-1-benzopyran-6-ol	Tocotrienols

Table 4.3.5 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Terpenes	435.3262	5.46	4-[(1E,3Z,5E,7E,9E,11E,13E,15E)-17-hydroxy-3,7,12,16-tetramethylheptadeca-1,3,5,7,9,11,13,15-octaen-1-yl]-3,5,5-trimethylcyclohex-3-en-1-ol	Triterpenoids
	303.2318	6.15	1,4a-dimethyl-7-propan-2-yl-2,3,4,4b,5,9,10,10a-octahydrophenanthrene-1-carboxylic acid	Diterpenoids
	301.2168	6.32	6,7-Dehydrosandaracopimaric acid	Diterpenoids
Others	229.1552	1.05	Fatty acid methyl esters	Fatty acid methyl esters
	177.0547	3.21	3-(1,3-benzodioxol-5-yl)prop-2-enal	Benzodioxoles
	179.1065	3.32	(4S)-4-hydroxy-3-methyl-2-[(2Z)-penta-2,4-dienyl]cyclopent-2-en-1-one	Secondary alcohols
	181.1221	4.51	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols
	189.1641	4.95	Branched unsaturated hydrocarbons	Branched unsaturated hydrocarbons
	189.1631	5.28	Branched unsaturated hydrocarbons	Branched unsaturated hydrocarbons

Table 4.3.5 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Others	277.2164	6.27	Octadeca-9,11,13,15-tetraenoic acid	Lineolic acids and derivatives
	277.2163	6.39	9,12,15,17-octadecatetraenoic acid	Lineolic acids and derivatives
	237.1484	6.58	[3R-(3alpha,4beta,4abeta,6alpha)]-4,4a,5,6,7,8-Hexahydro-3,4a-dihydroxy-4-methyl-6-(1-methylethenyl)-2(3H)-naphthalenone	Cyclohexenones
	613.4832	9.24	(2S)-1-hydroxy-3-[(9Z,12Z)-octadeca-9,12-dienoyloxy]propan-2-yl (6Z,9Z,12Z,15Z)-octadeca-6,9,12,15-tetraenoate	Lineolic acids and derivatives
	429.3732	9.28	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols

4.3.6 *Epiphyllum oxypetalum* LYMOOI 071

LCMSMS analysis of extract from *Epiphyllum oxypetalum* enabled the identification of 33 putative compounds (Table 4.3.6) belonging to different chemical families. It contains 1 putative primary metabolite and 32 putative secondary metabolites.

Table 4.3.6: List of putative compounds in LYMOOOI 071, consist of 33 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	136.0614	0.96	7H-purin-6-amine	Adenine
Secondary metabolites				
Nitogen containing compounds	138.0545	0.71	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids
	158.1173	0.94	8-methyl-8-azabicyclo[3.2.1]octane-3,6-diol	Tropane alkaloids
	238.1076	1.49	4-methoxy-6-methyl-7,8-dihydro-5H-[1,3]dioxolo[4,5-g]isoquinolin-5-ol	Tetrahydroisoquinolines

Table 4.3.6 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	192.1019	1.50	6,7-dimethoxy-3,4-dihydroisoquinoline	Dihydroisoquinolines
	188.0701	1.96	3-(1*H*-indol-3-yl)prop-2-enoic acid	Indoles
	205.0972	1.97	L-tryptophan	L-tryptophan
	178.0858	2.10	Prop-2-enyl 2-aminobenzoate	Benzoic acid esters
	312.1230	3.57	Velucryptine	Benzylisoquinolines
	314.1394	4.17	(1S,9R)-3-hydroxy-4,13-dimethoxy-17-azatetracyclo[7.5.3.01,10.02,7]heptadeca-2(7),3,5,10,13-pentaen-12-one	Phenanthrenes and derivatives
	344.1488	4.29	7-amino-10-hydroxy-1,2,3-trimethoxy-6,7-dihydro-5H-benzo[a]heptalen-9-one	Tropolones
	124.0862	13.96	Benzene-1,2,4-triamine	Aniline and substituted anilines
Phenolic	155.0700	1.85	4-(2-hydroxyethyl)benzene-1,2-diol	Tyrosols
	199.0962	2.34	3-(4-hydroxy-3-methoxyphenyl)propane-1,2-diol	Methoxyphenols
	199.0961	2.57	2,3,5-trimethoxy-6-methylphenol	Methoxyphenols

Table 4.3.6 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolic	225.0760	2.75	3-(3-hydroxy-4,5-dimethoxyphenyl)prop-2-enoic acid	Hydroxycinnamic acids
	447.1287	3.44	5,7-dihydroxy-2-(4-methoxyphenyl)-6-[3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]chromen-4-one	Flavonoid C-glycosides
	311.1284	3.56	4-hydroxy-3-(3-hydroxy-1-phenylbutyl)chromen-2-one	4-hydroxycoumarins
	285.0758	3.64	5,8-dihydroxy-7-methoxy-2-phenylchromen-4-one	7-O-methylated flavonoids
	431.1343	3.76	Isoflavonoid C-glycosides	Isoflavonoid C-glycosides
	269.0813	4.85	5-hydroxy-3-(4-methoxyphenyl)chromen-4-one	4'-O-methylisoflavones
Terpenes	207.1379	2.70	3,5,5-trimethyl-4-(3-oxobut-1-enyl)cyclohex-2-en-1-one	Sesquiterpenoids
	249.1126	3.12	Microhelenin F	Gamma butyrolactones
	455.3516	8.15	Melilotigenin B	Triterpenoids

Table 4.3.6 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Terpene	397.3469	8.15	Ergosterol D	Ergosterols and derivatives
	457.3678	8.49	3,9-dihydroxy-4,6~{a},6~{b},8~{a},11,11,14~{b}-heptamethyl-1,2,3,4~{a},5,6,7,8,9,10,12,12~{a},14,14~{a}-tetradecahydropicene-4-carbaldehyde	Triterpenoids
	445.3684	9.04	5-hydroxy-2,6,15-trimethyl-14-(6-methylheptan-2-yl)tetracyclo[8.7.0.0^{2},^{7}.0^{11},^{15}]heptadec-1(10)-ene-6-carboxylate	Triterpenoids
	443.3893	9.30	3a,5a,5b,8,8,11a-hexamethyl-1-prop-1-en-2-yl-1,2,3,4,5,6,7,7a,9,10,11,11b,12,13,13a,13b-hexadecahydrocyclopenta[a]chrysene-9,10-diol	Triterpenoids

Table 4.3.6 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Others	241.1549	1.10	1-hydroxy-6-(2-hydroxybutan-2-yl)-3-(2-methylpropyl)pyrazin-2-one	Pyrazines
	229.1549	1.12	Fatty acid methyl esters	Fatty acid methyl esters
	151.0750	2.15	3-[(1E)-3-hydroxyprop-1-en-1-yl]phenol	Cinnamyl alcohols
	237.1487	6.58	[3R-(3alpha,4beta,4abeta,6alpha)]-4,4a,5,6,7,8-Hexahydro-3,4a-dihydroxy-4-methyl-6-(1-methylethenyl)-2(3H)-naphthalenone	Cyclohexenones
	429.3735	9.28	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols

4.3.7 *Pereskia bleo* LYMOOI 059

LCMSMS analysis of extract from *Pereskia bleo* enabled the identification of 23 putative compounds (Table 4.3.7) belonging to different chemical families. It contains 2 putative primary metabolites and 21 putative secondary metabolites.

Table 4.3.7: List of putative compounds in LYMOOOI 059, consist of 23 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	268.1036	1.57	2-(6-aminopurin-9-yl)-5-(hydroxymethyl) oxolane-3,4-diol	adenosine
Carbohydrates	205.1181	0.60	2-acetamido-4-amino-2,4,6-trideoxy-D-galactopyranose	Hexoses
Secondary metabolites				
Nitrogen containing compounds	125.0709	0.63	4,6-dimethyl-1*H*-pyrimidin-2-one	Pyrimidones
	205.1179	0.70	2-amino-6-acetamido-5-hydroxyhexanoic acid	Alpha amino acids
	138.0549	0.66	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids

Table 4.3.7 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	118.0862	0.68	3-(dimethylamino)propanoic acid	Trialkylamines
	188.0702	1.09	3-(1*H*-indol-3-yl)prop-2-enoic acid	Indoles
	166.0860	1.10	3-amino-3-phenylpropanoic acid	Beta amino acids and derivatives
	120.0807	1.11	2,3-dihydro-1~{H}-indole	Indolines
	205.0967	1.26	L-tryptophan	L-tryptophan
	312.1233	3.57	Velucryptine	Benzylisoquinolines
Phenolics	595.1663	2.53	Kaempferol 3-rhamnoside-7-glucoside	Flavonoid-7-O-glycosides
	579.1702	3.03	Swertisin 2"-O-arabinoside	Flavonoid C-glycosides
	741.2243	3.06	Pelargonidin-3-O-rutinoside-5-O-beta-D-glucoside	Pelargonidin-3-O-rutinoside-5-O-beta-D-glucoside
	433.1131	3.11	Resokaempferol 7-glucoside	Flavonoid-7-O-glycosides
	595.1662	3.18	Kaempferol 3-galactoside-7-rhamnoside	Flavonoid-7-O-glycosides

Table 4.3.7 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolic	197.1171	3.30	4-(3-hydroxybutyl)-2-methoxyphenol	Methoxyphenols
Terpenes	275.2002	4.52	(3E,5E,7E)-8-[(4R)-4-hydroxy-2,6,6-trimethylcyclohex-1-en-1-yl]-6-methylocta-3,5,7-trien-2-one	Sesquiterpenoids
Others	229.1549	1.11	Fatty acid methyl esters	Fatty acid methyl esters
	179.1066	3.29	(4S)-4-hydroxy-3-methyl-2-[(2Z)-penta-2,4-dienyl]cyclopent-2-en-1-one	Secondary alcohols
	293.2116	4.53	10-methoxyheptadec-1-en-4,6-diyne-3,9-diol	Long-chain fatty alcohols
	256.2636	7.10	Hexadecanamide	Fatty amides
	165.0912	9.31	2,7-dimethylocta-2,4,6-trienedial	Medium-chain aldehydes

4.3.8 *Laurentia longiflora* (L.) Peterm LYMOOI 026

LCMSMS analysis of extract from ***Laurentia longiflora*** enabled the identification of 19 putative compounds (Table 4.3.8) belonging to different chemical families. It contains 2 putative primary metabolites and 17 putative secondary metabolites.

Table 4.3.8: List of putative compounds in LYMOOOI 026, consist of 19 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	268.1039	1.60	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	adenosine
Proteins	198.1236	0.64	Histidine and derivatives	Histidine and derivatives
Secondary metabolites				
Nitrogen containing compounds	166.0861	1.08	3-amino-3-phenylpropanoic acid	Beta amino acids and derivatives
	205.0972	1.98	L-tryptophan	L-tryptophan

Table 4.3.8 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	158.1538	2.05	Piperidines	Piperidines
	196.1119	3.29	6,11-dihydro-5*H*-benzo[b][1]benzazepine	Dibenzazepines
	164.1070	3.85	[(7S)-7-methyl-5H,6H,7H-cyclopenta[c]pyridin-4-yl]methanol	Pyridines and derivatives
	168.1383	3.90	2,3,4,6,7,8,9,9~{a}-octahydro-1~{H}-quinolizine-1-carbaldehyde	Lupinine-type alkaloids
	326.2114	4.42	2-[6-(2-hydroxy-2-phenylethyl)piperidin-2-yl]-1-phenylethanol	Aralkylamines
	124.0877	14.02	benzene-1,2,4-triamine	Aniline and substituted anilines
Phenolics	653.1357	3.33	Luteolin 3'-methyl ether 7-glucuronosyl-(1->2)-glucuronide	Flavonoid-7-O-glucuronides
	338.2115	5.75	Stilbenes	Stilbenes

Table 4.3.8 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Terpenes	411.3621	7.29	(3S,10R,13R)-10,13-dimethyl-17-[(Z,2R)-5-propan-2-ylhept-5-en-2-yl]-2,3,4,9,11,12,14,15,16,17-decahydro-1H-cyclopenta[a]phenanthren-3-ol	Stigmastanes and derivatives
	457.3678	7.29	3,9-dihydroxy-4,6~{a},6~{b},8~{a},11,11,14~{b}-heptamethyl-1,2,3,4~{a},5,6,7,8,9,10,12,12~{a},14,14~{a}-tetradecahydropicene-4-carbaldehyde	Triterpenoids
	191.1792	7.30	Acyclic monoterpenoids	Acyclic monoterpenoids
	565.4041	8.01	2,3-Didehydro-3-hydroxy-beta,beta-caroten-4-one	Xanthophylls
	445.3684	9.70	5-hydroxy-2,6,15-trimethyl-14-(6-methylheptan-2-yl)tetracyclo[8.7.0.0^{2},^{7}.0^{11},^{15}]heptadec-1(10)-ene-6-carboxylate	Triterpenoids

Table 4.3.8 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Terpenes	205.1959	12.07	1-methyl-4-(6-methylhept-5-en-2-yl)cyclohexa-1,4-diene	Sesquiterpenoids
Others	217.1957	12.15	Polycyclic hydrocarbons	Polycyclic hydrocarbons

4.3.9 *Lobelia Chinensis* Lour LYMOOI 023

LCMSMS analysis of extract from *Lobelia Chinensis* enabled the identification of 21 putative compounds (Table 4.3.9) belonging to different chemical families. It contains 2 putative primary metabolites and 19 putative secondary metabolites.

Table 4.3.9: List of putative compounds in LYMOOOI 023, consist of 21 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	136.0609	0.98	7H-purin-6-amine	Adenine
	268.1042	1.59	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
Secondary metabolites				
Nitrogen containing compounds	138.0548	0.80	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids
	144.1383	1.32	(+)-Allosedridine	Piperidines

Table 4.3.9 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	138.0548	0.80	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids
	144.1383	1.32	(+)-Allosedridine	Piperidines
Phenolic	158.1539	2.06	Piperidines	Piperidines
	609.1823	3.94	Isoscoparin 2"-O-rhamnoside	Flavonoid C-glycosides
Terpenes	207.1375	2.76	3,5,5-trimethyl-4-(3-oxobut-1-enyl)cyclohex-2-en-1-one	Sesquiterpenoids
	361.1647	5.38	Antheridic acid	Gamma butyrolactones
	445.3683	9.73	5-hydroxy-2,6,15-trimethyl-14-(6-methylheptan-2-yl)tetracyclo[8.7.0.0^{2},^{7}.0^{11},^{15}]heptadec-1(10)-ene-6-carboxylate	Triterpenoids
	409.3837	10.07	Ferna-7,9(11)-diene	Triterpenoids
	423.3622	10.92	Glochidone	Triterpenoids

Table 4.3.9 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Others	229.1544	1.09	Fatty acid methyl esters	Fatty acid methyl esters
	241.1544	1.21	1-hydroxy-6-(2-hydroxybutan-2-yl)-3-(2-methylpropyl)pyrazin-2-one	Pyrazines
	180.1015	1.69	3,4-Methylenedioxyamphetamine	Benzodioxoles
	404.2643	2.62	Acetic acid [(2S,3R,4S,5R,6R)-2-[(2R,3S,4R,5R)-4-(dimethylamino)-2,5,6-trimethyl-tetrahydropyran-3-yl]oxy-3,5-dimethoxy-6-methyl-tetrahydropyran-4-yl] ester	Acetic acid [(2S,3R,4S,5R,6R)-2-[(2R,3S,4R,5R)-4-(dimethylamino)-2,5,6-trimethyl-tetrahydropyran-3-yl]oxy-3,5-dimethoxy-6-methyl-tetrahydropyran-4-yl] ester

Table 4.3.9 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Others	261.1120	5.14	Methyl (2Z)-3-{5-[(4Z)-1-hydroxyhept-4-en-2-yn-1-yl]furan-2-yl}prop-2-enoate	Furanoid fatty acids
	277.2153	5.96	9,12,15,17-octadecatetraenoic acid	Lineolic acids and derivatives
	277.1796	6.10	1-(3-heptyloxiran-2-yl)oct-7-en-2,4-diyne-1,6-diol	Fatty alcohols
	429.3735	9.28	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols

4.3.10 *Ageratum conyzoides* L. LYMOOI 016

LCMSMS analysis of extract from *Ageratum conyzoides* enabled the identification of 39 putative compounds (Table 4.3.10) belonging to different chemical families. It contains 1 putative primary metabolite and 38 putative secondary metabolites.

Table 4.3.10: List of putative compounds in LYMOOOI 016, consists of 39 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	268.1040	1.41	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
Secondary metabolites				
Nitrogen containing compounds	348.1444	2.11	Pyrrolizines	Pyrrolizines
	300.1808	2.28	Alkaloids and derivatives	Alkaloids and derivatives
	178.0862	2.36	7-methyl-5H,6H,7H-cyclopenta[c]pyridine-4-carboxylic acid	Pyridinecarboxylic acids

Table 4.3.10 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	316.1756	2.46	Alkaloids and derivatives	Alkaloids and derivatives
Phenolics	163.0384	2.82	3-Hydroxycoumarin	Hydroxycoumarins
	303.0491	2.96	2-(3,4-dihydroxyphenyl)-3,6,7-trihydroxychromen-4-one	Flavonols
	303.0497	3.02	2-(3,4-dihydroxyphenyl)-3,7,8-trihydroxychromen-4-one	Flavonols
	165.0904	3.64	2-methoxy-5-(prop-1-en-1-yl)phenol	Methoxyphenols
	461.1443	4.05	6-beta-D-Glucopyranosyl-5-hydroxy-7-methoxy-2-(4-methoxyphenyl)-4H-1-benzopyran-4-one	Flavonoid C-glycosides
	303.0490	4.08	2-(2,5-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one	Flavonols
	301.0708	4.67	5,7,8-Trihydroxy-2-(4-methoxyphenyl)-4H-1-benzopyran-4-one	4'-O-methylated flavonoids
	359.1117	4.94	5-Hydroxy-2-(4-hydroxy-3-methoxyphenyl)-3,7-dimethoxy-6-methyl-4H-1-benzopyran-4-one	7-O-methylated flavonoids

Table 4.3.10 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolics	299.0911	4.96	5-hydroxy-2-(4-hydroxyphenyl)-7-methoxy-8-methylchromen-4-one	7-O-methylated flavonoids
	329.1023	5.06	5-hydroxy-6,7-dimethoxy-2-(4-methoxyphenyl) chromen-4-one	7-O-methylated flavonoids
	329.1025	5.07	3,5,7-Trihydroxy-6-methylflavanone 3-acetate	Flavanonols
	315.1228	5.51	4,5,14-trimethoxy-8,17-dioxatetracyclo[8.7.0.0^{2},^{7}.0^{11},^{16}]heptadeca-2,4,6,11(16),12,14-hexaene	Pterocarpans
	315.1228	5.54	5,7-dihydroxy-2-(4-methoxyphenyl)-6,8-dimethyl-2,3-dihydrochromen-4-one	4'-O-methylated flavonoids
	285.0754	5.65	5-hydroxy-2-(2-hydroxyphenyl)-7-methoxychromen-4-one	7-O-methylated flavonoids
	313.1073	5.66	3-(3,4-dimethoxyphenyl)-7-methoxychromen-4-one	7-O-methylisoflavones
	285.0762	5.70	5,7-dihydroxy-2-(4-hydroxyphenyl)-6-methylchromen-4-one	Flavones

Table 4.3.10 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolics	359.1132	5.78	2,5,7-Trihydroxy-6,8-dimethyl-3-(3',4'-methylenedioxybenzyl)-chroman-4-one	Homoisoflavanones
	313.1072	6.60	5-hydroxy-7-methoxy-2-(4-methoxyphenyl)-6-methylchromen-4-one	7-O-methylated flavonoids
	299.0921	7.37	5-Hydroxy-2-(4-hydroxyphenyl)-7-methoxy-6-methyl-4H-1-benzopyran-4-one	7-O-methylated flavonoids
Terpenes	780.2711	2.58	Tripfordine A	Terpene lactones
	231.1384	5.16	[3aR-(3aalpha,8abeta,9aalpha)]-3a,7,8,8a,9,9a-Hexahydro-5,8a-dimethyl-3-methylenenaphtho[2,3-b]furan-2(3H)-one	Eudesmanolides, secoeudesmanolides, and derivatives
	233.1540	5.85	2-(4,7-dimethyl-2,3,4,4a,5,6-hexahydronaphthalen-1-yl)prop-2-enoic acid	Sesquiterpenoids
	231.1384	6.03	[3aS-(3aalpha,5abeta,9aalpha,9bbeta)]-3a,4,5,5a,9a,9b-Hexahydro-5a,9-dimethyl-3-methylenenaphtho[1,2-b]furan-2(3H)-one	Eudesmanolides, secoeudesmanolides, and derivatives
	353.2689	6.87	Tomentol	Sesquiterpenoids

Table 4.3.10 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Terpenes	425.3785	8.46	Triterpenoids	Triterpenoids
Others	229.1546	0.97	Fatty acid methyl esters	Fatty acid methyl esters
	227.1278	1.99	2-[(1R,2R)-2-[(Z,4S)-4-hydroxypent-2-enyl]-3-oxocyclopentyl]acetic acid	Jasmonic acids
	179.1065	3.29	(4S)-4-hydroxy-3-methyl-2-[(2Z)-penta-2,4-dienyl]cyclopent-2-en-1-one	Secondary alcohols
	177.0551	3.37	3-(1,3-benzodioxol-5-yl)prop-2-enal	Benzodioxoles
	181.1226	4.51	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols
	237.1488	4.62	[3R-(3alpha,4beta,4abeta,6alpha)]-4,4a,5,6,7,8-Hexahydro-3,4a-dihydroxy-4-methyl-6-(1-methylethenyl)-2(3H)-naphthalenone	Cyclohexenones

Table 4.3.10 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Others	301.1073	4.74	3'-O-Methylbrazilin	1-benzopyrans
	293.2120	5.87	10-methoxyheptadec-1-en-4,6-diyne-3,9-diol	Long-chain fatty alcohols
	165.0912	9.35	2,7-dimethylocta-2,4,6-trienedial	Medium-chain aldehydes

4.3.11 *Artemisia vulgaris* L. LYMOOI 028

LCMSMS analysis of extract from *Artemisia vulgaris* enabled the identification of 29 putative compounds (Table 4.3.11) belonging to different chemical families. It contains 1 putative primary metabolite and 28 putative secondary metabolites.

Table 4.3.11: List of putative compounds in LYMOOOI 028, consist of 29 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	136.0613	0.99	7H-purin-6-amine	Adenine
Secondary metabolites				
Nitrogen containing compounds	104.1068	0.66	3-(dimethylamino)propan-1-ol	1,3-aminoalcohols
	144.1018	0.99	1-aminocyclohexane-1-carboxylic acid	L-alpha-amino acids
	120.0807	1.07	2,3-dihydro-1~{H}-indole	Indolines

Table 4.3.11 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	188.0704	1.75	3-(1*H*-indol-3-yl)prop-2-enoic acid	Indoles
	205.0972	1.98	L-tryptophan	L-tryptophan
	124.0879	14.04	Benzene-1,2,4-triamine	Aniline and substituted anilines
Phenolic	189.0545	2.99	2,3-dihydrofuro[3,2-g]chromen-7-one	Psoralens
	223.0599	3.45	7-hydroxy-5,6-dimethoxychromen-2-one	7-hydroxycoumarins
	433.1125	3.56	3,5-dihydroxy-2-phenyl-7-[(2*S*,4*S*,5*S*)-3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxychromen-4-one	Flavonoid-7-O-glycosides
	331.0812	5.02	2-(3,4-dihydroxyphenyl)-5,7-dihydroxy-3-methoxy-6-methylchromen-4-one	3-O-methylated flavonoids
	359.1132	5.77	2,5,7-Trihydroxy-6,8-dimethyl-3-(3',4'-methylenedioxybenzyl)-chroman-4-one	Homoisoflavanones

Table 4.3.11 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Terpenes	249.1484	2.96	[3aS-(3aalpha,5beta,5abeta,9balpha)]-3a,4,5,5a,6,7,8,9b-Octahydro-5-hydroxy-5a,9-dimethyl-3-methylenenaphtho[1,2-b]furan-2(3H)-one	Eudesmanolides, secoeudesmanolides, and derivatives
	231.1379	3.18	[3aS-(3aalpha,5abeta,9aalpha,9bbeta)]-3a,4,5,5a,9a,9b-Hexahydro-5a,9-dimethyl-3-methylenenaphtho[1,2-b]furan-2(3H)-one	Eudesmanolides, secoeudesmanolides, and derivatives
	249.1489	3.23	[3aS-(3aalpha,5abeta,6beta,9bbeta)]-3a,4,5,5a,6,7,8,9b-Octahydro-6-hydroxy-5a,9-dimethyl-3-methylenenaphtho[1,2-b]furan-2(3H)-one	Eudesmanolides, secoeudesmanolides, and derivatives
	247.1329	3.50	3aR-(3aalpha,4aalpha,6beta,8abeta,9aalpha)]-3a,4,4a,5,6,8a,9,9a-Octahydro-6-hydroxy-8a-methyl-3,5-bis(methylene)naphtho[2,3-b]furan-2(3H)-one	Eudesmanolides, secoeudesmanolides, and derivatives
	265.1437	3.59	6,7-dihydroxy-8~{a}-methyl-3,5-dimethylidene-3~{a},4,4~{a},6,7,8,9,9~{a}-octahydrobenzo[f][1]benzofuran-2-one	Eudesmanolides, secoeudesmanolides, and derivatives

Table 4.3.11 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Terpenes	249.1482	4.00	[3aR-(3aalpha,5beta,8beta,8abeta,9aalpha)]-3a,5,6,7,8,8a,9,9a-Octahydro-8-hydroxy-5,8a-dimethyl-3-methylenenaphtho[2,3-b]furan-2(3H)-one	Eudesmanolides, secoeudesmanolides, and derivatives
	249.1486	4.29	7-hydroxy-5,8~{a}-dimethyl-3-methylidene-5,6,7,8,9,9~{a}-hexahydro-3~{a}~{H}-benzo[f][1]benzofuran-2-one	Eudesmanolides, secoeudesmanolides, and derivatives
	351.2157	4.58	(1R,2R,4R,6S,8S,9R,10S,13S,16R)-2,6,8,16-tetrahydroxy-5,5,9-trimethyl-14-methylidenetetracyclo[11.2.1.01,10.04,9]hexadecan-15-one	Kaurane diterpenoids
	277.2161	5.97	17-hydroxy-13-methyl-2,4,5,6,7,8,9,10,11,12,14,15,16,17-tetradecahydro-1H-cyclopenta[a]phenanthren-3-one	Estrogens and derivatives
	191.1797	6.18	Acyclic monoterpenoids	Acyclic monoterpenoids
	213.1275	7.24	[4-methyl-7-(prop-1-en-2-yl)azulen-1-yl]methanol	Guaianes

Table 4.3.11 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Others	229.1547	0.97	Fatty acid methyl esters	Fatty acid methyl esters
	227.1279	2.44	Tuberonic acid	Jasmonic acids
	235.1330	3.65	1-(7-methoxy-2,2-dimethylchromen-6-yl)ethanol	2,2-dimethyl-1-benzopyrans
	181.1224	4.50	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols
	237.1489	6.58	[3R-(3alpha,4beta,4abeta,6alpha)]-4,4a,5,6,7,8-Hexahydro-3,4a-dihydroxy-4-methyl-6-(1-methylethenyl)-2(3H)-naphthalenone	Cyclohexenones
	251.2009	7.23	Hexadeca-2,4,6-trienoic acid	Long-chain fatty acids

4.3.12 *Blumea balsamifera* (L.) DC LYMOOI 043

LCMSMS analysis of extract from *Blumea balsamifera* enabled the identification of 31 putative compounds (Table 4.3.12) belonging to different chemical families. It contains 31 putative secondary metabolites.

Table 4.3.12: List of putative compounds in LYMOOOI 043, consist of 31 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Secondary metabolites				
Nitrogen containing compounds	118.0857	0.83	3-(dimethylamino)propanoic acid	Trialkylamines
	144.1018	0.83	1-aminocyclohexane-1-carboxylic acid	L-alpha-amino acids
Phenolics	319.0810	3.56	3,5,7,4'-Tetrahydroxy-8-methoxyflavanone	8-O-methylated flavonoids
	195.1015	3.73	2,5-Dimethoxy-4-(2-propenyl)phenol	Methoxyphenols
	319.0822	3.99	(2~{S})-5,7,8-trihydroxy-2-(3-hydroxy-4-methoxyphenyl)-2,3-dihydrochromen-4-one	4'-O-methylated flavonoids

Table 4.3.12 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolics	333.0967	4.83	5,7,3'-Trihydroxy-2',4'-dimethoxyisoflavanone	3'-hydroxy,4'-methoxyisoflavonoids
	359.1126	6.35	5-Hydroxy-2-(4-hydroxy-3-methoxyphenyl)-3,7-dimethoxy-6-methyl-4H-1-benzopyran-4-one	7-O-methylated flavonoids
Terpenes	191.1062	2.87	2,6-dimethyldeca-2,4,6,8-tetraenedial	Acyclic monoterpenoids
	233.1535	3.32	(E,E,E)-2-(4,8-Dimethyl-10-oxo-3,7-cyclodecadien-1-ylidene)-propanal	Germacrane sesquiterpenoids
	407.2059	3.40	Rabdophyllin G	Diterpene lactones
	191.1434	3.92	4-(2,6,6-trimethylcyclohexa-1,3-dien-1-yl)but-3-en-2-one	Sesquiterpenoids
	219.1739	4.13	2-methyl-6-(4-methylphenyl)hept-2-en-4-ol	Sesquiterpenoids
	269.1748	4.29	[1S-(1alpha,2beta,4abeta,8alpha,8aalpha)]-Decahydro-1,8-dihydroxy-4a,8-dimethyl-a-methylene-2-naphthaleneacetic acid	Eudesmane, isoeudesmane or cycloeudesmane sesquiterpenoids

Table 4.3.12 (Continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Terpenes	349.2010	4.35	6-hydroxy-4,8-dimethyl-13-methylidenetetracyclo[10.2.1.0^{1,9}.0^{3,8}] pentadecane-2,4-dicarboxylic acid	C20-gibberellin 6-carboxylic acids
	331.1902	4.42	methyl 11-methyl-6-methylidene-16-oxo-15-oxapentacyclo[9.3.2.1^{5,8}.0^{1,10}.0^{2,8}] heptadecane-9-carboxylate	Diterpene lactones
	349.2009	4.44	Gibberellin A112	C20-gibberellin 6-carboxylic acids
	251.1640	4.93	Valerenolic acid	Sesquiterpenoids
	233.1535	4.94	Bemadienolide	Naphthofurans
	315.1954	5.48	6,7-Dehydroroyleanone	Diterpenoids
	333.2064	5.51	Apo-13'-fucoxanthinone	Sesquiterpenoids
	289.2528	6.05	(2R,4aS,4bR,8S,8aR,10aS)-7-ethenyl-1,1,4a,8-tetramethyl-1,2,3,4,4a,4b,5,8,8a,9,10,10a-dodecahydrophenanthren-2-ol	Isocopalane and spongiane diterpenoids

Table 4.3.12 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Terpenes	411.3629	9.57	(3S,10R,13R)-10,13-dimethyl-17-[(Z,2R)-5-propan-2-ylhept-5-en-2-yl]-2,3,4,9,11,12,14,15,16,17-decahydro-1H-cyclopenta[a]phenanthren-3-ol	Stigmastanes and derivatives
	425.3787	9.63	Antiquol C	Triterpenoids
Others	229.1548	1.00	Fatty acid methyl esters	Fatty acid methyl esters
	227.1273	2.29	2-[(1R,2R)-2-[(Z,4S)-4-hydroxypent-2-enyl]-3-oxocyclopentyl]acetic acid	Jasmonic acids
	179.1062	3.29	(4S)-4-hydroxy-3-methyl-2-[(2Z)-penta-2,4-dienyl]cyclopent-2-en-1-one	Secondary alcohols
	205.1588	4.44	2-Benzylidene-1-heptanol	Cinnamyl alcohols

Table 4.3.12 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Others	181.1218	4.50	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols
	367.2115	4.93	9S,15S-dihydroxy-11-oxo-thromboxa-5Z,13E,17Z-trienoic acid	Long-chain fatty acids
	293.2103	5.61	13-oxooctadeca-9,11,15-trienoic acid	Lineolic acids and derivatives
	279.2320	6.21	octadeca-9,12,15-trienoic acid	Lineolic acids and derivatives

4.3.13 *Cosmos sulphureus* LYMOOI 075

LCMSMS analysis of extract from *Cosmos sulphureus* enabled the identification of 38 putative compounds (Table 4.3.13) belonging to different chemical families. It contains 1 putative primary metabolite and 37 putative secondary metabolites.

Table 4.3.13: List of putative compounds in LYMOOOI 075, consist of 38 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	268.1043	1.37	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	adenosine
Secondary metabolites				
Nitrogen containing compounds	166.0859	1.15	3-amino-3-phenylpropanoic acid	Beta amino acids and derivatives
	188.0697	1.20	3-(1*H*-indol-3-yl)prop-2-enoic acid	Indoles
	205.0976	1.54	L-tryptophan	L-tryptophan

Table 4.3.13 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolics	377.0863	1.06	3,5,7,3',4'-Pentahydroxy-6-methoxyflavanone 3-acetate	6-O-methylated flavonoids
	163.0382	1.84	3-Hydroxycoumarin	Hydroxycoumarins
	163.0386	2.09	4-hydroxychromen-2-one	4-hydroxycoumarins
	355.1027	2.11	1-[3-(3,4-dihydroxyphenyl)prop-2-enoyloxy]-3,4,5-trihydroxycyclohexane-1-carboxylic acid	Quinic acids and derivatives
	433.1129	2.18	1-hydroxy-3-(hydroxymethyl)-8-{[3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxy}-9,10-dihydroanthracene-9,10-dione	Anthraquinones
	465.1033	2.68	2-(3,4-dihydroxyphenyl)-6-beta-D-Glucopyranosyl-3,5,7-trihydroxy-4H-1-benzopyran-4-one	Flavonoid C-glycosides

Table 4.3.13 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolics	611.1600	2.93	7-{[(2S,3R,4S,5S,6R)-4,5-dihydroxy-6-(hydroxymethyl)-3-{[(2S,3R,4R,5R,6S)-3,4,5-trihydroxy-6-methyloxan-2-yl]oxy}oxan-2-yl]oxy}-2-(3,4-dihydroxyphenyl)-3,5-dihydroxy-4H-chromen-4-one	Flavonoid-7-O-glycosides
	595.1660	2.99	Kaempferol 3-rhamnoside-7-glucoside	Flavonoid-7-O-glycosides
	433.1135	3.04	Resokaempferol 7-glucoside	Flavonoid-7-O-glycosides
	197.1168	3.31	4-(3-hydroxybutyl)-2-methoxyphenol	Methoxyphenols
	449.1087	3.33	6-beta-D-Glucopyranosyl-3,5,7-trihydroxy-2-(4-hydroxyphenyl)-4H-1-benzopyran-4-one	Flavonoid C-glycosides
	433.1137	3.55	3,5-dihydroxy-2-phenyl-7-[(2*S*,4*S*,5*S*)-3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxychromen-4-one	Flavonoid-7-O-glycosides

Table 4.3.13 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolics	449.1087	3.55	Quercetin 3-O-L-rhamnoside	Flavonoid-3-O-glycosides
	303.0505	3.64	2-(3,4-dihydroxyphenyl)-3,7,8-trihydroxychromen-4-one	Flavonols
	287.0556	3.80	3,7,8-trihydroxy-2-(4-hydroxyphenyl)chromen-4-one	Flavonols
	435.0926	3.84	2-(3,4-dihydroxyphenyl)-5,7-dihydroxy-3-(3,4,5-trihydroxyoxan-2-yl)oxychromen-4-one	Flavonoid-3-O-glycosides
	303.0504	4.53	2-(3,4-dihydroxyphenyl)-3,6,7-trihydroxychromen-4-one	Flavonols
	303.0503	14.04	2-(2,5-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one	Flavonols
Terpenes	219.1744	5.10	2-methyl-6-(4-methylphenyl)hept-2-en-4-ol	Sesquiterpenoids

Table 4.3.13 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Terpenes	275.2014	5.20	(3E,5E,7E)-8-[(4R)-4-hydroxy-2,6,6-trimethylcyclohex-1-en-1-yl]-6-methylocta-3,5,7-trien-2-one	Sesquiterpenoids
	275.2008	5.46	Estrogens and derivatives	Estrogens and derivatives
	207.1738	5.83	3-methyl-4-(2,6,6-trimethylcyclohexen-1-yl)but-3-en-2-one	Sesquiterpenoids
	277.2166	5.99	17-hydroxy-13-methyl-2,4,5,6,7,8,9,10,11,12,14,15,16,17-tetradecahydro-1H-cyclopenta[a]phenanthren-3-one	Estrogens and derivatives
	411.3622	8.77	(3S,10R,13R)-10,13-dimethyl-17-[(Z,2R)-5-propan-2-ylhept-5-en-2-yl]-2,3,4,9,11,12,14,15,16,17-decahydro-1H-cyclopenta[a]phenanthren-3-ol	Stigmastanes and derivatives
	445.3685	9.02	5-hydroxy-2,6,15-trimethyl-14-(6-methylheptan-2-yl)tetracyclo[8.7.0.0^{2},^{7}.0^{11},^{15}]heptadec-1(10)-ene-6-carboxylate	Triterpenoids

Table 4.3.13 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Others	209.1171	4.05	(Z)-3-Oxo-2-(2-pentenyl)-1-cyclopenteneacetic acid	Cyclic ketones
	209.1179	4.21	2-(4-oxo-5-pent-2-enylcyclopent-2-en-1-yl)acetic acid	Cyclic ketones
	181.1223	4.53	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols
	291.1959	5.19	Deoxy phytoprostane J1	Prostaglandins and related compounds
	293.2117	5.48	10-methoxyheptadec-1-en-4,6-diyne-3,9-diol	Long-chain fatty alcohols
	279.2321	6.20	9,12,14-octadecatrienoic acid	Lineolic acids and derivatives
	295.2269	6.35	(6Z,9Z)-11-(3-pentyloxiran-2-yl)undeca-6,9-dienoic acid	Long-chain fatty acids
	282.2794	7.52	octadec-9-enamide	Fatty amides

Table 4.3.13 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Other	429.3736	9.27	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols

4.3.14 *Elephantopus scaber* L. LYMOOI 074

LCMSMS analysis of extract from *Elephantopus scaber* enabled the identification of 14 putative compounds (Table 4.3.14) belonging to different chemical families. It contains 2 putative primary metabolites and 12 putative secondary metabolites.

Table 4.3.14: List of putative compounds in LYMOOOI 074, consist of 14 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	136.0620	0.92	7H-purin-6-amine	Adenine
	268.1042	1.58	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
Secondary metabolites				
Nitrogen containing compounds	104.1069	0.60	3-(dimethylamino)propan-1-ol	1,3-aminoalcohols
	118.0860	0.78	3-(dimethylamino)propanoic acid	Trialkylamines

Table 4.3.14 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolics	163.0381	2.05	8-hydroxy-2H-chromen-2-one	Hydroxycoumarins
	377.0862	3.22	3,5,7,3',4'-Pentahydroxy-6-methoxyflavanone 3-acetate	6-O-methylated flavonoids
	447.0926	3.67	Apigenin-7-O-glucuronide	Flavonoid-7-O-glucuronides
	507.1140	3.84	Quercetin 3-(6"-acetylglucoside) Quercetin 3-O-2G-rhamnosylrutinoside (C00005955)	Flavonoid-3-O-glycosides
	231.1024	4.83	2,2-dimethyl-3,4-dihydropyrano[3,2-g]chromen-8-one	Linear pyranocoumarins
Terpenes	275.2012	6.76	(3E,5E,7E)-8-[(4R)-4-hydroxy-2,6,6-trimethylcyclohex-1-en-1-yl]-6-methylocta-3,5,7-trien-2-one	Sesquiterpenoids
	425.3782	11.23	Olean 18-en-3-one	Triterpenoids
	409.3836	11.69	Ferna-7,9(11)-diene	Triterpenoids

Table 4.3.14 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Others	293.2111	5.46	10-methoxyheptadec-1-en-4,6-diyne-3,9-diol	Long-chain fatty alcohols
	295.2277	5.66	8-(3-octa-2,5-dienyloxiran-2-yl)octanoic acid	Medium-chain fatty acids

4.3.15 *Elephantopus tomentosus* L. LYMOOI 021

LCMSMS analysis of extract from *Elephantopus tomentosus* enabled the identification of 33 putative compounds (Table 4.3.15) belonging to different chemical families. It contains 1 putative primary metabolite and 32 putative secondary metabolites.

Table 4.3.15: List of putative compounds LYMOOOI 021, consist of 33 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	136.0615	0.97	7H-purin-6-amine	Adenine
Secondary metabolites				
Nitrogen containing compounds	160.1333	0.92	3-aminooctanoic acid	Beta amino acids and derivatives
	124.0864	13.97	benzene-1,2,4-triamine	Aniline and substituted anilines

Table 4.3.15 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	206.1399	13.97	N-(3-methylbut-2-enyl)-1,4,5,7-tetrahydropurin-6-imine	Imidazopyrimidines
Phenolics	265.1075	3.75	Devenyol	7-hydroxycoumarins
	347.1497	4.53	(10-hydroxy-8,8-dimethyl-2-oxo-9,10-dihydropyrano[2,3-f]chromen-9-yl) 3-methylbutanoate	Angular pyranocoumarins
	147.0809	4.96	3-(4-methylphenyl)prop-2-enal	Cinnamaldehydes
	161.0599	4.96	6-Methylcoumarin	Coumarins and derivatives
Terpenes	263.1274	2.65	9alpha-Hydroxyzaluzalin C	Guaianolides and derivatives
	207.1382	2.74	3,5,5-trimethyl-4-(3-oxobut-1-enyl)cyclohex-2-en-1-one	Sesquiterpenoids
	275.1284	4.44	Terpene lactones	Terpene lactones

Table 4.3.15 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Terpenes	277.2166	6.00	17-hydroxy-13-methyl-2,4,5,6,7,8,9,10,11,12,14,15,16,17-tetradecahydro-1H-cyclopenta[a]phenanthren-3-one	Estrogens and derivatives
	411.3629	7.09	(3S,10R,13R)-10,13-dimethyl-17-[(Z,2R)-5-propan-2-ylhept-5-en-2-yl]-2,3,4,9,11,12,14,15,16,17-decahydro-1H-cyclopenta[a]phenanthren-3-ol	Stigmastanes and derivatives
	191.1796	7.19	Acyclic monoterpenoids	Acyclic monoterpenoids
	457.3685	7.29	3,9-dihydroxy-4,6~{a},6~{b},8~{a},11,11,14~{b}-heptamethyl-1,2,3,4~{a},5,6,7,8,9,10,12,12~{a},14,14~{a}-tetradecahydropicene-4-carbaldehyde	Triterpenoids
	425.3784	7.52	Antiquol C	Triterpenoids
	441.3723	8.17	(2S,5S,11S,14R,15R)-5-hydroxy-2,6,6,15-tetramethyl-14-[(2R)-6-methylhept-5-en-2-yl]tetracyclo[8.7.0.0^{2},^{7}.0^{11},^{15}]heptadec-1(10)-ene-11-carbaldehyde	Triterpenoids

Table 4.3.15 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Terpenes	423.3616	8.19	Glochidone	Triterpenoids
	445.3681	9.01	5-hydroxy-2,6,15-trimethyl-14-(6-methylheptan-2-yl)tetracyclo[8.7.0.0^{2},^{7}.0^{11},^{15}]heptadec-1(10)-ene-6-carboxylate	Triterpenoids
	485.3619	9.01	Dehydrotumulosic acid	Dihydroxy bile acids, alcohols and derivatives
	409.3835	9.47	Ferna-7,9(11)-diene	Triterpenoids
	271.2424	11.80	1,1,4a-trimethyl-7-propan-2-yl-2,3,4,9,10,10a-hexahydrophenanthrene	Diterpenoids
	205.1952	11.98	3,8-dimethyl-5-propan-2-yl-1,2,6,7,8,8a-hexahydroazulene	Guaianes
Others	229.1549	1.01	Fatty acid methyl esters	Fatty acid methyl esters
	241.1548	1.11	1-hydroxy-6-(2-hydroxybutan-2-yl)-3-(2-methylpropyl)pyrazin-2-one	Pyrazines
	211.1697	3.22	1-cyclohexylcyclohexane-1-carboxylic acid	Carboxylic acids

Table 4.3.15 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Others	261.1129	4.53	4-methoxy-6-[(E)-2-(4-methoxyphenyl)ethenyl]-5,6-dihydro-2H-pyran-2-one	Kavalactones
	187.1122	4.94	Long-chain fatty alcohols	Long-chain fatty alcohols
	169.1013	4.95	trideca-1,3,5,11-tetraen-7,9-diyne	Enynes
	147.0808	5.62	4-phenylbut-2-enal	Benzene and substituted derivatives
	165.0911	9.27	2,7-dimethylocta-2,4,6-trienedial	Medium-chain aldehydes
	429.3737	9.28	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols
	259.2426	11.88	Unsaturated aliphatic hydrocarbons	Unsaturated aliphatic hydrocarbons

4.3.16 *Mikania cordata* (Burm.f) B.L. Rob LYMOOI 022

LCMSMS analysis of extract from *Mikania cordata* enabled the identification of 43 putative compounds (Table 4.3.16) belonging to different chemical families. It contains 2 putative primary metabolites and 41 putative secondary metabolites.

Table 4.3.16: List of putative compounds in LYMOOOI 022, consist of 43 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Vitamins	429.3723	9.81	Vitamin D and derivatives	Vitamin D and derivatives
Pigments	593.2758	8.81	Chlorins	Chlorins
Secondary metabolites				
Nitrogen containing compounds	116.0700	0.62	(2Z)-2-(methylamino)but-2-enoic acid	Alpha amino acids
	104.1067	0.63	3-(dimethylamino)propan-1-ol	1,3-aminoalcohols
	138.0550	0.66	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids

Table 4.3.16 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	144.1014	0.92	1-aminocyclohexane-1-carboxylic acid	L-alpha-amino acids
	166.0860	1.05	2-(dimethylamino)benzoic acid	Aminobenzoic acids
	120.0809	1.09	2,3-dihydro-1~{H}-indole	Indolines
	166.0860	1.12	3-amino-3-phenylpropanoic acid	Beta amino acids and derivatives
	188.0706	1.95	3-(1*H*-indol-3-yl)prop-2-enoic acid	Indoles
	205.0971	1.95	L-tryptophan	L-tryptophan
	217.0973	2.41	3-(1-phenylethyl)imidazole-4-carboxylic acid	Carbonylimidazoles
	322.1801	4.95	2-(6-phenacylpiperidin-2-yl)-1-phenylethanone	Alkyl-phenylketones
	316.2845	6.22	1,2-aminoalcohols	1,2-aminoalcohols
	124.0868	13.98	Benzene-1,2,4-triamine	Aniline and substituted anilines
Phenolics	317.0656	3.54	2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxy-6-methylchromen-4-one	Flavonols
	479.1185	3.58	Myricetin 4'-O-methyl ether 3-O-alpha-L-rhamnopyranoside	Flavonoid-3-O-glycosides

Table 4.3.16 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolics	331.0813	4.00	Aromadendrin 3-acetate	Flavanonols
	493.1345	4.07	Rhamnazin 3-galactoside	Flavonoid-3-O-glycosides
	361.0918	4.12	3,5,7,4'-Tetrahydroxy-3'-methoxyflavanone 3-acetate	3'-O-methylated flavonoids
	317.0654	4.75	3,5,6,7-Tetrahydroxy-4'-methoxyflavone	Flavonols
	301.0706	4.87	6-C-Methylkaempferol	Flavonols
	221.1166	6.18	2-(1-hydroxycyclopentyl)-2-phenylacetic acid	Benzene and substituted derivatives
	205.0853	6.43	7-ethoxy-4-methyl-2H-chromen-2-one	Coumarins and derivatives
Terpenes	259.2061	3.84	(3~{E},5~{E},7~{E})-6-methyl-8-(2,6,6-trimethylcyclohexen-1-yl)octa-3,5,7-trien-2-one	Sesquiterpenoids

Table 4.3.16 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Terpenes	229.1215	4.17	Eremophilane, 8,9-secoeremophilane and furoeremophilane sesquiterpenoids	Eremophilane, 8,9-secoeremophilane and furoeremophilane sesquiterpenoids
	275.2002	4.63	(3E,5E,7E)-8-[(4R)-4-hydroxy-2,6,6-trimethylcyclohex-1-en-1-yl]-6-methylocta-3,5,7-trien-2-one	Sesquiterpenoids
	231.1371	5.41	[3aS-(3aalpha,5abeta,9aalpha,9bbeta)]-3a,4,5,5a,9a,9b-Hexahydro-5a,9-dimethyl-3-methylenenaphtho[1,2-b]furan-2(3H)-one	Eudesmanolides, secoeudesmanolides, and derivatives
	413.1596	5.57	9-(hydroxymethyl)-3,6-dimethyl-2,7-dioxo-2H,3H,3aH,4H,5H,7H,9aH,9bH-azuleno[4,5-b]furan-4-yl 2-(4-hydroxyphenyl)acetate	1-hydroxy-2-unsubstituted benzenoids
	277.2159	5.85	Estrogens and derivatives	Estrogens and derivatives
	445.3668	9.03	5-hydroxy-2,6,15-trimethyl-14-(6-methylheptan-2-yl)tetracyclo[8.7.0.0^{2},^{7}.0^{11},^{15}]heptadec-1(10)-ene-6-carboxylate	Triterpenoids

Table 4.3.16 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Terpenes	409.3828	9.46	Ferna-7,9(11)-diene	Triterpenoids
	277.2156	10.90	17-hydroxy-13-methyl-2,4,5,6,7,8,9,10,11,12,14,15,16,17-tetradecahydro-1H-cyclopenta[a]phenanthren-3-one	Estrogens and derivatives
Others	241.1548	1.08	1-hydroxy-6-(2-hydroxybutan-2-yl)-3-(2-methylpropyl)pyrazin-2-one	Pyrazines
	229.1552	1.08	Fatty acid methyl esters	Fatty acid methyl esters
	174.1490	2.61	9-aminononanoic acid	Medium-chain fatty acids
	211.1692	3.17	1-cyclohexylcyclohexane-1-carboxylic acid	Carboxylic acids

Table 4.3.16 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Others	209.1169	3.80	2-(4-oxo-5-pent-2-enylcyclopent-2-en-1-yl)acetic acid	Cyclic ketones
	293.2109	4.04	10-methoxyheptadec-1-en-4,6-diyne-3,9-diol	Long-chain fatty alcohols
	181.1219	4.51	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols
	429.3727	9.28	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols
	758.5695	11.21	[(2R)-2,3-bis(octadec-9-enoyloxy)propoxy][2-(methylamino)ethoxy]phosphinic acid	Monomethylphosphatidyl ethanolamines

4.3.17 *Vernonia esculenta* Hemsl. Ex. Hems l. LYMOOI 024

LCMSMS analysis of extract from *Vernonia esculenta* enabled the identification of 17 putative compounds (Table 4.3.17) belonging to different chemical families. It contains 17 putative secondary metabolites.

Table 4.3.17: List of putative compounds in LYMOOOI 024, consist of 17 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Secondary metabolites				
Nitrogen containing compounds	104.1068	0.65	3-(dimethylamino)propan-1-ol	1,3-aminoalcohols
	118.0862	0.66	3-(dimethylamino)propanoic acid	Trialkylamines
	138.0549	0.68	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids
	144.1015	1.00	1-aminocyclohexane-1-carboxylic acid	L-alpha-amino acids
	120.0807	1.10	2,3-dihydro-1~{H}-indole	Indolines
	166.0864	1.10	3-amino-3-phenylpropanoic acid	Beta amino acids and derivatives

Table 4.3.17 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	217.0974	2.40	3-(1-phenylethyl)imidazole-4-carboxylic acid	Carbonylimidazoles
Phenolics	163.0391	1.69	3-Hydroxycoumarin	Hydroxycoumarins
	355.1026	2.74	1-[3-(3,4-dihydroxyphenyl)prop-2-enoyloxy]-3,4,5-trihydroxycyclohexane-1-carboxylic acid	Quinic acids and derivatives
	463.0872	2.99	Kaempferol 3-glucuronide	Flavonoid-3-O-glucuronides
	189.0546	3.02	2,3-dihydrofuro[3,2-g]chromen-7-one	Psoralens
	241.0859	3.39	3-(4-hydroxyphenyl)-2*H*-chromen-7-ol	Hydroxyisoflavonoids
	213.0911	3.52	1,2-dihydrophenanthrene-1,2-diol	Phenanthrols
	393.1548	3.76	8-(3-methylbut-2-en-1-yl)-7-{[3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxy}-2H-chromen-2-one	Coumarin glycosides

Table 4.3.17 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Others	229.1551	1.08	Fatty acid methyl esters	Fatty acid methyl esters
	277.2170	5.85	9,12,15,17-octadecatetraenoic acid	Lineolic acids and derivatives
	279.2319	6.08	9,12,14-octadecatrienoic acid	Lineolic acids and derivatives

4.3.18 *Jatropha padagrica* LYMOOI 042

LCMSMS analysis of extract from *Jatropha padagrica* enabled the identification of 19 putative compounds (Table 4.3.18) belonging to different chemical families. It contains 3 putative primary metabolites and 16 putative secondary metabolites.

Table 4.3.18: List of putative compounds in LYMOOOI 042, consist of 19 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	136.0617	0.97	7H-purin-6-amine	Adenine
	268.1042	1.62	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
Proteins	175.1190	0.61	(3~{S})-3-azaniumyl-5-(diaminomethylideneazaniumyl)pentanoate	Beta amino acids and derivatives

Table 4.3.18 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Secondary metabolites				
Nitrogen containing compounds	118.0860	0.83	3-(dimethylamino)propanoic acid	Trialkylamines
	144.0801	2.41	3-methylquinoline	Quinolines and derivatives
	217.0971	2.43	3-(1-phenylethyl)imidazole-4-carboxylic acid	Carbonylimidazoles
	206.1409	10.18	N-(3-methylbut-2-enyl)-1,4,5,7-tetrahydropurin-6-imine	Imidazopyrimidines
Phenolics	209.0440	2.74	5,6-dihydroxy-7-methoxychromen-2-one	Hydroxycoumarins
	209.0442	3.11	3-(1-Carboxyvinyloxy)-benzoic acid	Phenoxyacetic acid derivatives
	223.0599	3.59	7-hydroxy-5,6-dimethoxychromen-2-one	7-hydroxycoumarins
	223.0601	3.59	Saikochromone A	Chromones
	207.0650	3.92	6-hydroxy-7-methoxy-4-methylchromen-2-one	Hydroxycoumarins

Table 4.3.18 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Terpenes	393.1953	4.81	1α-hydroxyandrost-4-ene-3,17-dione	Androgens and derivatives
	321.2058	4.82	7,15-dihydroxy-9-methyl-14-methylidenetetracyclo[11.2.1.0^{1},^{10}.0^{4},^{9}]hexadecane-5-carboxylic acid	Kaurane diterpenoids
	299.2003	6.36	(-)-Sonderianol	Diterpenoids
Others	229.1548	0.97	Fatty acid methyl esters	Fatty acid methyl esters
	371.1129	4.94	Meridinol	Dibenzylbutyrolactone lignans
	279.2323	6.07	9,12,14-octadecatrienoic acid	Lineolic acids and derivatives
	279.2321	6.18	Octadeca-9,12,15-trienoic acid	Lineolic acids and derivatives

4.3.19 *Ricinus communis* LYMOOI 027

LCMSMS analysis of extract from *Ricinus communis* enabled the identification of 31 putative compounds (Table 4.3.19) belonging to different chemical families. It contains 1 putative primary metabolite and 30 putative secondary metabolites.

Table 4.3.19: List of putative compounds in LYMOOOI 027, consist of 31 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	268.1041	1.61	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
Secondary metabolites				
Nitrogen containing compounds	138.0547	0.69	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids
	190.0495	2.17	8-hydroxy-2-quinolinecarboxylic acid	Quinoline carboxylic acids

Table 4.3.19 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	165.0653	4.98	4-methoxy-1-methyl-2-oxopyridine-3-carbonitrile	Ricinine
Phenolics	177.0543	1.98	7-hydroxy-6-methyl-2H-chromen-2-one	7-hydroxycoumarins
	223.0596	2.78	7-hydroxy-5,6-dimethoxychromen-2-one	7-hydroxycoumarins
	303.0502	2.87	2-(2,5-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one	Flavonols
	611.1601	3.01	7-{[(2S,3R,4S,5S,6R)-4,5-dihydroxy-6-(hydroxymethyl)-3-{[(2S,3R,4R,5R,6S)-3,4,5-trihydroxy-6-methyloxan-2-yl]oxy}oxan-2-yl]oxy}-2-(3,4-dihydroxyphenyl)-3,5-dihydroxy-4H-chromen-4-one	Flavonoid-7-O-glycosides
	197.1171	3.16	4-(3-hydroxybutyl)-2-methoxyphenol	Methoxyphenols
	449.1087	3.33	3,4,5-trihydroxy-6-[[5-hydroxy-2-(4-hydroxyphenyl)-4-oxo-2,3-dihydrochromen-7-yl]oxy]oxane-2-carboxylic acid	Flavonoid-7-O-glucuronides

Table 4.3.19 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolics	465.1037	3.64	2-(3,4-dihydroxyphenyl)-6-beta-D-Glucopyranosyl-3,5,7-trihydroxy-4H-1-benzopyran-4-one	Flavonoid C-glycosides
	303.0502	3.65	2-(3,4-dihydroxyphenyl)-3,7,8-trihydroxychromen-4-one	Flavonols
	435.0928	3.75	2-(3,4-dihydroxyphenyl)-5,7-dihydroxy-3-(3,4,5-trihydroxyoxan-2-yl)oxychromen-4-one	Flavonoid-3-O-glycosides
	449.1077	3.85	6-beta-D-Glucopyranosyl-3,5,7-trihydroxy-2-(4-hydroxyphenyl)-4H-1-benzopyran-4-one	Flavonoid C-glycosides
	535.1090	3.92	3-[(6-{[3-(2,4-dihydroxyphenyl)-5-hydroxy-4-oxo-4H-chromen-7-yl]oxy}-3,4,5-trihydroxyoxan-2-yl)methoxy]-3-oxopropanoic acid	Isoflavonoid O-glycosides
	419.0978	3.99	5,7-dihydroxy-2-(4-hydroxyphenyl)-3-(3,4,5-trihydroxyoxan-2-yl)oxychromen-4-one	Flavonoid-3-O-glycosides
	303.0491	4.22	2-(3,4-dihydroxyphenyl)-3,6,7-trihydroxychromen-4-one	Flavonols
	353.2686	6.70	1-(4-hydroxy-3-methoxyphenyl)tetradecane-3,5-diol	Gingerdiols

Table 4.3.19 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Terpenes	209.1535	2.76	(6R,9R)-9-Hydroxy-4-megastigmen-3-one	Sesquiterpenoids
	227.1639	2.76	4,5-Dihydrovomifoliol	Sesquiterpenoids
	191.1431	2.77	4-(2,6,6-trimethylcyclohexa-1,3-dien-1-yl)but-3-en-2-one	Sesquiterpenoids
	275.2002	5.56	(3E,5E,7E)-8-[(4R)-4-hydroxy-2,6,6-trimethylcyclohex-1-en-1-yl]-6-methylocta-3,5,7-trien-2-one	Sesquiterpenoids
	277.2162	5.86	17-hydroxy-13-methyl-2,4,5,6,7,8,9,10,11,12,14,15,16,17-tetradecahydro-1H-cyclopenta[a]phenanthren-3-one	Estrogens and derivatives
	409.2828	11.28	Ferna-7,9(11)-diene	Triterpenoids

Table 4.3.19 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Others	229.1546	1.00	Fatty acid methyl esters	Fatty acid methyl esters
	209.1536	2.26	4-(2,2,6-trimethyl-7-oxabicyclo[4.1.0]heptan-1-yl)but-3-en-2-one	Oxepanes
	138.0547	2.34	Phenylcarbamic acid	Phenylcarbamic acids
	179.1065	3.29	(4S)-4-hydroxy-3-methyl-2-[(2Z)-penta-2,4-dienyl]cyclopent-2-en-1-one	Secondary alcohols
	211.1701	3.58	1-cyclohexylcyclohexane-1-carboxylic acid	Carboxylic acids
	181.1216	4.27	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols
	429.3737	9.28	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols

4.3.20 *Senna tora* (L.) Roxb LYMOOI 010

LCMSMS analysis of extract from *Senna tora* enabled the identification of 18 putative compounds (Table 4.3.20) belonging to different chemical families. It contains 2 putative primary metabolites and 16 putative secondary metabolites.

Table 4.3.20: List of putative compounds in LYMOOOI 010, consist of 18 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	268.1043	1.59	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
Pigments	557.4724	8.89	Xanthophylls	Xanthophylls
Secondary metabolites				
Nitrogen containing compounds	138.0550	0.84	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids
	158.1176	0.84	8-methyl-8-azabicyclo[3.2.1]octane-3,6-diol	Tropane alkaloids
	147.1127	1.10	2,5-diaminohexanoic acid	Alpha amino acids

Table 4.3.20 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	188.0700	1.97	3-(1*H*-indol-3-yl)prop-2-enoic acid	Indoles
Phenolic	303.0492	4.07	2-(3,4-dihydroxyphenyl)-3,6,7-trihydroxychromen-4-one	Flavonols
	435.1289	4.45	5,7-dihydroxy-2-(4-hydroxyphenyl)-3-[(3,4,5-trihydroxy-6-methyloxan-2-yl)oxy]-3,4-dihydro-2H-1-benzopyran-4-one	Flavonoid-3-O-glycosides
Terpenes	181.1224	4.48	Methyl 4-prop-1-en-2-ylcyclohexene-1-carboxylate	Menthane monoterpenoids
	561.5030	9.64	3-[(3Z,7E,11E,13E,15E,19Z,23Z)-3,7,11,16,20,24,28-heptamethylnonacosa-3,7,11,13,15,19,23,27-octaen-1-yl]-2,2-dimethyloxirane	Sesquaterpenoids
	559.4874	9.66	3-[(3E,7E,9Z,11Z,13E,15Z,19E,23E)-3,7,11,16,20,24,28-heptamethylnonacosa-3,7,9,11,13,15,19,23,27-nonaen-1-yl]-2,2-dimethyloxirane	Sesquaterpenoids

Table 4.3.20 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Others	174.1489	0.83	9-aminononanoic acid	Medium-chain fatty acids
	209.1168	2.87	(Z)-3-Oxo-2-(2-pentenyl)-1-cyclopenteneacetic acid	Cyclic ketones
	293.2105	4.34	10-methoxyheptadec-1-en-4,6-diyne-3,9-diol	Long-chain fatty alcohols
	273.0760	4.44	5,6-Dehydromethysticin	Kavalactones
	291.1948	4.90	Deoxy phytoprostane J1	Prostaglandins and related compounds
	256.2629	7.27	Hexadecanamide	Fatty amides
	429.3732	9.27	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols

4.3.21 *Senna occidentalis* (L.) Link LYMOOI 030

LCMSMS analysis of extract from *Senna occidentalis* enabled the identification of 21 putative compounds (Table 4.3.21) belonging to different chemical families. It contains 1 putative primary metabolite and 20 putative secondary metabolites.

Table 4.3.21: List of putative compounds in LYMOOOI 030, consist of 21 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	268.1038	1.37	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
Secondary metabolites				
Nitrogen containing compounds	138.0545	0.68	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids
	120.0806	1.11	2,3-dihydro-1~{H}-indole	Indolines
	188.0703	1.13	3-(1*H*-indol-3-yl)prop-2-enoic acid	Indoles

Table 4.3.21 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	205.0968	1.97	L-tryptophan	L-tryptophan
	217.0967	2.41	3-(1-phenylethyl)imidazole-4-carboxylic acid	Carbonylimidazoles
Phenolics	433.1135	1.85	3,5-dihydroxy-2-phenyl-7-[(2*S*,4*S*,5*S*)-3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxychromen-4-one	Flavonoid-7-O-glycosides
	595.1660	2.81	Kaempferol 3-rhamnoside-7-glucoside	Flavonoid-7-O-glycosides
	433.1130	3.22	Resokaempferol 7-glucoside	Flavonoid-7-O-glycosides
	625.1767	3.30	Rhamnocitrin 3-glucosyl-(1->2)-galactoside	Flavonoid-3-O-glycosides
	463.1241	3.45	8-beta-D-Glucopyranosyl-5,7-dihydroxy-2-(3-hydroxy-4-methoxyphenyl)-4H-1-benzopyran-4-one	Flavonoid 8-C-glycosides
	579.1709	3.50	Swertisin 2"-O-arabinoside	Flavonoid C-glycosides
	771.2138	3.94	Isovitexin 2"-O-(6"'-feruloyl)glucoside	Flavonoid C-glycosides
	609.1820	3.95	Isoscoparin 2"-O-rhamnoside	Flavonoid C-glycosides

Table 4.3.21 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolics	271.0966	4.78	2-(4-hydroxyphenyl)-7-methoxy-2,3-dihydrochromen-4-one	7-O-methylated flavonoids
	301.0708	5.03	6-C-Methylkaempferol	Flavonols
Terpenes	181.1219	4.51	methyl 4-prop-1-en-2-ylcyclohexene-1-carboxylate	Menthane monoterpenoids
	409.3838	10.81	Ferna-7,9(11)-diene	Triterpenoids
Others	229.1546	1.05	Fatty acid methyl esters	Fatty acid methyl esters
	177.0540	2.82	3-(1,3-benzodioxol-5-yl)prop-2-enal	Benzodioxoles
	429.3734	9.28	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols

4.3.22 *Malpighia coccigera* LYMOOI 052

LCMSMS analysis of extract from *Malpighia coccigera* enabled the identification of 10 putative compounds (Table 4.3.22) belonging to different chemical families. It contains 1 putative primary metabolite and 9 putative secondary metabolites.

Table 4.3.22: List of putative compounds in LYMOOOI 052, consist of 10 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Proteins	174.1123	0.64	Methyl 2-acetamido-3-methylbutanoate	N-acyl-alpha amino acids and derivatives
Secondary metabolites				
Nitrogen containing compounds	118.0860	0.67	3-(dimethylamino)propanoic acid	Trialkylamines
	138.0545	0.82	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids
	144.1016	0.83	1-aminocyclohexane-1-carboxylic acid	L-alpha-amino acids

Table 4.3.22 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	158.1172	0.91	8-methyl-8-azabicyclo[3.2.1]octane-3,6-diol	Tropane alkaloids
Terpenes	413.3784	9.69	(3S,8S,9S,10R,13R,14S,17R)-10,13-dimethyl-17-[(2R)-4,5,6-trimethylhept-3-en-2-yl]-2,3,4,7,8,9,11,12,14,15,16,17-dodecahydro-1H-cyclopenta[a]phenanthren-3-ol	Gorgostanes and derivatives
Others	229.1547	1.00	Fatty acid methyl esters	Fatty acid methyl esters
	279.2319	6.15	Octadeca-9,12,15-trienoic acid	Lineolic acids and derivatives
	279.2320	6.19	Octadeca-6,9,12-trienoic acid	Lineolic acids and derivatives
	256.2639	7.34	Hexadecanamide	Fatty amides

4.3.23 *Melia azedarach* L. LYMOOI 002

LCMSMS analysis of extract from *Melia azedarach* enabled the identification of 18 putative compounds (Table 4.3.23) belonging to different chemical families. It contains 1 putative primary metabolite and 17 putative secondary metabolites.

Table 4.3.23: List of putative compounds in LYMOOOI 002, consist of 18 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	136.0612	0.94	7H-purin-6-amine	adenine
Secondary metabolites				
Nitrogen containing compounds	100.0756	0.64	piperidin-2-one	Piperidinones
	146.0811	0.64	trans-4-Hydroxy-N-methyl-L-proline	Proline and derivatives
	116.0702	0.93	(2Z)-2-(methylamino)but-2-enoic acid	Alpha amino acids

Table 4.3.23 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	120.0807	1.01	2,3-dihydro-1~{H}-indole	Indolines
	166.0861	1.05	3-amino-3-phenylpropanoic acid	Beta amino acids and derivatives
	205.0974	1.96	L-tryptophan	L-tryptophan
Phenolics	199.0600	2.21	Phenylpropanoic acids	Phenylpropanoic acids
	165.0543	2.33	3-(4-hydroxyphenyl)prop-2-enoic acid	Hydroxycinnamic acids
	193.0496	2.67	7-hydroxy-8-methoxychromen-2-one	7-hydroxycoumarins
	303.0501	3.30	2-(2,5-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one	Flavonols
	627.1551	3.38	2-(3,4-dihydroxyphenyl)-5,7,8-trihydroxy-3-[(2*S*,5*S*)-3,4,5-trihydroxy-6-[[(2*R*,4*S*,5*R*)-3,4,5-trihydroxy-6-methyloxan-2-yl]oxymethyl]oxan-2-yl]oxychromen-4-one	Flavonoid-3-O-glycosides
	611.1607	3.57	7-{[(2S,3R,4S,5S,6R)-4,5-dihydroxy-6-(hydroxymethyl)-3-{[(2S,3R,4R,5R,6S)-3,4,5-trihydroxy-6-methyloxan-2-yl]oxy}oxan-2-yl]oxy}-2-(3,4-dihydroxyphenyl)-3,5-dihydroxy-4H-chromen-4-one	Flavonoid-7-O-glycosides

Table 4.3.23 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolics	465.1030	3.84	2-(3,4-dihydroxyphenyl)-6-beta-D-Glucopyranosyl-3,5,7-trihydroxy-4H-1-benzopyran-4-one	Flavonoid C-glycosides
	317.0659	3.91	2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxy-6-methylchromen-4-one	Flavonols
	467.2072	5.60	6-hydroxy-7-(4-hydroxyphenyl)-5-methoxy-2,2-dimethyl-10-(3-methylbut-2-enyl)pyrano[3,2-g]chromen-8-one	Cyclic peptides
Terpenes	425.3786	8.10	4,4,6a,6b,8a,11,12,14b-octamethyl-2,3,4a,5,6,7,8,9,10,11,12,12a-dodecahydro-1H-picen-3-ol	Triterpenoids
Others	229.1549	1.12	Fatty acid methyl esters	Fatty acid methyl esters

4.3.24 *Toona sinensis* LYMOOI 047

LCMSMS analysis of extract from *Toona sinensis* enabled the identification of 29 putative compounds (Table 4.3.24) belonging to different chemical families. It contains 29 putative secondary metabolites.

Table 4.3.24: List of putative compounds in LYMOOOI 047, consist of 29 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Secondary metabolites				
Nitrogen containing compounds	116.070	0.64	(2Z)-2-(methylamino)but-2-enoic acid	Alpha amino acids
	120.081	1.15	2,3-dihydro-1*H*-indole	Indolines
	166.087	1.15	3-amino-3-phenylpropanoic acid	Beta amino acids and derivatives
	188.071	1.61	3-(1*H*-indol-3-yl)prop-2-enoic acid	Indoles
	205.097	1.79	L-tryptophan	L-tryptophan
	186.222	4.41	N,N-dimethyldecan-1-amine	Trialkylamines

Table 4.3.24 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	124.087	13.97	benzene-1,2,4-triamine	Aniline and substituted anilines
Phenolics	185.045	2.51	methyl 3,4,5-trihydroxybenzoate	Galloyl esters
	315.071	2.72	Norbergenin	Gallic acid and derivatives
	303.050	2.84	2-(2,5-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one	Flavonols
	465.104	2.94	2-[3,4-dihydroxy-5-[(2*S*,3*R*,4*S*,5*S*,6*R*)-3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxyphenyl]-5,7-dihydroxychromen-4-one	Flavonoid O-glycosides
	465.103	3.64	2-(3,4-dihydroxyphenyl)-6-beta-D-Glucopyranosyl-3,5,7-trihydroxy-4H-1-benzopyran-4-one	Flavonoid C-glycosides
	303.050	3.65	2-(3,4-dihydroxyphenyl)-3,7,8-trihydroxychromen-4-one	Flavonols
	435.093	3.80	2-(3,4-dihydroxyphenyl)-5,7-dihydroxy-3-(3,4,5-trihydroxyoxan-2-yl)oxychromen-4-one	Flavonoid-3-O-glycosides

Table 4.3.24 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolics	419.098	3.96	5,7-dihydroxy-2-(4-hydroxyphenyl)-3-(3,4,5-trihydroxyoxan-2-yl)oxychromen-4-one	Flavonoid-3-O-glycosides
	287.055	4.12	3,7,8-trihydroxy-2-(4-hydroxyphenyl)chromen-4-one	Flavonols
	433.113	4.13	Kaempherol 3-O-alpha-rhamnoside	Flavonoid-3-O-glycosides
Terpenes	303.050	4.56	2-(3,4-dihydroxyphenyl)-3,6,7-trihydroxychromen-4-one	Flavonols
	225.148	3.10	4-hydroxy-4-(3-hydroxybut-1-enyl)-3,5,5-trimethylcyclohex-2-en-1-one	Sesquiterpenoids
	235.169	4.84	Petasol	Eremophilane, 8,9-secoeremophilane and furoeremophilane sesquiterpenoids

Table 4.3.24 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Terpenes	715.353	5.03	3-[3-[3,4-dihydroxy-6-methyl-5-[3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxyoxan-2-yl]oxy-5,14-dihydroxy-10-(hydroxymethyl)-13-methyl-2,3,4,6,7,8,9,11,12,15,16,17-dodecahydro-1*H*-cyclopenta[a]phenanthren-17-yl]-2*H*-furan-5-one	Cardenolide glycosides and derivatives
	271.243	6.11	1,1,4*a*-trimethyl-7-propan-2-yl-2,3,4,9,10,10*a*-hexahydrophenanthrene	Diterpenoids
	445.368	9.73	5-hydroxy-2,6,15-trimethyl-14-(6-methylheptan-2-yl)tetracyclo[8.7.0.0^{2},^{7}.0^{11},^{15}]heptadec-1(10)-ene-6-carboxylate	Triterpenoids
Others	179.106	3.29	(4S)-4-hydroxy-3-methyl-2-[(2Z)-penta-2,4-dienyl]cyclopent-2-en-1-one	Secondary alcohols
	181.122	4.51	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols
	291.196	5.07	Deoxy phytoprostane J1	Prostaglandins and related compounds

Table 4.3.24 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Others	277.217	5.84	octadeca-9,11,13,15-tetraenoic acid	Lineolic acids and derivatives
	256.264	7.30	Hexadecanamide	Fatty amides

4.3.25 *Morus alba* Y.B. Wu LYMOOI 050

LCMSMS analysis of extract from *Morus alba* enabled the identification of 25 putative compounds (Table 4.3.25) belonging to different chemical families. It contains 1 putative primary metabolite and 24 putative secondary metabolites.

Table 4.3.25: List of putative compounds in LYMOOOI 050, consist of 25 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	268.1046	1.16	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	adenosine
Secondary metabolites				
Nitrogen containing compounds	138.0547	0.79	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids
	188.0702	1.40	3-(1*H*-indol-3-yl)prop-2-enoic acid	Indoles
	205.0974	1.97	L-tryptophan	L-tryptophan

Table 4.3.25 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	217.0975	2.42	3-(1-phenylethyl)imidazole-4-carboxylic acid	Carbonylimidazoles
Phenolic	163.0387	1.50	8-hydroxy-2H-chromen-2-one	Hydroxycoumarins
	303.0501	2.81	2-(3,4-dihydroxyphenyl)-3,6,7-trihydroxychromen-4-one	Flavonols
	611.1616	2.87	7-{[(2S,3R,4S,5S,6R)-4,5-dihydroxy-6-(hydroxymethyl)-3-{[(2S,3R,4R,5R,6S)-3,4,5-trihydroxy-6-methyloxan-2-yl]oxy}oxan-2-yl]oxy}-2-(3,4-dihydroxyphenyl)-3,5-dihydroxy-4H-chromen-4-one	Flavonoid-7-O-glycosides
	465.1027	3.11	2-(3,4-dihydroxyphenyl)-6-beta-D-Glucopyranosyl-3,5,7-trihydroxy-4H-1-benzopyran-4-one	Flavonoid C-glycosides
	303.0502	3.36	2-(2,5-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one	Flavonols

Table 4.3.25 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolic	449.1088	3.39	3,4,5-trihydroxy-6-[[5-hydroxy-2-(4-hydroxyphenyl)-4-oxo-2,3-dihydrochromen-7-yl]oxy]oxane-2-carboxylic acid	Flavonoid-7-O-glucuronides
	449.1085	3.43	5,7-dihydroxy-2-(4-hydroxyphenyl)-3-{[3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxy}-4H-chromen-4-one	Flavonoid-3-O-glycosides
	287.0553	3.57	3,7,8-trihydroxy-2-(4-hydroxyphenyl)chromen-4-one	Flavonols
	205.0852	5.98	7-ethoxy-4-methyl-2H-chromen-2-one	Coumarins and derivatives
Terpenes	275.1996	5.42	(3E,5E,7E)-8-[(4R)-4-hydroxy-2,6,6-trimethylcyclohex-1-en-1-yl]-6-methylocta-3,5,7-trien-2-one	Sesquiterpenoids
	277.2163	5.95	17-hydroxy-13-methyl-2,4,5,6,7,8,9,10,11,12,14,15,16,17-tetradecahydro-1H-cyclopenta[a]phenanthren-3-one	Estrogens and derivatives

Table 4.3.25 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Terpenes	551.4257	9.00	3,5,5-trimethyl-4-[(1E,3E,5E,7E,9E,11E,13E,15E,17E)-3,7,12,16-tetramethyl-18-[(1S)-2,6,6-trimethylcyclohexa-2,4-dien-1-yl]octadeca-1,3,5,7,9,11,13,15,17-nonaenyl]cyclohex-3-en-1-ol	Xanthophylls
Others	229.1552	0.96	Fatty acid methyl esters	Fatty acid methyl esters
	241.1538	1.22	1-hydroxy-6-(2-hydroxybutan-2-yl)-3-(2-methylpropyl)pyrazin-2-one	Pyrazines
	179.1066	3.30	(4S)-4-hydroxy-3-methyl-2-[(2Z)-penta-2,4-dienyl]cyclopent-2-en-1-one	Secondary alcohols
	181.1220	4.52	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols
	291.1954	4.90	Deoxy phytoprostane J1	Prostaglandins and related compounds

Table 4.3.25 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Others	181.1219	5.57	4-(butoxymethyl)phenol	Benzylethers
	341.1379	5.99	(2E)-1-[2,4-dihydroxy-3-(3-methylbut-2-en-1-yl)phenyl]-3-(2,4-dihydroxyphenyl)prop-2-en-1-one	3-prenylated chalcones
	613.4835	9.20	(2S)-1-hydroxy-3-[(9Z,12Z)-octadeca-9,12-dienoyloxy]propan-2-yl (6Z,9Z,12Z,15Z)-octadeca-6,9,12,15-tetraenoate	Lineolic acids and derivatives

4.3.26 *Sauropus spatulifolius* Beilla LYMOOI 054

LCMSMS analysis of extract from *Sauropus spatulifolius* enabled the identification of 17 putative compounds (Table 4.3.26) belonging to different chemical families. It contains 1 putative primary metabolite and 16 putative secondary metabolites.

Table 4.3.26: List of putative compounds in LYMOOOI 054, consist of 17 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	268.1037	1.50	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	adenosine
Secondary metabolites				
Nitrogen containing compounds	138.0548	0.79	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids
	205.0974	1.97	L-tryptophan	L-tryptophan
	217.0973	2.41	3-(1-phenylethyl)imidazole-4-carboxylic acid	Carbonylimidazoles

Table 4.3.26 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	273.1597	3.77	(1*R*,9*R*,10*R*,11*R*)-11-hydroxy-16-methyl-6,14-diazatetracyclo[7.5.3.01,10.02,7]heptadeca-2(7),3,16-trien-5-one	Phenanthrolines
	231.1488	5.26	5,6-Dehydroalbine	Aralkylamines
	231.1488	5.26	5,6-Dehydroalbine	Aralkylamines
Phenolics	163.0388	1.45	8-hydroxy-2H-chromen-2-one	Hydroxycoumarins
Terpenes	583.4142	7.95	(3S,3'R,4R)-7',8'-Didehydro-beta,beta-carotene-3,3',4-triol	Triterpenoids
	601.4261	8.05	19-(3,4-dihydroxy-2,6,6-trimethylcyclohexen-1-yl)-1-(4-hydroxy-1,2,2-trimethylcyclopentyl)-4,8,13,17-tetramethylnonadeca-2,4,6,8,10,12,14,16,18-nonaen-1-one	Xanthophylls
	551.4257	9.00	3,5,5-trimethyl-4-[(1E,3E,5E,7E,9E,11E,13E,15E,17E)-3,7,12,16-tetramethyl-18-[(1S)-2,6,6-trimethylcyclohexa-2,4-dien-1-yl]octadeca-1,3,5,7,9,11,13,15,17-nonaenyl]cyclohex-3-en-1-ol	Xanthophylls

Table 4.3.26 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Terpenes	445.3683	9.73	5-hydroxy-2,6,15-trimethyl-14-(6-methylheptan-2-yl)tetracyclo[8.7.0.0^{2},^{7}.0^{11},^{15}]heptadec-1(10)-ene-6-carboxylate	Triterpenoids
Others	177.0548	2.05	3-(1,3-benzodioxol-5-yl)prop-2-enal	Benzodioxoles
	136.0751	3.08	N-phenylacetamide	Benzene and substituted derivatives
	181.1216	4.53	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols
	282.2789	7.26	octadec-9-enamide	Fatty amides
	613.4833	9.23	(2S)-1-hydroxy-3-[(9Z,12Z)-octadeca-9,12-dienoyloxy]propan-2-yl (6Z,9Z,12Z,15Z)-octadeca-6,9,12,15-tetraenoate	Lineolic acids and derivatives
	429.3731	9.27	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols

4.3.27 *Peperomia pellucida* LYMOOI 051

LCMSMS analysis of extract from *Peperomia pellucida* enabled the identification of 41 putative compounds (Table 4.3.27) belonging to different chemical families. It contains 1 putative primary metabolite and 40 putative secondary metabolites.

Table 4.3.27: List of putative compounds in LYMOOOI 051, consist of 41 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	268.1041	1.11	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
Secondary metabolites				
Nitrogen containing compounds	138.0548	0.83	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids
	120.0807	1.08	2,3-dihydro-1~{H}-indole	Indolines
	188.0706	1.97	3-(1*H*-indol-3-yl)prop-2-enoic acid	Indoles

Table 4.3.27 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	205.0974	1.97	L-tryptophan	L-tryptophan
	314.1756	2.36	Isoamuronine	Proaporphines
	217.0972	2.42	3-(1-phenylethyl)imidazole-4-carboxylic acid	Carbonylimidazoles
	272.1281	2.62	Norhydromorphone	Morphinans
	286.1436	2.82	Isococlaurine	Benzylisoquinolines
	298.1442	3.15	(-)-Stepharine (C00025631)	Proaporphines
	328.1551	3.18	(+)-N-Methyllindcarpine	Aporphines
	330.1704	3.33	4-[[(1S)-6,7-dimethoxy-1,2,3,4-tetrahydroisoquinolin-2-ium-1-yl]methyl]-2-methoxyphenol	Benzylisoquinolines
	342.1703	3.43	(9-methoxy-3-methyl-2,4,4a,7,7a,13-hexahydro-1H-4,12-methanobenzofuro[3,2-e]isoquinolin-7-yl) acetate	Morphinans
	310.1440	3.61	Isolaureline	Aporphines
	314.1391	4.02	(1S,9R)-3-hydroxy-4,13-dimethoxy-17-azatetracyclo[7.5.3.01,10.02,7]heptadeca-2(7),3,5,10,13-pentaen-12-one	Phenanthrenes and derivatives

Table 4.3.27 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	344.1497	4.21	7-amino-10-hydroxy-1,2,3-trimethoxy-6,7-dihydro-5H-benzo[a]heptalen-9-one	Tropolones
	302.1753	5.76	N-demethylbelladine	Norbelladine-type amaryllidaceae alkaloids
Phenolics	611.1612	1.88	Paeonoside	Flavonoid-7-O-glycosides
	611.1612	2.87	(+)-Sinocrassoside C1	Flavonoid-7-O-glycosides
	595.1664	2.99	Kaempferol 3-rhamnoside-7-glucoside	Flavonoid-7-O-glycosides
	581.1502	3.12	Isoorientin 2"-O-xyloside	Flavonoid C-glycosides
	449.1085	3.32	6-{3,5-dihydroxy-2-[3-(4-hydroxyphenyl)prop-2-enoyl]phenoxy}-3,4,5-trihydroxyoxane-2-carboxylic acid	Flavonoid O-glycosides
	625.1771	3.51	Isorhamnetin 3-rhamnoside-7-glucoside	Flavonoid-7-O-glycosides
	433.1135	3.55	3,5-dihydroxy-2-phenyl-7-[(2*S*,4*S*,5*S*)-3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxychromen-4-one	Flavonoid-7-O-glycosides

Table 4.3.27 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolics	463.1238	3.63	5,7-dihydroxy-2-(3-hydroxy-4-methoxyphenyl)-3-[(2*S*,3*S*,5*R*)-3,4,5-trihydroxy-6-methyloxan-2-yl]oxychromen-4-one	Flavonoid-3-O-glycosides
	477.1394	3.71	5-hydroxy-2-(3-hydroxy-4-methoxyphenyl)-7-methoxy-6-[(2*S*,4*R*,5*S*)-3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]chromen-4-one	Flavonoid C-glycosides
	403.1753	4.98	Magnone A	7,9'-epoxylignans
	169.0856	6.03	4-(1-hydroxyethyl)-2-methoxyphenol	Methoxyphenols
	329.1016	6.27	5-hydroxy-6,7-dimethoxy-2-(4-methoxyphenyl)chromen-4-one	7-O-methylated flavonoids
Terpenes	389.1959	6.00	Salvisplendin C	Diterpene lactones
	413.3787	9.67	(3S,8S,9S,10R,13R,14S,17R)-10,13-dimethyl-17-[(2R)-4,5,6-trimethylhept-3-en-2-yl]-2,3,4,7,8,9,11,12,14,15,16,17-dodecahydro-1H-cyclopenta[a]phenanthren-3-ol	Gorgostanes and derivatives

Table 4.3.27 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Others	166.0862	0.94	2-hydroxy-2-phenylpropanamide	Phenylacetamides
	256.0962	2.99	1-Hydroxy-3-methoxy-N-methylacridone	Acridones
	209.0804	3.90	Anthriscinol	Benzodioxoles
	197.0806	4.05	methyl 3,4-dimethoxybenzoate	P-methoxybenzoic acids and derivatives
	181.1218	4.51	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols
	219.1013	4.80	1-[2-(3-hydroxyprop-1-en-2-yl)-2,3-dihydro-1-benzofuran-5-yl]ethanone	Acetophenones
	193.0852	5.22	[4-(1-hydroxyprop-2-enyl)phenyl] acetate	Phenol esters
	319.1533	6.85	Pyranones and derivatives	Pyranones and derivatives
	760.5859	11.65	[2-(methylamino)ethoxy]({2-[(9Z)-octadec-9-enoyloxy]-3-(octadecanoyloxy)propoxy})phosphinic acid	Monomethylphosphatidyl ethanolamines
	221.1172	6.08	2-(1-hydroxycyclopentyl)-2-phenylacetic acid	Benzene and substituted derivatives

4.3.28 *Piper sarmentosum* Roxb. LYMOOI 044

LCMSMS analysis of extract from *Piper sarmentosum* enabled the identification of 35 putative compounds (Table 4.3.28) belonging to different chemical families. It contains 1 putative primary metabolite and 34 putative secondary metabolites.

Table 4.3.28: List of putative compounds in LYMOOOI 044, consist of 35 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	268.1042	1.79	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
Secondary metabolites				
Nitrogen containing compounds	104.1069	0.64	3-(dimethylamino)propan-1-ol	1,3-aminoalcohols
	118.0859	0.64	3-(dimethylamino)propanoic acid	Trialkylamines
	138.0549	0.68	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids

Table 4.3.28 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	205.0971	2.08	L-tryptophan	L-tryptophan
	188.0704	2.08	3-(1*H*-indol-3-yl)prop-2-enoic acid	Indoles
	314.1744	2.89	Isoamuronine	Proaporphines
	342.1702	3.65	Lirioferine	Aporphines
	353.1856	3.87	Minovincine	Aspidospermatan-type alkaloids
	300.1603	5.70	11,12-dimethoxy-2,6,8,9-tetrahydro-1H-indolo[7a,1-a]isoquinolin-2-ol	Erythrinanes
Phenolics	595.1662	2.02	5,7-dihydroxy-2-(4-hydroxy-3-methoxyphenyl)-6-[3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]-8-(3,4,5-trihydroxyoxan-2-yl)-4H-chromen-4-one	Flavonoid 8-C-glycosides
	579.1713	2.53	Swertisin 2"-O-arabinoside	Flavonoid C-glycosides
	595.1665	2.56	Apigenin 7-allosyl-(1->2)-glucoside	Flavonoid-7-O-glycosides
	179.0709	3.01	3-(3-hydroxy-4-methoxyphenyl)prop-2-enal	Methoxyphenols
	607.1661	3.32	6"-Acetylapiin	Flavonoid-7-O-glycosides

Table 4.3.28 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolics	433.1132	3.45	3,5-dihydroxy-2-phenyl-7-[(2*S*,4*S*,5*S*)-3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxychromen-4-one	Flavonoid-7-O-glycosides
	193.0856	3.70	3-(3,4-dimethoxyphenyl)prop-2-enal	Cinnamaldehydes
	161.0589	3.79	6-Methylcoumarin	Coumarins and derivatives
	191.0702	3.95	7-Methoxy-6-methyl-2H-1-benzopyran-2-one	Coumarins and derivatives
	221.0809	4.64	5-hydroxy-7-methoxy-2,8-dimethylchromen-4-one	Chromones
	191.0704	5.60	7-methoxy-4-methyl-1-benzopyran-2-one	Coumarins and derivatives
	179.1071	6.54	2-methoxy-5-methyl-4-prop-1-enylphenol	Methoxyphenols
Terpenes	209.1180	5.44	(4-hydroxy-5-methyl-2-propan-2-ylphenyl) acetate	Aromatic monoterpenoids
Others	166.0862	1.01	2-hydroxy-2-phenylpropanamide	Phenylacetamides
	174.1490	1.10	9-aminononanoic acid	Medium-chain fatty acids
	238.1072	1.59	(3-hydroxy-2,2-dimethyl-3*H*-1-benzofuran-7-yl) *N*-methylcarbamate	Coumarans

Table 4.3.28 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Others	193.0865	2.67	[4-(1-hydroxyprop-2-enyl)phenyl] acetate	Phenol esters
	225.1120	2.89	3-(3,4,5-trimethoxyphenyl)prop-2-en-1-ol	Cinnamyl alcohols
	248.1289	3.99	1-(4-methoxyphenyl)-3-morpholin-4-ylprop-2-en-1-one	Benzoyl derivatives
	197.0813	4.04	methyl 3,4-dimethoxybenzoate	P-methoxybenzoic acids and derivatives
	181.1225	4.49	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols
	279.2325	6.06	9,12,14-octadecatrienoic acid	Lineolic acids and derivatives
	217.1231	6.38	2E,4E-Tetradecadiene-8,10-diynoic acid	Long-chain fatty acids
	237.1491	6.57	[3R-(3alpha,4beta,4abeta,6alpha)]-4,4a,5,6,7,8-Hexahydro-3,4a-dihydroxy-4-methyl-6-(1-methylethenyl)-2(3H)-naphthalenone	Cyclohexenones
	304.2639	7.41	Icosa-5,8,11,14-tetraenamide	Fatty amides

4.3.29 *Persicaria chinensis* (L.) H. Gross var. chinensis LYMOOI 037

LCMSMS analysis of extract from *Persicaria chinensis* enabled the identification of 24 putative compounds (Table 4.3.29) belonging to different chemical families. It contains 2 putative primary metabolites and 22 putative secondary metabolites.

Table 4.3.29: List of putative compounds in LYMOOOI 037, consist of 24 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolite				
Nucleic acids	136.0617	0.96	7H-purin-6-amine	Adenine
	268.1046	1.62	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
Secondary metabolite				
Nitrogen containing compounds	138.0547	0.80	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids
	160.1334	0.90	3-aminooctanoic acid	Beta amino acids and derivatives

Table 4.3.29 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	120.0809	1.09	2,3-dihydro-1~{H}-indole	Indolines
	166.0863	1.10	3-amino-3-phenylpropanoic acid	Beta amino acids and derivatives
	205.0976	1.96	L-tryptophan	L-tryptophan
	188.0707	1.98	3-(1*H*-indol-3-yl)prop-2-enoic acid	Indoles
	217.0976	2.42	3-(1-phenylethyl)imidazole-4-carboxylic acid	Carbonylimidazoles
Phenolics	147.0440	2.19	3-phenylprop-2-ynoic acid	Benzene and substituted derivatives
	303.0504	3.75	2-(3,4-dihydroxyphenyl)-3,7,8-trihydroxychromen-4-one	Flavonols
	449.1078	3.78	2-(3,4-dihydroxyphenyl)-5,6-dihydroxy-7-(3,4,5-trihydroxy-6-methyloxan-2-yl)oxychromen-4-one	Flavonoid-7-O-glycosides
	303.0504	3.86	2-(3,4-dihydroxyphenyl)-3,6,7-trihydroxychromen-4-one	Flavonols
	581.1507	3.87	Luteolin 7-apiosyl-(1->2)-glucoside Luteolin 7-O-[2-(beta-D-apiofuranosyl)-beta-D-glucopyranoside]	Flavonoid-7-O-glycosides

Table 4.3.29 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolics	581.1509	3.89	Isoorientin 2''-O-xyloside	Flavonoid C-glycosides
	303.0493	4.76	2-(2,5-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one	Flavonols
Terpenes	445.3681	9.74	5-hydroxy-2,6,15-trimethyl-14-(6-methylheptan-2-yl)tetracyclo[8.7.0.0^{2},^{7}.0^{11},^{15}]heptadec-1(10)-ene-6-carboxylate	Triterpenoids
Others	229.1551	1.09	Fatty acid methyl esters	Fatty acid methyl esters
	241.1548	1.16	1-hydroxy-6-(2-hydroxybutan-2-yl)-3-(2-methylpropyl)pyrazin-2-one	Pyrazines
	179.1066	3.29	(4S)-4-hydroxy-3-methyl-2-[(2Z)-penta-2,4-dienyl]cyclopent-2-en-1-one	Secondary alcohols
	181.1221	4.52	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols
	277.2164	5.97	9,12,15,17-octadecatetraenoic acid	Lineolic acids and derivatives

Table 4.3.29 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Others	256.2639	7.10	Hexadecanamide	Fatty amides
	429.3732	9.27	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols

4.3.30 *Brucea javanica* (L.) Merr. LYMOOI 020

LCMSMS analysis of extract from *Brucea javanica* enabled the identification of 19 putative compounds (Table 4.3.30) belonging to different chemical families. It contains 1 putative primary metabolite and 18 putative secondary metabolites.

Table 4.3.30: List of putative compounds in LYMOOOI 020, consist of 19 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	268.1044	1.03	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	adenosine
Secondary metabolites				
Nitrogen containing compounds	144.1016	0.66	1-aminocyclohexane-1-carboxylic acid	L-alpha-amino acids
	138.0550	0.83	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids
	188.1282	0.90	Trialkylamines	Trialkylamines

Table 4.3.30 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	160.1332	0.92	3-aminooctanoic acid	Beta amino acids and derivatives
	124.0863	13.96	benzene-1,2,4-triamine	Aniline and substituted anilines
	206.1396	13.97	N-(3-methylbut-2-enyl)-1,4,5,7-tetrahydropurin-6-imine	Imidazopyrimidines
Phenolics	177.0548	2.82	7-hydroxy-6-methyl-2H-chromen-2-one	7-hydroxycoumarins
	579.1716	3.49	5-hydroxy-2-(4-hydroxyphenyl)-7-[3,4,5-trihydroxy-6-[(3,4,5-trihydroxy-6-methyloxan-2-yl)oxymethyl]oxan-2-yl]oxychromen-4-one	Flavonoid-7-O-glycosides
	433.1134	3.62	Kaempherol 3-O-alpha-rhamnoside	Flavonoid-3-O-glycosides
	465.1184	4.84	5,7-dihydroxy-2-[2-(4-hydroxy-3-methoxyphenyl)-3-(hydroxymethyl)-2,3-dihydro-1,4-benzodioxin-6-yl]chromen-4-one	Flavonolignans
	449.1071	14.03	6-beta-D-Glucopyranosyl-3,5,7-trihydroxy-2-(4-hydroxyphenyl)-4H-1-benzopyran-4-one	Flavonoid C-glycosides

Table 4.3.30 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Terpenes	463.1598	3.24	Leucanthin A	Terpene lactones
	391.2475	6.23	3-(3,14,16-trihydroxy-10,13-dimethyl-1,2,3,4,5,6,7,8,9,11,12,15,16,17-tetradecahydrocyclopenta[a]phenanthren-17-yl)-2H-furan-5-one	Cardenolides and derivatives
Others	229.1548	0.97	Fatty acid methyl esters	Fatty acid methyl esters
	241.1550	1.08	1-hydroxy-6-(2-hydroxybutan-2-yl)-3-(2-methylpropyl)pyrazin-2-one	Pyrazines
	177.0545	2.62	3-(1,3-benzodioxol-5-yl)prop-2-enal	Benzodioxoles
	277.2171	5.84	9,12,15,17-octadecatetraenoic acid	Lineolic acids and derivatives
	279.2328	6.05	octadeca-7,9,12-trienoic acid	Lineolic acids and derivatives

4.3.31 *Solanum nigrum* L. LYMOOI 003

LCMSMS analysis of extract from *Solanum nigrum* enabled the identification of 28 putative compounds (Table 4.3.31) belonging to different chemical families. It contains 2 putative primary metabolites and 26 putative secondary metabolites.

Table 4.3.31: List of putative compounds in LYMOOOI 003, consist of 28 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	136.0614	1.61	7H-purin-6-amine	adenine
	268.1042	1.61	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	adenosine
Secondary metabolites				
Nitrogen containing compounds	138.0547	0.67	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids
	116.0703	0.92	(2Z)-2-(methylamino)but-2-enoic acid	Alpha amino acids

Table 4.3.31 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	166.0862	1.08	3-amino-3-phenylpropanoic acid	Beta amino acids and derivatives
	120.0806	1.11	2,3-dihydro-1~{H}-indole	Indolines
	144.0803	1.87	8-methylquinoline	Quinolines and derivatives
	188.0703	1.96	3-(1*H*-indol-3-yl)prop-2-enoic acid	Indoles
	205.0967	1.98	L-tryptophan	L-tryptophan
	314.1386	3.65	4~{a}-hydroxy-9-methoxy-3-methyl-2,4,7~{a},13-tetrahydro-1~{H}-4,12-methanobenzofuro[3,2-e]isoquinolin-7-one	Morphinans
	314.1393	3.68	(1S,9R)-3-hydroxy-4,13-dimethoxy-17-azatetracyclo[7.5.3.01,10.02,7]heptadeca-2(7),3,5,10,13-pentaen-12-one	Phenanthrenes and derivatives
	284.1285	4.03	Crotsparine	Proaporphines
Phenolics	207.0650	3.14	5,7-dihydroxy-2,6-dimethylchromen-4-one	Chromones
	317.0662	3.92	3,5,7-trihydroxy-2-(2-hydroxy-4-methoxyphenyl)chromen-4-one	Flavonols

Table 4.3.31 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolics	301.0704	4.07	Ptaeroxylol	Flavonols
	463.1235	4.08	5,7-dihydroxy-2-(3-hydroxy-4-methoxyphenyl)-6-[3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]chromen-4-one	Flavonoid C-glycosides
	345.0967	5.90	2-(3,4-dihydroxyphenyl)-5-hydroxy-3,7-dimethoxy-6-methylchromen-4-one	7-O-methylated flavonoids
Terpenes	438.2387	3.52	(2E)-3-(4-hydroxyphenyl)-N-[3-({4-[(2E)-3-(4-hydroxyphenyl)prop-2-enamido]butyl}amino)propyl]prop-2-enamide	Styrenes
	263.2373	6.35	6,10,14-trimethylpentadeca-5,9,13-trien-2-one	Acyclic diterpenoids
	445.3682	9.75	5-hydroxy-2,6,15-trimethyl-14-(6-methylheptan-2-yl)tetracyclo[8.7.0.0^{2},^{7}.0^{11},^{15}]heptadec-1(10)-ene-6-carboxylate	Triterpenoids

Table 4.3.31 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Others	189.1597	0.72	Medium-chain fatty acids	Medium-chain fatty acids
	185.0808	2.08	2-[(5*S*,6*R*)-5,6-dihydroxycyclohexa-1,3-dien-1-yl]propanoic acid	1,2-diols
	139.0753	2.45	1,2-dimethoxybenzene	Dimethoxybenzenes
	177.0542	2.82	3-(1,3-benzodioxol-5-yl)prop-2-enal	Benzodioxoles
	188.1646	2.82	10-aminodecanoic acid	Medium-chain fatty acids
	181.1214	4.51	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols
	256.2633	7.30	Hexadecanamide	Fatty amides
	429.3733	9.28	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols

4.3.32 *Solanum torvum* Sw. LYMOOI 013

LCMSMS analysis of extract from *Solanum torvum* enabled the identification of 19 putative compounds (Table 4.3.32) belonging to different chemical families. It contains 1 putative primary metabolite and 18 putative secondary metabolites.

Table 4.3.32: List of putative compounds in LYMOOOI 013, consist of 19 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Carbohydrates	382.1726	2.22	(2~{R},3~{S},4~{S},5~{R},6~{R})-2-(hydroxymethyl)-6-[6-[[(~{E})-4-hydroxy-3-methylbut-2-enyl]amino]purin-7-yl]oxane-3,4,5-triol	trans-zeatin-7-N-glucoside
Secondary metabolites				
Nitrogen containing compounds	104.1068	0.65	3-(dimethylamino)propan-1-ol	1,3-aminoalcohols
	138.0549	0.80	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids

Table 4.3.32 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	218.1029	1.00	2-(3-carboxypropanoylamino)pentanoic acid	N-acyl-L-alpha-amino acids
	120.0806	1.08	2,3-dihydro-1~{H}-indole	Indolines
	166.0861	1.17	3-amino-3-phenylpropanoic acid	Beta amino acids and derivatives
	188.0706	1.96	3-(1*H*-indol-3-yl)prop-2-enoic acid	Indoles
	205.0975	1.99	L-tryptophan	L-tryptophan
	124.0877	13.92	benzene-1,2,4-triamine	Aniline and substituted anilines
Phenolics	121.0645	1.08	1-phenylethenol	Styrenes
	251.1396	2.34	1-hydroxy-2-unsubstituted benzenoids	1-hydroxy-2-unsubstituted benzenoids
	147.0442	2.58	3-phenylprop-2-ynoic acid	Benzene and substituted derivatives
	323.1281	3.10	3,4-Didehydroglabridin	Pyranoisoflavonoids
	325.1438	3.35	5,7-dihydroxy-6-(3-methylbut-2-enyl)-2-phenyl-2,3-dihydrochromen-4-one	6-prenylated flavanones

Table 4.3.32 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolic	325.1441	3.69	(-)-phaseolin	Pterocarpans
Terpenes	538.2287	3.43	Terpene glycosides	Terpene glycosides
Others	229.1547	1.04	Fatty acid methyl esters	Fatty acid methyl esters
	241.1549	1.25	1-hydroxy-6-(2-hydroxybutan-2-yl)-3-(2-methylpropyl)pyrazin-2-one	Pyrazines
	341.1374	3.73	5-[[4-(1,3-benzodioxol-5-ylmethyl)oxolan-3-yl]methyl]-1,3-benzodioxole	9,9'-epoxylignans

4.3.33 *Centella asiatica* (L.) DC LYMOOI 046

LCMSMS analysis of extract from *Centella asiatica* enabled the identification of 24 putative compounds (Table 4.3.33) belonging to different chemical families. It contains 1 putative primary metabolite and 23 putative secondary metabolites.

Table 4.3.33: List of putative compounds in LYMOOOI 046, consist of 24 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	268.1046	1.62	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
Secondary metabolites				
Nitrogen containing compounds	120.0809	1.12	2,3-dihydro-1~{H}-indole	Indolines
	166.0867	1.13	3-amino-3-phenylpropanoic acid	Beta amino acids and derivatives
	188.0701	1.14	3-(1*H*-indol-3-yl)prop-2-enoic acid	Indoles

Table 4.3.33 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	205.0976	1.97	L-tryptophan	L-tryptophan
Phenolics	163.0392	1.65	3-Hydroxycoumarin 3-Coumarinol	Hydroxycoumarins
	163.0389	2.06	8-hydroxy-2H-chromen-2-one	Hydroxycoumarins
	479.0821	2.74	Quercetin 3-galacturonide	Flavonoid-3-O-glucuronides
	163.0391	3.62	4-hydroxychromen-2-one	4-hydroxycoumarins
	287.0559	3.69	3,7,8-trihydroxy-2-(4-hydroxyphenyl)chromen-4-one	Flavonols
	463.0873	3.72	Kaempferol 3-glucuronide	Flavonoid-3-O-glucuronides
Terpenes	487.3415	4.13	2α,19α-dihydroxy-3-oxo-12-ursen-28-oic acid	Triterpenoids

Table 4.3.33 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Terpenes	471.3464	5.55	8-hydroxy-2,2,6a,6b,9,9,12a-heptamethyl-10-oxo-3,4,5,6,6a,7,8,8a,11,12,13,14b-dodecahydro-1H-picene-4a-carboxylic acid	Triterpenoids
	197.1319	6.08	1,4-dimethyl-7-prop-1-en-2-ylazulene	Guaianes
	353.2685	6.37	Tomentol	Sesquiterpenoids
	435.3257	8.06	4-[(1E,3Z,5E,7E,9E,11E,13E,15E)-17-hydroxy-3,7,12,16-tetramethylheptadeca-1,3,5,7,9,11,13,15-octaen-1-yl]-3,5,5-trimethylcyclohex-3-en-1-ol	Triterpenoids
	551.4251	8.99	3,5,5-trimethyl-4-[(1E,3E,5E,7E,9E,11E,13E,15E,17E)-3,7,12,16-tetramethyl-18-[(1S)-2,6,6-trimethylcyclohexa-2,4-dien-1-yl]octadeca-1,3,5,7,9,11,13,15,17-nonaenyl]cyclohex-3-en-1-ol	Xanthophylls
	569.4352	9.00	4-[(1E,3E,5E,7E,9E,11E,13E,15E)-16-(4,4,7a-trimethyl-2,4,5,6,7,7a-hexahydro-1-benzofuran-2-yl)-3,7,12-trimethylheptadeca-1,3,5,7,9,11,13,15-octaen-1-yl]-3,5,5-trimethylcyclohex-3-en-1-ol	Xanthophylls
	423.3619	10.48	Glochidone	Triterpenoids
	409.3832	11.51	Ferna-7,9(11)-diene	Triterpenoids

Table 4.3.33 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Others	187.1472	6.08	7-ethyl-1,4-dimethyl-4,5-dihydroazulene	Branched unsaturated hydrocarbons
	613.4824	8.93	(2S)-1-hydroxy-3-[(9Z,12Z)-octadeca-9,12-dienoyloxy]propan-2-yl (6Z,9Z,12Z,15Z)-octadeca-6,9,12,15-tetraenoate	Lineolic acids and derivatives
	429.3731	9.27	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols
	760.5852	11.60	[2-(methylamino)ethoxy]({2-[(9Z)-octadec-9-enoyloxy]-3-(octadecanoyloxy)propoxy})phosphinic acid	Monomethylphosphatidyl ethanolamines

4.3.34 *Eryngium foetifum* L. LYMOOI 038

LCMSMS analysis of extract from *Eryngium foetifum* enabled the identification of 13 putative compounds (Table 4.3.34) belonging to different chemical families. It contains 1 putative primary metabolite and 12 putative secondary metabolites.

Table 4.3.34: List of putative compounds LYMOOOI 038, consist of 13 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	268.1044	1.61	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
Secondary metabolites				
Nitrogen containing compounds	205.0968	1.96	L-tryptophan	L-tryptophan
	188.0700	1.97	3-(1*H*-indol-3-yl)prop-2-enoic acid	Indoles

Table 4.3.34 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	280.1911	5.98	7-hydroxy-2,12-dimethyl-13-propan-2-yl-10-oxa-2-azatetracyclo[5.4.1.1^{8,11}.0^{4,12}] tridecan-9-one	Indoles and derivatives
	206.1394	13.96	N-(3-methylbut-2-enyl)-1,4,5,7-tetrahydropurin-6-imine	Imidazopyrimidines
Phenolic	163.0383	2.09	8-hydroxy-2H-chromen-2-one	Hydroxycoumarins
	163.0382	2.29	3-Hydroxycoumarin	Hydroxycoumarins
	327.1435	3.28	1-Methoxy-3-(4-hydroxyphenyl)-2E-propenal 4'-glucoside	Phenolic glycosides
	303.0490	3.44	2-(3,4-dihydroxyphenyl)-3,6,7-trihydroxychromen-4-one	Flavonols
Terpenes	203.1790	6.92	Eremophila-1(10),8,11-triene	Eremophilane, 8,9-secoeremophilane and furoeremophilane sesquiterpenoids

Table 4.3.34 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Others	229.1549	1.01	Fatty acid methyl esters	Fatty acid methyl esters
	181.1223	4.51	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols
	429.3737	9.28	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols

4.3.35 *Hydrocotyle sibthorpioides* Lam LYMOOI 069

LCMSMS analysis of extract from *Hydrocotyle sibthorpioides* enabled the identification of 30 putative compounds (Table 4.3.35) belonging to different chemical families. It contains 2 putative primary metabolite and 28 putative secondary metabolites.

Table 4.3.35: List of putative compounds in LYMOOOI 069, consist of 30 compounds

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Primary metabolites				
Nucleic acids	136.0614	0.99	7*H*-purin-6-amine	Adenine
	268.1039	1.09	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
Secondary metabolites				
Nitrogen containing compounds	160.1330	0.95	3-aminooctanoic acid	Beta amino acids and derivatives
	188.0700	1.96	3-(1*H*-indol-3-yl)prop-2-enoic acid	Indoles

Table 4.3.35 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Nitrogen containing compounds	205.0969	1.99	L-tryptophan	L-tryptophan
	217.0969	2.42	3-(1-phenylethyl)imidazole-4-carboxylic acid	Carbonylimidazoles
	207.1246	8.63	2-amino-5-(diaminomethylideneamino)-2-(fluoromethyl)pentanoic acid	Alpha amino acids
	206.1410	11.17	N-(3-methylbut-2-enyl)-1,4,5,7-tetrahydropurin-6-imine	Imidazopyrimidines
Phenolic	163.0387	1.59	3-Hydroxycoumarin3-Coumarinol	Hydroxycoumarins
	163.0386	1.74	5-Hydroxycoumarin	Hydroxycoumarins
	163.0383	1.76	8-hydroxy-2H-chromen-2-one	Hydroxycoumarins
	355.1026	2.35	1-[3-(3,4-dihydroxyphenyl)prop-2-enoyloxy]-3,4,5-trihydroxycyclohexane-1-carboxylic acid	Quinic acids and derivatives
	449.1080	2.47	6-beta-D-Glucopyranosyl-3,5,7-trihydroxy-2-(4-hydroxyphenyl)-4H-1-benzopyran-4-one	Flavonoid C-glycosides
	433.1127	2.99	Kaempherol 3-O-alpha-rhamnoside	Flavonoid-3-O-glycosides
	303.0498	3.40	2-(3,4-dihydroxyphenyl)-3,7,8-trihydroxychromen-4-one	Flavonols

Table 4.3.35 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Phenolics	595.1660	3.47	2-(3,4-dihydroxyphenyl)-5-hydroxy-3,7-bis[(3,4,5-trihydroxy-6-methyloxan-2-yl)oxy]chromen-4-one	Flavonoid-7-O-glycosides
	579.1710	3.55	5-hydroxy-2-(4-hydroxyphenyl)-7-[3,4,5-trihydroxy-6-[(3,4,5-trihydroxy-6-methyloxan-2-yl)oxymethyl]oxan-2-yl]oxychromen-4-one	Flavonoid-7-O-glycosides
	449.1070	3.56	Quercetin 3-O-L-rhamnoside	Flavonoid-3-O-glycosides
	465.1020	3.64	2-(3,4-dihydroxyphenyl)-6-beta-D-Glucopyranosyl-3,5,7-trihydroxy-4H-1-benzopyran-4-one	Flavonoid C-glycosides
	173.0595	5.79	2-hydroxynaphthalene-1-carbaldehyde	Naphthols and derivatives
	269.0810	5.84	5-hydroxy-3-(4-methoxyphenyl)chromen-4-one	4'-O-methylisoflavones
	337.1069	7.32	3-hydroxy-8-methoxy-3-methyl-2,4-dihydrobenzo[a]anthracene-1,7,12-trione	Angucyclines
	207.1019	8.21	(Z)-4-(4-hydroxy-3-methoxyphenyl)-3-methylbut-3-en-2-one	Hydroxycinnamic acids and derivatives

Table 4.3.35 (continued)

Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
Terpenes	275.2014	7.40	(3E,5E,7E)-8-[(4R)-4-hydroxy-2,6,6-trimethylcyclohex-1-en-1-yl]-6-methylocta-3,5,7-trien-2-one	Sesquiterpenoids
Others	229.1550	1.09	Fatty acid methyl esters	Fatty acid methyl esters
	177.0539	3.30	3-(1,3-benzodioxol-5-yl)prop-2-enal	Benzodioxoles
	181.1220	4.52	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols
	293.2115	5.47	10-methoxyheptadec-1-en-4,6-diyne-3,9-diol	Long-chain fatty alcohols
	295.2270	5.59	(6Z,9Z)-11-(3-pentyloxiran-2-yl)undeca-6,9-dienoic acid	Long-chain fatty acids

CHAPTER 5

DISCUSSION

5.1 Identification of Plant Based on Traditional Approach: Morphological Identification

At least at first glance, morphology plays an important role discovering the plant species and their subsequent description and taxonomic classification. The plant collection was done via morphological identification, which was performed by direct observation characters including leaves, flowers, fruits, and seeds (Amri et al., 2019; Santos et al., 2012). Each plant species was identified by the botanist in the field and later verified by the expert from Forest Reserve Institute Malaysia (FRIM). Identification of plant species is based on a few characteristics such as either whole plant, or flowers or stem or fruit or leaves of the plant as suggested by Prasad et al. (2011). Here, in this study, whole plant and leaves were used as the fundamental for plant identification and supplemented with different features to maximize the identification of plant samples.

Plant identification using the feature of leaves includes the observation on shape, colour, texture, and for details, the study can consider the leaves bases, venation, and margins as well (Thanikkal et al., 2018). According to Waldchen

et al. (2018), leaf shape is the key feature for traditional taxonomy, and can easily be distinguished by layman. Another study emphasised the importance of leaf structure by deducing only the characteristics of a leaf from the identification of plant species (Kolivand et al., 2018). In this study, two plants were identified based on their leaves structure, *Mikania cordata* and *Malpighia coccigera*. *Mikania cordata* have leaves structures of heart-shaped but with a pointed tip, while *Malpighia coccigera*'s leaves are thorny at the leaf margin. For the plant *Alternanthera sessilis*, *Persicaria chinensis*, and *Sauropus spatulifolius,* colour is one of the identification markers. *Alternanthera sessilis* have red to brownish colour leaves. *Persicaria chinensis* have a brownish to blackish V-shape spot on the upper surface of the leaves. *Sauropus spatulifolius* have the green coloured leaves with white veins. For the case of *Acanthopanax trifoliatus*, three leaflets are arranged together to form the special leaves arrangement for the plant. Special leaves texture on *Artemisia vulgaris*, *Blumea balsamifera*, and *Piper sarmentosum* becomes one of the identification features during the on-field visit. The upper surface of the leaves of *Artemisia vulgaris* is green and hairless, but their lower surface if white and with fine hairs. For *Blumea balsamifera* the upper surface is pilose, and the lower surface is densely silky woolly hair. *Piper sarmentosum* consists of waxy surface texture on leaves that become its distinct features.

Morphological character, including the reproductive organs, is valuable in plant identification (Q. Li et al., 2019). As in this study, there are few samples that are collected during the mature stage; flowers and fruit become one of the main differentiating criteria during the collection process. Those plants are

Laurentia longiflora, *Ageratum conyzoides*, *Celosia argentea*, *Cosmos sulphureus, Gomphrena globosa, Jatropha podagrica*, *Elephantopus scaber*, *Elephantopus tomentosus* and *Eryngium foetidum*. The presence of fruit or seed play's role in the identification of *Annona muricata*, *Morus alba*, *Ricinus communis*, *Solanum nigrum*, *Senna tora*, and *Senna occidentalis*. The external morphology of plant *Senna tora* and *Senna occidentalis* are quite similar; the fruit is one of the features that are used to distinguish them during field collection. Both of the plant samples have sickle-shaped fruit, but those in *Senna tora* are slightly round in cross-section while those in *Senna occidentalis* are flattened. Plants from the family of Cactaceae were identified based on morphological observations on their stem structures. *Epiphyllum oxypetalum* has no leaves, but the modified stem looks like a leaf. *Pereskia bleo* has woody stems with thorns parallel in bundles.

The identification of some plant samples has to be based on their whole morphology structure, including the leaves, height, and flower. These plants are small perennial plants (*Centella asiatica*, *Hydrocotyle sibthorpioides*, *Lobelia chinensis*, and *Peperomia pellucida*), shrubs (*Brucea javanica*), and trees (*Melia azedarach*, *Solanum torvum*, *Toona sinensis*, and *Vernonia esculenta*). For the case of small perennial plants, the plants are small in size, and it loses morphology traits after pressed. For the shrubs and trees, the plant press can only contain certain parts. Therefore, for these plants, photographs are crucial to document the exact appearance of plant samples during the time of collection. According to Gómez-Bellver et al. (2019), photographs including in herbarium specimen enable to increase the taxonomic value in few conditions when the

plant sample considered as large species such as trees, succulent plants with difficult to dry or presence of thorns, plants that totally lose morphological traits that are essential for identification once dried or pressed and in the case that the specimen is the only individual in a given locality.

5.2 Identification of Plant Based on Molecular Approach: DNA Barcoding

The question of which gene can serve as a barcode for local medicinal plants remains to be answered. A suitable marker is critically important for time and cost saving. Kress and Erikson (2008) had three criteria while Ford et al. (2009) proposed five considerations as key criteria for barcoding. In the current study, CBOL Plant Working Group barcoding markers for a land plant to figure out the identity of 35 local medicinal plants of Malaysia was used. The DNA extraction procedures and quality of extracted DNA are crucial elements for the success of the further downstream application. No complexities were observed in extracting the DNA. Based on the high PCR and sequencing success rate by *rbc*L, good quality DNA could be obtained from all the collected medicinal plants. Therefore, the low performance of *mat*K and ITS in PCR and sequencing may not be associated to DNA extraction protocol and quality of extracted DNA, rather due to the non-specificity of the chosen primer sequences. Non-specificity of primer tends to produce PCR products with undesirable and unrelated amplicons (Dieffenbach et al., 1993).

5.2.1 PCR and Sequencing Success Rate

According to Ford et al. (2009), *rbc*L was suggested as the core barcode because of its historical popularities rather than its power in barcoding species. Only *rbc*L was amplifiable and sequenced in all individual plants in the current study. A high success rate of amplification and sequencing was found in the tropical cloud forest (Kress et al., 2010) and mangrove species (Saddhe et al., 2016). The higher rate of success is due to the lower mean number of species per family in both the study. Primer universality of *rbc*L was already shown by other researched by achieves rather good amplification and sequencing rates ranging from 90% to 100% (China Plant BOL Group et al., 2011; Maloukh et al., 2017; Bafeel et al., 2014; de Groot et al., 2011) and was confirmed by the results in this study.

In contrast to *rbc*L, the success rate of amplification and sequencing of *mat*K was 74.29% and 84.62%, respectively, the lowest among the three barcode regions in the current study. Unsuccessful amplification for *mat*K in *Primulaceae* (Yan et al., 2011) and a low success rate of PCR using *mat*K in Berberis were reported (Roy et al., 2010). Hollingsworth et al. (2011) reported the issues of amplification and sequencing were due to high sequence variability in the primer binding site. Similar issues were reported in research of timber species in tropical countries and species of *Nyssaceae* (Fatima et al., 2019; Wang et al., 2012). *mat*K was even reported with inconsistent amplification resulted to exclude from the study of Swetha et al. (2014). The difficulty of *mat*K for barcoding invasive aquatic plants of the Netherlands was reported by

Ghahramanzadeh et al. (2013). The problem still exists even though 41 different primer combinations and various amplification protocols were combined. Many researchers have questioned its usefulness as a core barcode owing to its inferior amplification and sequencing performance. The challenges of finding a universal primer of *mat*K is a flaw from the viewpoint of barcoding experiments.

The challenge of moderate efficiency of amplification and sequencing also happened in the analysis of ITS, in which 88.57% and 87.10% of success rates were recorded, respectively. As compared with other DNA barcodes, overlapping peaks can be observed in the ITS region; thus, multiple amplification and sequencing were required until best result was obtained. This indicates that ITS was difficult to sequence. There have been other mixed reports of PCR success and sequencing with ITS, depending on particular primer and plant species. The result of this study was corroborated with those of Bolson et al. (2015), reporting 91% of amplification and 78% of sequencing success rate for wood samples from Atlantic Rainforests. However, other studies reported its difficulty in low PCR amplification success rate (Kang et al., 2017; Chen et al., 2010).

5.2.2 Efficiency of the Barcode Markers for resolving Identity

One of the aims of DNA barcoding is to identify the known or unknown species by matching the barcode sequence to available confirmed reference sequences. Though the aim of the current study was not discriminating the species group but in identifying the single plant species, therefore this study is

solely on NCBI Blast analysis and comparing the result with morphological identification verified by Forest Research Institute Malaysia (FRIM). The purpose is addressed in the current study using the BLAST method. The allocation of each query sequence to a particular taxon was attempted with three possible outcomes. The species of an assigned taxon with the highest BLAST (%) matches with morphology identification was assigned as 'correct'. 'Ambiguous' assigned for those samples with only being able to identify to genus-level or match several plants of the same genus. Those samples that do not exist in the reference database or were not from expected plant samples were marked as 'no match or incorrect identification'. Current study shows that DNA barcoding alone is insufficient to identify plant species to correct species level as all the three barcode markers have a low success rate in resolving the plant sample to species level. The study result indicated that only 37-46% of the plant sample under study identified to species-level using a barcoding approach. Moderate to high identification rates (74-96%) was obtained for genus-level identification.

A study from Naim and Mahboob (2019) for *Piper* species collected from northern Peninsular Malaysia showed that *rbc*L was a reliable barcode as it can identify 99.8% of the sample to species-level. Contrarily, the variation in the *rbc*L region exists for the above genus level is 74.77%, while for species-level only achieved a 37.14% in this study. It only has low discriminatory power; variation of the *rbc*L barcode is insufficient to discriminate the different species. The same finding was observed in wild plant of Saudi Arabian, as the *rbc*L sequences only enabled identification of 17% to species level but with 92% of

the sample to genus level (Bafeel et al., 2012). A study of vascular plants of Canada reported the identification of 91% at the genus level and 44% at the species level (Braukmann et al., 2017). This study revealed that *rbc*L is unsuitable for species level identification for the local medicinal plants, however, its primer universality, high amplification and sequencing rate make it useful for the identification of degraded plant sample for which no initial identification hypothesis exists (Veldman et al., 2020).

*mat*K region has successfully resolved the species of Fabaceae by yielded 96% and 80% identification success rates at the genus and species level, respectively (Ting et al., 2011). The finding was supported by the research report of Parmentier et al. (2013) on African Rainforest Trees by also reporting 90% and 81.1% for both the genus and species level identification. In current study, our result for genus level identification is in line with the previous researcher by reporting a 95.45% of identification success rate. However, its performance in species-level identification was relatively weak, with only 40.9% success rate. The result is not unexpected as its failure in discriminating the taxa *Roscoes* species and *Bambusa* species was reported previously (Dequan et al., 2014; Das et al., 2013).

The best result for taxonomic identification was gained by ITS, reported 46.15% for species-level identification and 92.3% for genus-level discrimination. The results in this study were similar to the finding of Huang et al. (2015) using Asian Tropical Trees by reporting higher in genus level as compared to species level identification, approximately 50% for species and genus 76% identification

rate. In another study on Lauraceae, the highest discriminatory power of ITS was recorded with 57.5% at the species level and 70% at the genus level (Z. F. Liu et al., 2017). However, compared to other researchers, this result is considered moderate. The ability of ITS in discriminating species of *Crawfurdia* is beyond doubt by perfectly identifying all the studied samples (Zhang et al., 2016). Previous publications in recent year revealed that ITS is a potential barcode to discriminate *Momordica* species and Asteraceae family perfectly (Santhosh Kumar et al., 2020; Buddhachat et al., 2020).

5.2.3 Factors That Affect Species Discrimination

Plant DNA barcoding for species discrimination in plant communities satisfies the criterions of standardisation, scalability, and simplicity (Pei et al., 2015). The use of DNA sequences as barcodes to identify plant species assumes that each of the plant species bears a unique set of barcodes (Parmentier et al., 2013). Our result showed that three of the loci could be used (though not ideal) as genetic regions for plant DNA barcoding studies in genus-level identification. However, in dataset from the study showed some sequences may remain unidentifiable or unmatched to species-level; the obtained range of 3.85% to 20% of plant species that are not matched to the expected described taxon.

For the *rbc*L region, there are up to seven plant species are not assigned to expected species. There are *Epiphyllum oxypetalum*, *Pereskia bleo*, *Ageratum conyzoides*, *Malpighia coccigera, Melia azedarach*, *Sauropus spatulifolius*, and *Vernonia esculenta*. For the other two regions, the unmatched sequences

occurred in *Blumea balsamifera* for matK sequences; *Ageratum conyzoides* and *Vernonia esculenta* for ITS sequences. Out of the other eight plant samples, seven of the samples were assigned to the plant species under the same family but different in morphological structure. Poor coverage of species in sequence databases was reported by Ferri et al (2008) and Raime et al. (2020). The database of The Barcode of Life DataSystems (BOLD) (Ratnasingham and Hebert, 2007) and Genbank (Benson et al., 2018) are the two main general databases of DNA barcode for plants, fungi, and animals. Parmentier et al. (2013) brought out the issue of sequences availability in database as major limiting factor of DNA barcoding. In a real case study, as in *Vernonia esculenta*, the sequence is absent from the reference database. *Vernonia esculenta* was assigned to another plant samples and thus increased the misidentification rate. While *mat*K of *Blumea balsamifera* was assigned to a non-closely related plant in terms of the plant family. Since the *rbc*L and ITS of this plant sample were successfully identified to species level, thus can exclude the issues of extracted DNA, rather due to non-specificity of the selected primer sequences or problem during sequencing. Ideally, all the sequence data in either database should have identified by taxonomic expert. However, given the inherent nature of any public database it is inevitable that some erroneous data may be present in them (Meiklejohn et al., 2019).

Various studies have been carried out from different perspectives to find out the reasons why plant barcodes are often shared between plant species. There are few drivers including evolutionary history of plants, plant hybridization, and seed or pollen dispersal in plant species. According to Ford et al. (2009), the

challenge in developing barcoding markers is the propensity of plants to undergo hybridization, and their breeding behaviour. Naciri et al. (2012) stressed the importance of considering the organelle inheritance and dispersal abilities during choosing markers. Yet, at the same time, the paper reported that, for most species both characteristics are often not known precisely enough (Naciri et al., 2012).

5.3 Untargeted Metabolite Profiling

Thousands of different secondary metabolites were found in plants as a means for survival, albeit being challenged by all other living organisms on this planet (Wink, 2015). Metabolite profiling as a detection tool is gaining popularity in many fields of biology, being applied to access the urine sample for diabetes patients (Tam et al., 2017), the changes of metabolite during insect growth (D. Li et al., 2019), and health status of fish (Nurdalila et al., 2019). It has also been used to study the chemistry diverse of medicinal plants (Méndez-López et al., 2020; Olennikov et al., 2019). The current study enabled an initial screening of the chemical composition of 35 local medicinal plants and highlighted the potential of some of the medicinal herbs at the metabolite level.

Extraction is the most crucial steps in metabolite profiling because it makes compromises for the comprehensive of metabolites discovered during research (Fiehn, 2006; Mamat et al., 2019). Solvent plays a major role in the comprehensiveness, completeness and representativeness of the metabolites extracted (Theodoridis et al., 2012). Recommendation of suitable solvent for plant material is challenging due to the feature of various bioactive compounds

in plant may have different solubilities in different solvents (Truong et al., 2019). Current study utilised the solvent of chloroform, methanol, and NaCl in double distilled water for the extraction. Chloroform and methanol solvent were good sources for extracts of different classes of compounds (Khanam et al., 2015). Methanol was chosen as the solvent because it could dissolve more diversity of compound, including polar, semi-polar and non-polar compounds (Rumidatul, Rahmawati and Sunarya, 2020), which means it has higher extraction efficiency. Chloroform is a non-polar solvent useful in extraction of terpenoid and flavonoid compounds (Pandey and Tripathi, 2014). Chigayo et al. (2016) and Eloff (1998) reported that with a methanol/chloroform/water combined solvent increase the yield of plant extraction. Addition of water to the solvent proved to increase the extraction efficiency as it able to increase the polarity of extractant (Chigayo et al.,2016, Xie et al., 2015).

5.3.1 Potential Metabolites

The medicinal features of plants could be ascribed to the existence of bioactive compounds. Therefore, it is necessary to point out that some putative 'known unknown' metabolites have been previously reported with various functions.

5.3.1.1 Deacetylcolchiceine

7-amino-10-hydroxy-1,2,3-trimethoxy-6,7-dihydro-5H-benzo[a] heptalen-9-one (deacetylcolchiceine) are found in four different plants which are,

Althernanthera sessilis, *Celosia argentea* L., *Epiphyllum oxypetalum*, and *Peperomia pellucida*. The derivatives of the metabolites were previously reported with activities on cancer cell lines (Kurek, 2018). However, the toxicity that it presents limited its clinical usefulness (Tormos and Bosca, 2013).

5.3.1.2 Glochidone

Glochidone was detected in the extract of *Elephantopus tomentosus* L.(21), *Lobelia chinensis* Lour.(23), and *Centella asiatica* (L.) Urb (46). Glochidone is an active compound in *Phyllanthus watsonii* and *Phyllanthus pulcher* (Ramasamy et al., 2012; Dasiman and Bahari, 2021). Glochidone showed anticancer activity on erythroleukemic and small cell lung cancer cell lines (Sakkrom et al., 2010) and antinociceptive (Meira et al., 2012).

5.3.1.3 10-methoxyheptadec-1-en-4,6-diyne-3,9-diol (Panaquinquecol 1)

10-methoxyheptadec-1-en-4,6-diyne-3,9-diol also known as Panaquinquecol 1. This putative compound was found in *Celosia argentea*, *Cosmos sulphureus*, *Pereskia bleo*, *Ageratum conyzoides*, *Mikania cordata, Elephantopus scaber*, *Senna tora*, and *Hydrocotyle vulgaris*. Panaquinquecol 1 inhibited the leukemia cells (L-1210) completely in tissue cultures at 0.5 µg/mL (Sullivan, 2011). A similar finding was observed in the study by Satoh et al. (2007), showed that cytotoxicity against leukemia cells (L-1210) was approximately ten times more potent than natural acetylenes (Satoh et al., 2007).

5.3.1.4 Crotsparine

Crotsparine was found in *Solanum nigrum* and *Annona muricata*. Extracted crotsparine from *Uvaria klaineana* showed antiplasmodial activity against chloroquine-resistant K1 and FcB1 strains of *Plasmodium falciparum* (Akendengue et al., 2002). Concerning the antibacterial activity, crotsparine showed weak activities against *Bacillus subtilis*, *Candida albicans*, *Escherichia coli*, and *Pseudomonas aeruginosa*, and *Staphylococcus aureus* (Legoabe, 2004). Shahwar et al. (2015) results showed that crotsparine possesses antiradical and antioxidant properties.

5.3.1.5 Dehydrotumulosic acid

Dehydrotumulosic acid was detected in *Elephantopus tomentosus*; it is one of the main terpenoids in *Wolfiporia cocos* (Fu et al., 2018) and *Poria cocos* (Song et al., 2002). The putative compound was reported with anti-inflammatory function previously (Giner et al., 2000; Prieto et al., 2003). Prieto et al. (2003) reported the anti-inflammatory activity is associated with inhibiting leukotriene B4.

5.3.1.6 Antiquol C

The compound Antiquol C was found in *Elephantopus tomentosus* L. and *Blumea balsamifera* (L.) DC.. This compound was previously reported to be novel triterpene alcohol extracted from *Euphorbia antiquorum* L.

(Euphorbiaceae), a plant native to India and Sri Lanka. The study showed that this compound has inhibitory effects on Epstein-Barr Virus Activation and suggested it may be useful as a chemo preventive agent (Akihisa et al., 2002).

5.3.2 Potential Plants

5.3.2.1 *Celosia argentea* L LYMOOI 072

Celosia argentea is frequently used in Chinese medicine to cure trauma to blood and eye disease. The modern pharmacological activities reported its activities on antiinfection, antitumor, and antioxidant (Tang et al., 2016). In 2017, previous researcher concluded that *Celosia argentea*'s seeds possess anticancer activities against breast cancer cell lines and antiplatelet activities (Priyanka and Brindha, 2017). The result of this study supported the findings of anticancer property as there are two putative metabolites, 7-amino-10-hydroxy-1,2,3-trimethoxy-6,7-dihydro-5H-benzo[a]heptalen-9-one (deacetylcolchiceine) and 10-methoxyheptadec-1-en-4,6-diyne-3,9-diol (Panaquinquecol 1) are reported with anticancer activities. Putative identified phenanthrenes and derivatives from *Celosia argentea* are reported as rare secondary metabolites in plant kingdoms and this compound shows a wide range of biological activity such as antimicrobial, antioxidant and anti-inflammatory effects (Tóth et al., 2018). Compound 3-(1,3-benzodioxol-5-yl)prop-2-enal(3,4-methylenedioxycinnam-aldehyde) find in the current study was detected in *Piper philippinum*. Methanol extract of 3-(1,3-benzodioxol-5-yl)prop-2-enal(3,4-methylenedioxycinnam-

aldehyde) from Formosan plant showed antiplatelet activities in-vitro(Chen et al., 2007).

5.3.2.2 *Annona muricata* L. LYMOOI 048

Annona muricata has been widely studied due to its bioactivity and traditional use (Gavamukulya et al., 2017; Wahab et al., 2018). Finding from this study is in line with the previous studies (Mohanty et al., 2008) detecting a high number of alkaloid compounds in *Annona muricata*. Sixteen nitrogen-containing compounds were found in the current study of *Annona muricata* with alkaloids group are the most abundant metabolites, mainly comprising aporphines and isoquinolines. Aporphines Cissaglaberrimine showed relaxant activities towards tracheal (Cornélio et al., 1999) and Pachypodanthine belonging to *Pachypodanthium staudtii* plants showed antibacterial activity towards Gram-negative bacteria (Fankam et al., 2014). In this plant, benzylisoquinoline type alkaloids such as 4-[[(1S)-6,7-dimethoxy-1,2,3,4 tetrahydroisoquinolin-2-ium-1-yl] methyl]-2-methoxyphenol, 4- [(6,7-dimethoxy-1,2,3,4 tetrahydroisoquino lin-1-yl) methyl] phenol, Isococlaurine, and (-)-4'-O-Methylcoclaurine were observed. Currently there is no published literature on these metabolites; however, many benzylisoquinoline are reported to have therapeutic properties and potential use as drug (Singla et al., 2010). The putative compound 6-tuliposide B was reported to have potent antibacterial activity (Shigetomi et al., 2010).

5.3.2.3 *Eleutherococcus trifoliatus* (L.) S.Y. Hu LYMOOI 014

Eleutherococcus trifoliatus is widely used as folk medicine in South-East Asia countries as either edible plant or medicine (D. L. Li et al., 2015). Result from the study showed that *Eleutherococcus trifoliatus* is high in phenolic and terpenoid compounds. Numerous biological activities such as antioxidant and anti-inflammatory, which are due to the possible composition of flavonoid and phenolic compounds, have been reported (Hamid et al., 2013; Sithisarn and Jarikasem, 2010). Wang et al. (2014) associated the anti-inflammatory activity of *Eleutherococcus trifoliatus* with anticancer properties particularly in prostate cancer cells. Previous researcher suggested that terpenoid compounds isolated from the plant sample may be responsible for anticancer activity (D. L. Li et al., 2015). This study detected the presence of 3-(1,3-benzodioxol-5-yl) prop-2-enal (3,4-Methylenedioxycinnamaldehyde), a nitrogen containing compound that previously showed anticancer properties. Eucalyptanoic acid was previously reported isolated from *Eucalyptus* spp. (Okba et al., 2021; Begum et al., 2002). Eucalyptanoic acid extracted from *Eucalyptus camaldulensis* var. obtusa showed spasmolytic action, and at a higher dose, it showed inhibition of spontaneous contraction (Begum et al., 2002). Putative compound 4-hydroxycoumarin is one of the well-studied anticoagulant compounds (Arora and Mathur, 1963; Manolov et al., 2016).

5.3.2.4 *Epiphyllum oxypetalum* LYMOOI 071

Epiphyllum oxypetalum is traditionally used to cure liver infection, sexually transmitted diseases, and antiviral disease (Biswal et al., 2019). The presence of 1-hydroxy-6-(2-hydroxybutan-2-yl)-3-(2-methylpropyl) pyrazin-2-one (Hydroxyaspergillic acid) was reported for growth inhibition of bacteria (Nakamura and Shiro, 1959). Naik and Naikwade (2021) noticed the anticancer activity of extract of *Epiphyllum oxypetalum*, and the current study revealed the presence of compound 7-amino-10-hydroxy-1,2,3-trimethoxy-6,7-dihydro-5H-benzo[a]heptalen-9-one (deacetylcolchiceine) associated with this function. Gamma butyrolactone was detected in this *Epiphyllum oxypetalum*. This putative compound was reported with various medicinal functions such as anticancer, antibiotic, antioxidant, and immunosuppressive (Hur et al., 2021).

5.3.2.5 *Pereskia bleo* LYMOOI 059

Pereskia bleo is usually consumed by local Malaysia as raw vegetables or as decoction brewed from fresh leaves for treating diabetes, high blood pressure, and even cancer (Malek et al., 2009). Leaves and fruit of the plant were reported with components alkaloids, fatty acids, glycosides, lactones, phenolic, and terpenoid compounds (Zareisedehizadeh et al., 2014). Current studies detected four different types of glycosides includes Flavonoid-7-O-glycosides (Kaempferol 3-rhamnoside-7-glucoside, Swertisin 2"-O-arabinoside, Kaempferol 3-galactoside-7-rhamnoside), and Flavonoid C-glycosides

(Resokaempferol 7-glucoside). Up-to-date, there are no further studies on these four compounds, however, according to another research report (Fatanah et al., 2015), flavonoids exhibit higher antioxidant activities than phenolic acids. The antioxidant activity of *Perekia bleo* was well-studied by previous researchers (Johari and Khong, 2019) and the intake of antioxidant diets may slow the progression of Alzheimer's Disease (Sinyor et al., 2020). Fatty acid amides, hecadecanamide was reported with the function of penetrating the Central Nervous System (Adnan et al., 2021). Another study reported that oral consumption of hexadecanamide can upregulate neurotrophic factors in hippocampal neurons and improve memory and learning function (Patel et al., 2020). Based on the metabolite content of *Pereskia bleo* on flavonoid and hexadecanamide, it may suggest that *Pereskia bleo* may be explored for therapy for Alzheimer's Disease. The presence of putative compound 10-methoxyheptadec-1-en-4,6-diyne-3,9-diol (Panaquinquecol 1) suggested that *Pereskia bleo* may have anticancer properties. In year 2019, a scholar from University Sains Malaysia reported that ethyl acetate extract of the plant possesses high potential to treat cervical cancer (Mohd-Salleh et al., 2019). Indoles was present in *Pereskia bleo* extraction, and generally, indoles can serve as potent antidepressants (Hamid et al., 2017). Putative compound 4-(3-hydroxybutyl)-2-methoxyphenol (zingerol) that present in this plant was proposed as orally-active antidiarrhea drugs as it inhibits contractility of smooth muscle in the colon (Iwami et al., 2011).

5.3.2.6 *Lobelia chinensis* Lour. LYMOOI 023

Lobelia chinensis is a folk medicine in China for the treatment of lung cancer, inflammation and fever (K. C. Li et al., 2015). Piperidine alkaloids and flavonoids have been reported from *Lobelia chinensis* (Kuo et al., 2011; Shibano et al., 2001). Finding from current research is in accordance with previous studies by detected piperidines, allosedridine, and flavonoid compound of isoscoparin 2"-O-rhamnoside and 7-[4,5-dihydroxy-6-(hydroxymethyl)-3-(3, 4,5-trihydroxy-6-methyloxan-2-yl) oxyoxan-2-yl]oxy-5-hydroxy-2-(4-methoxy phenyl)chromen-4-one. 7-ethoxy-4-methyl-2H-chromen-2-one, coumarin found in the current study was found to have relaxant action on the tracheal (Sánchez-Recillas et al., 2014). Gamma-butyrolactone was detected in *Lobelia chinensis*, and in a previous study it showed the ability to inhibit A549 (human lung adenocarcinoma) and HL-60 (human promyelocytic leukemia) (Gliszczyńska et al., 2011). Antheridic acid, a type of Gamma-butyrolactone found in this study was reported to cure ulcers, eczema, cut, and wounds (Yadav et al., 2012). Triterpenoid - Glochidone is one of the active compounds in *Phyllanthus watsonii* and *Phyllanthus pulcher* (Ramasamy et al., 2012; Dasiman and Bahari, 2021). Glochidone showed anticancer activity on erythroleukemic and small cell lung cancer cell lines (Sakkrom et al., 2010) and antinociceptive (Meira et al., 2012). The presence of 1-hydroxy-6-(2-hydroxybutan-2-yl)-3-(2-methyl-propyl) pyrazin-2-one (Hydroxyaspergillic acid) suggested that it may have antibacterial activities. Sit et al. (2017) claimed that the antimicrobial activity of *Lobelia chinensis* is dependent on the species of microorganism, type of extraction solvent, and testing concentrations.

5.3.2.7 *Blumea balsamifera* (L.) DC. LYMOOI 043

Blumea balsamifera was used as folk medicine in Southeast Asia countries, such as Malaysia, Indonesia, China, and Thailand. There are more than 100 compounds that have been isolated from this plant, with major compounds consisting of terpenoids, phenols, and alkane (Pang et al., 2014). The current study enables the detection of 16 different types of terpene compounds, five phenolic and two nitrogen-containing compounds. There are four terpenoids compounds that were previously studied by researchers, which are Antiquol C, 6,7-Dehydroroyleanone, Valerenolic acid and Rabdophyllin G. Few studies have investigated the effect of 6,7-Dehydroroyleanone on anti-Leishmania activities (Oliveira et al., 2018; Demarchi et al., 2015). A study from Mariana et al. (2019) reported that compound 6,7-Dehydroroyleanone modulated the production of cytokines essential for the immune defense response to Leishmania, resulting in anti-Leishmania function. Compound 6,7-Dehydroroyleanone extracted from *Plectranthus madagascariensis* showed anticancer properties by enabling activation of caspases-3 and -9 and is able to induce apoptosis of cancer cells (Garcia et al., 2018). Compound 6,7-Dehydroroyleanone extracted from the Lamiaceae family suggested being a potential anti-tuberculosis drug as it showed a good effect on *Mycobacterium tuberculosis* clinical isolates and Multidrug Resistance isolates (Baldin et al., 2018). Besides, its effect in antitermitic activities was reported by Kusumoto et al. (2009). The studies so far have provided evidence of valerenolic acid as an anti-inflammatory agent by reducing NF-κB activity to 25% at the concentration of 100 μg/mL (Jacobo-Herrera et al., 2008). Rabdophyllin G is most commonly

known as Isodonoiol. Isodonoil has previously been isolated from few plants, such as *Isodon amethystoides* (Jin et al., 2010), *Isodon rubescens* var. lushanensis (Zhang et al., 2010), *Isodon Rubescens* (Hemsl.) H. Hara (Terpenes) and *Rabdosia* species (Takeda and Otsuka, 1995). A study from Zhang et al. (2010) on cytotoxicity assays using this compound reported moderate inhibitory activity towards Human histiocytic lymphoma, K562 and Jurkat cell lines.

As shown in the research of Köberl et al. (2013), secondary metabolites of same plants that are grown in different location may differ because the differences attributed to the microbe's environment of growing habitat. Diversification of plant secondary metabolites affected by the diversity of enemies (Speed et al., 2015). Previous research confirmed the close relationship between geographical origin and the chemical composition (Kim et al., 2020; Putri et al., 2019; Lee et al., 2014). Zhao et al. (2015) reported the metabolite different of tobacco leaves between two growing locations at the mature stage. Thus, precise location documentation for each collected plant is important to ensure the repeatability of research in discovering the same metabolite compositions.

5.4 Limitation

One of the main problems in regard to medicinal plant collection is the accessibility of wild medicinal plants. According to Chen et al. (2016), factor of overexploitation and uncontrolled deforestation and destruction of natural habitat led to species rarity. During the plant collection, research team realised

that some plants are restricted to particular habitat or state, which limit the activities of plant collection. However, there is no further research have been carrying out to study the relationship between growth of medicinal plant and geographical state.

The main challenge with DNA barcoding has been a lack of reference data that includes broad taxonomic samples with preferred candidate markers, and the agreement on a common barcode (Hollingsworth et al., 2011). To overcome the challenges, the three gene loci of current study was chosen based on the suggestion of CBOL. However, universal plant barcodes may not efficient in all genera of land plants (Roy et al., 2010). Similar viewpoints had been reported by other researchers as well (Shafqat et al., 2020; Giudicelli et al., 2015; Okoth et al., 2016). One option in improving species discrimination rate is doing multi loci sequencing by combining plastid and nuclear regions in barcoding studies (Liu et al., 2016; China Plant BOL Group et al., 2011). Notwithstanding, to perform multilocus DNA barcoding, a suite of universal gene markers that can fit on all the studied plant samples is a prerequisite (J. Liu et al., 2017). Failure of sequencing in gene region *mat*K and ITS restricted the use of multilocus DNA barcoding.

5.5 Future Studies

The current study shows that DNA barcoding of using the three suggested loci is helpful in identify the plant sample to genus level but not species level. To solve the issue of low identification rate of a single barcode,

future studies will need to target on multi-loci DNA barcoding. However, combine barcode increase the difficulties especially when one of the target loci failed in amplification. Therefore, prior to that, it is essential to design and optimise specific primer set for medicinal plants. The continued search for suitable loci for medicinal plant still an ongoing process to strengthened the database. Besides, can consider the use of complete chloroplast genome as it is a highly conserved circular DNA with stable genome and low substitution rates (Dong et al. 2013, Smith, 2015, Asaf et al., 2016).

In the context of metabolite profiling, application of untargeted metabolite profiling enabled the global screening of metabolites. By using this approach, current studies shortlisted some potential medicinal plants and potential metabolites. In future, studies with targeted approach can be applied and focus on isolate those potential metabolites, which could be a potential source for bioactive compound and may find potential use in pharmaceutical industry.

CHAPTER 6

CONCLUSION

Plants are important for human survival, particularly, the medicinal plants have been employed by mankind as medicines since old periods. However, there has not been much research reporting on the molecular identification using DNA barcoding and metabolite profiling on local plants. Therefore, current study attempts to compile the data on basic morphological description, with molecular identity and metabolites contents to improve the existing information on local medicinal plants for future work.

Selected 35 local medicinal plants were collected from Selangor, Negeri Sembilan and Johor, Malaysia for making herbarium voucher, taking photography, performing DNA barcoding and metabolite profiling. All the 35 herbarium vouchers with basic morphological description were deposited at Perdana Botanical Garden Kuala Lumpur. Current study highlighted the applicability of the DNA barcoding as a tool for genus-level identification but not species-level identification in local medicinal plants. This method cannot replace the traditional taxonomy approach but should rather be a complementary tool for plant identification. Species assignment using DNA barcoding in this study is limited by the specificity of the selected primer sequences. In future, design primer with more specificity to medicinal plants and consider the use of combination of more loci to increase the species identification rate.

Untargeted metabolite profiling enabled the detection of known-unknown putative metabolites on 35 local medicinal plants detected a total of 406 putative metabolites, with 160 putative phenolic compounds, 95 putative terpene compounds, 70 putative nitrogen containing compounds, and 81 other putative compounds. The medicinal properties of the known unknown metabolites were searched for the previously reported function. These studies short listed some potential metabolites which can be further isolated and may find potential use in pharmaceutical industry.

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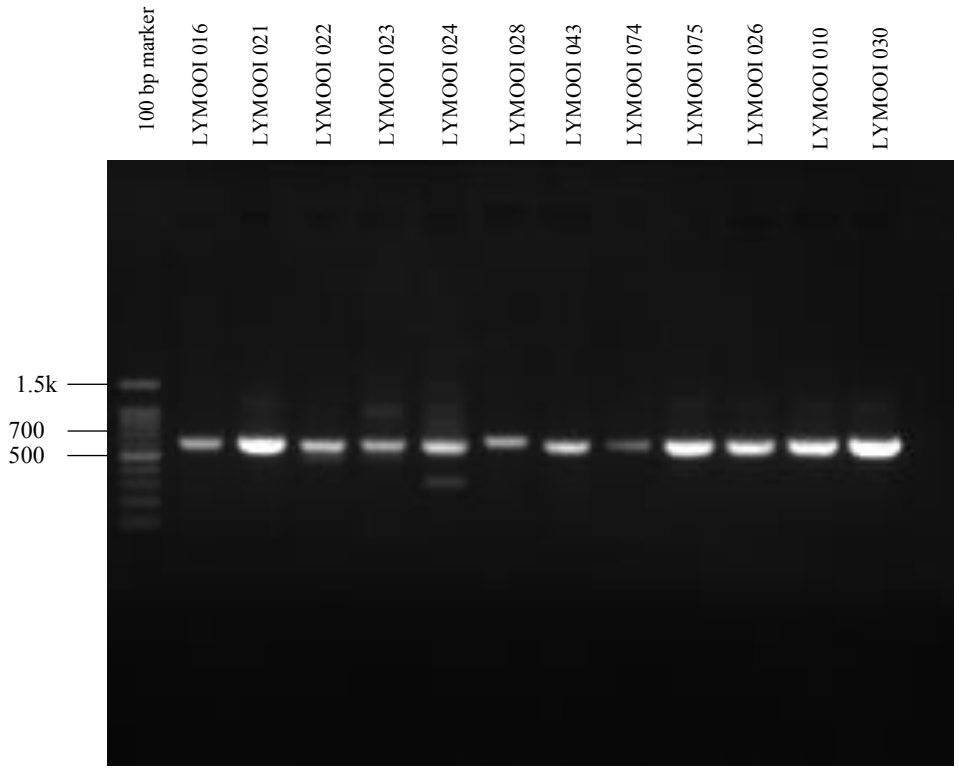
APPENDICES

APPENDIX A

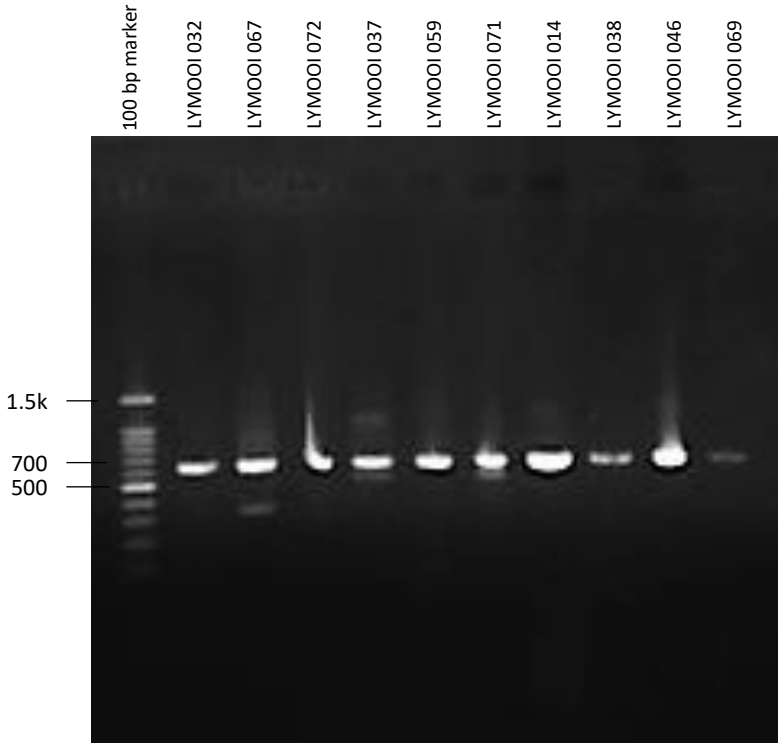
Agarose gel of PCR amplicons from plant DNA



Supplementary Figure 1: 1% Agarose gel electrophoresis of PCR product resulting from amplification of rbcLa_F/rbcLajf634R. Lanes labelled 100bp marker represent molecular weight marker (DM2100 ExcelBand™); sizes (in base pairs) are indicated on the left. Samples include *Ageratum conyzoides* L. (LYMOOI 016), *Elephantopus tomentosus* L. (LYMOOI 021), *Mikania cordata* (Burm. f) B.L. Rob (LYMOOI 022), *Lobelia chinensis* Lour (LYMOOI 023), *Vernonia esculenta* Hems.Ex. Hemsl (LYMOOI 024), *Artemisia vulgaris* L. (LYMOOI 028), *Blumea balsamifera* (L.) DC (LYMOOI 043), *Elephantopus scaber* L. (LYMOOI 074), *Cosmos sulphureus* (LYMOOI 075), *Laurentia longiflora* (L.) Peterm. (LYMOOI 026), *Senna tora* (L.) Roxb (LYMOOI 010), and *Senna occidentalis* (L.) Link (LYMOOI 030).

APPENDIX A

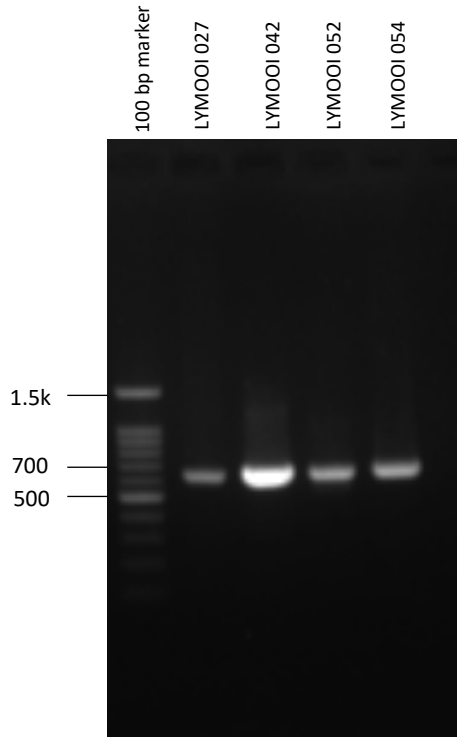
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 2: 1% Agarose gel electrophoresis of PCR product resulting from amplification of rbcLa_F/rbcLajf634R. Lanes labelled 100bp marker represent molecular weight marker (DM2100 ExcelBand™); sizes (in base pairs) are indicated on the left. Samples include *Gomphrena globosa* L. (LYMOOI 032), *Althernanthera sessilis* (LYMOOI 067), *Celosia argentea* L. (LYMOOI 072), *Persicaria chinensis* (L.) H. Gross var. chinensis (LYMOOI 037), *Pereskia bleo* (LYMOOI 059), *Epiphyllum oxypetalum* (LYMOOI 071), *Acanthopanax trifoliatus* (L.) S.Y. Hu (LYMOOI 014), *Eryngium foetidum* L. (LYMOOI 038), *Centella asiatica* (L.) Urb (LYMOOI 046), and *Hydrocotyle sibthorpioides* Lam. (LYMOOI 069).

APPENDIX A

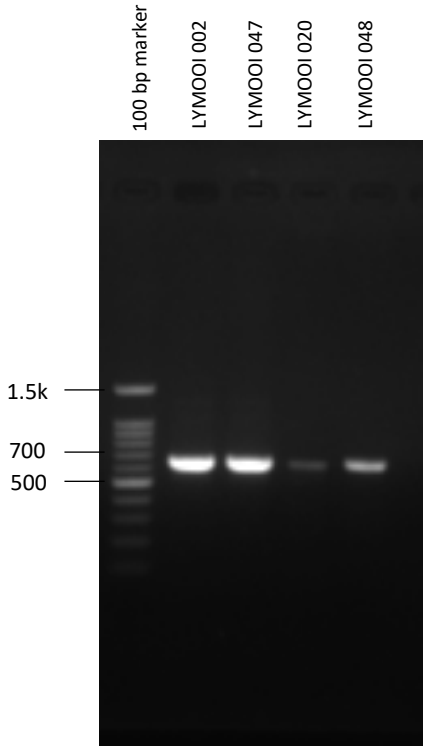
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 3: 1% Agarose gel electrophoresis of PCR product resulting from amplification of rbcLa_F/rbcLajf634R. Lanes labelled 100bp marker represent molecular weight marker (DM2100 ExcelBand™); sizes (in base pairs) are indicated on the left. Samples include *Ricinus communis* L. (LYMOOI 027), *Jatropha podagrica* (LYMOOI 042), *Malpighia coccigera* (LYMOOI 052), and *Sauropus spatulifolius* Beilla (LYMOOI 054).

APPENDIX A

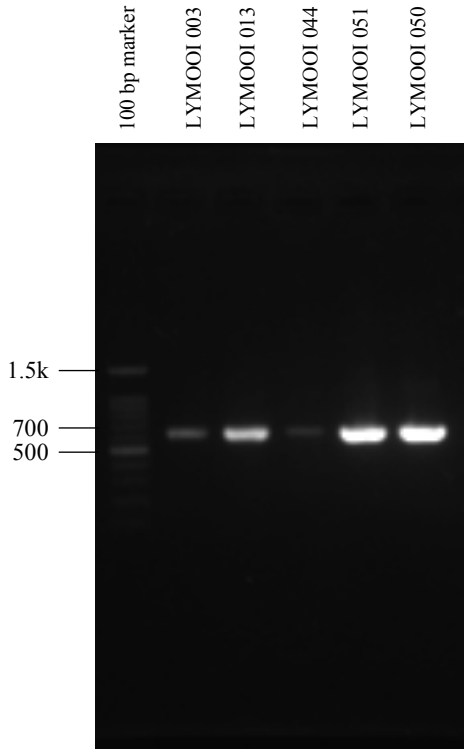
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 4: 1% Agarose gel electrophoresis of PCR product resulting from amplification of rbcLa_F/rbcLajf634R. Lanes labelled 100bp marker represent molecular weight marker (DM2100 ExcelBand™); sizes (in base pairs) are indicated on the left. Samples include *Melia azedarach* L. (LYMOOI 002), *Toona sinensis* (A. Juss.) (LYMOOI 047), *Brucea javanica* (Linn) Merr. (LYMOOI 020), and *Annona muricata* L. (LYMOOI 048).

APPENDIX A

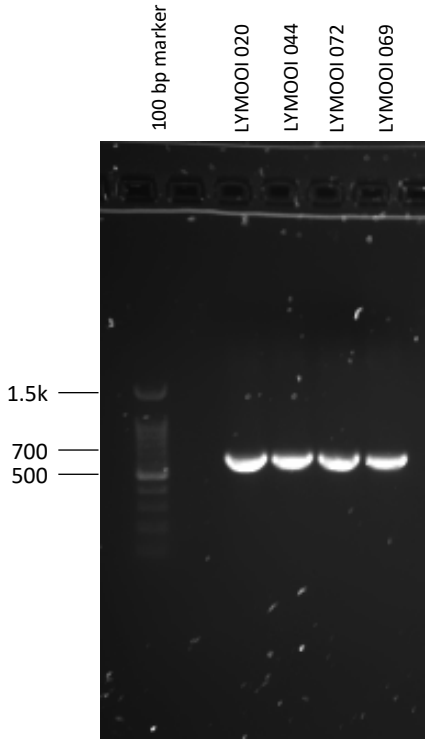
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 5: 1% Agarose gel electrophoresis of PCR product resulting from amplification of rbcLa_F/rbcLajf635R. Lanes labelled 100bp marker represent molecular weight marker (DM2100 ExcelBand™); sizes (in base pairs) are indicated on the left. Samples include *Solanum nigrum* L. (LYMOOI 003), *Solanum torvum* Sw. (LYMOOI 013), *Piper sarmentosum* Roxb (LYMOOI 044), *Peperomia pellucida* (LYMOOI 051) and *Morus alba* Y.B Wu (LYMOOI 050).

APPENDIX A

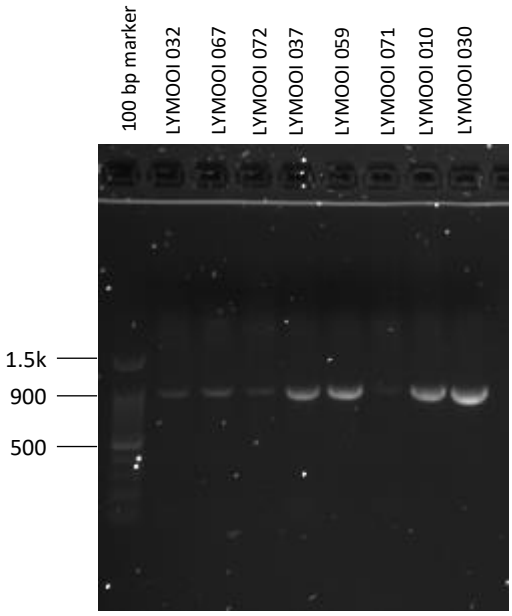
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 6: 1% Agarose gel electrophoresis of PCR product resulting from amplification of rbcLa_F/rbcLajf634R. Lanes labelled 100bp marker represent molecular weight marker (DM2100 ExcelBand™); sizes (in base pairs) are indicated on the left. Samples include *Brucea javanica* (Linn) Merr. (LYMOOI 020), *Piper sarmentosum* Roxb (LYMOOI 044), *Celosia argentea* L. (LYMOOI 072), and *Hydrocotyle sibthorpioides* Lam. (LYMOOI 069).

APPENDIX A

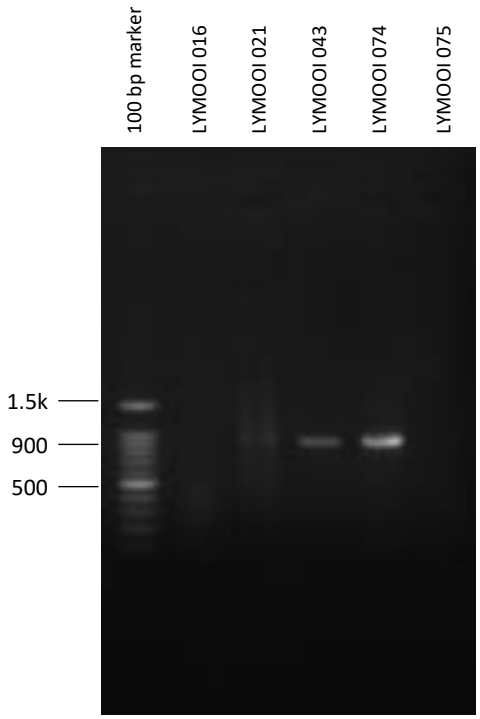
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 7: 1% Agarose gel electrophoresis of PCR product resulting from amplification of matK_390F/matK_1326r. Lanes labelled 100bp marker represent molecular weight marker (DM2100 ExcelBand™); sizes (in base pairs) are indicated on the left. Samples include *Gomphrena globosa* L. (LYMOOI 032), *Althernanthera sessilis* (LYMOOI 067), *Celosia argentea* L. (LYMOOI 072), *Persicaria chinensis* (L.) H. Gross var. chinensis (LYMOOI 037), *Pereskia bleo* (LYMOOI 059), *Epiphyllum oxypetalum* (LYMOOI 071), *Senna tora* (L.) Roxb (LYMOOI 010), and *Senna occidentalis* (L.) Link (LYMOOI 030).

APPENDIX A

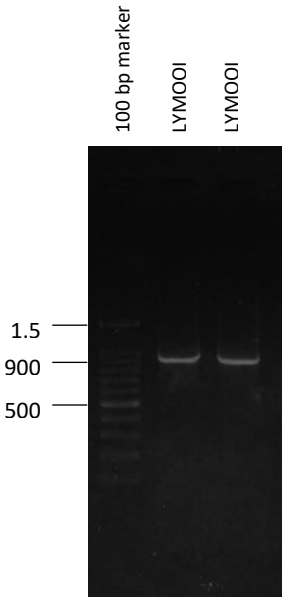
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 8: 1% Agarose gel electrophoresis of PCR product resulting from amplification of matK_390F/matK_1326r. Lanes labelled 100bp marker represent molecular weight marker (DM2100 ExcelBand™); sizes (in base pairs) are indicated on the left. Samples include *Ageratum conyzoides* L. (LYMOOI 016), *Elephantopus tomentosus* L. (LYMOOI 021), *Blumea balsamifera* (L.) DC (LYMOOI 043), *Elephantopus scaber* L. (LYMOOI 074), and *Cosmos sulphureus* (LYMOOI 075).

APPENDIX A

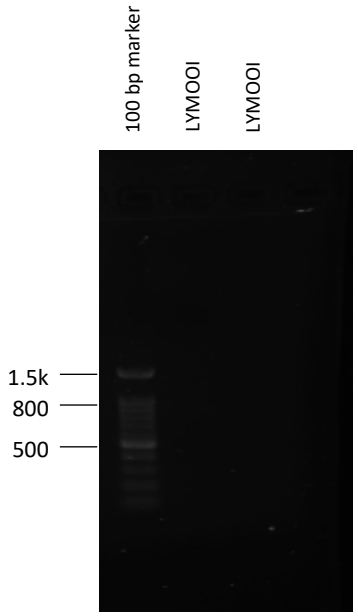
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 9:1% Agarose gel electrophoresis of PCR product resulting from amplification of matK_390F/matK_1326r. Lanes labelled 100bp marker represent molecular weight marker (DM2100 ExcelBand™); sizes (in base pairs) are indicated on the left. Samples include *Solanum nigrum* L. (LYMOOI 003), and *Solanum torvum* Sw. (LYMOOI 013).

APPENDIX A

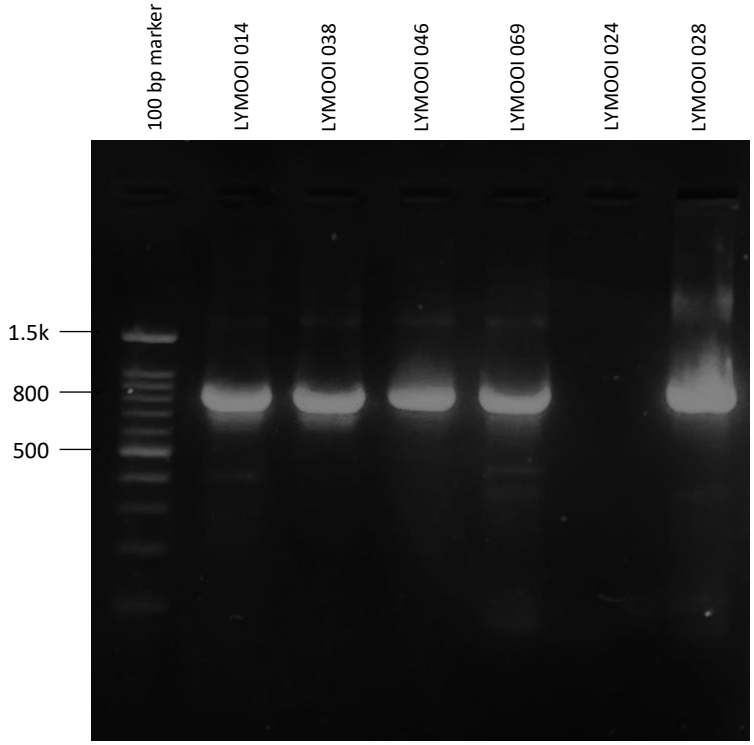
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 10:1% Agarose gel electrophoresis of PCR product resulting from amplification of matK_390F/matK_1326r. Lanes labelled 100bp marker represent molecular weight marker (DM2100 ExcelBand™); sizes (in base pairs) are indicated on the left. Samples include *Piper sarmentosum* Roxb (LYMOOI 044), and *Piper sarmentosum* Roxb (LYMOOI 051).

APPENDIX A

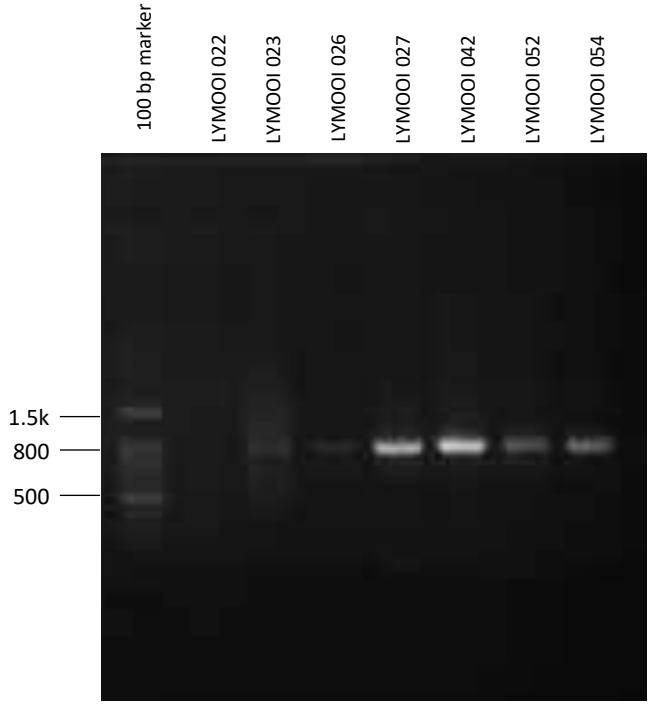
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 11:1% Agarose gel electrophoresis of PCR product resulting from amplification of matK_390F/matK_1326r. Lanes labelled 100bp marker represent molecular weight marker (DM2100 ExcelBand™); sizes (in base pairs) are indicated on the left. Samples include *Acanthopanax trifoliatus* (L.) S.Y. Hu (LYMOOI 014), *Eryngium foetidum* L. (LYMOOI 038), *Centella asiatica* (L.) Urb (LYMOOI 046), *Hydrocotyle sibthorpioides* Lam. (LYMOOI 069), *Vernonia esculenta* Hems.Ex. Hemsl (LYMOOI 024), *and Artemisia vulgaris* L. (LYMOOI 028).

APPENDIX A

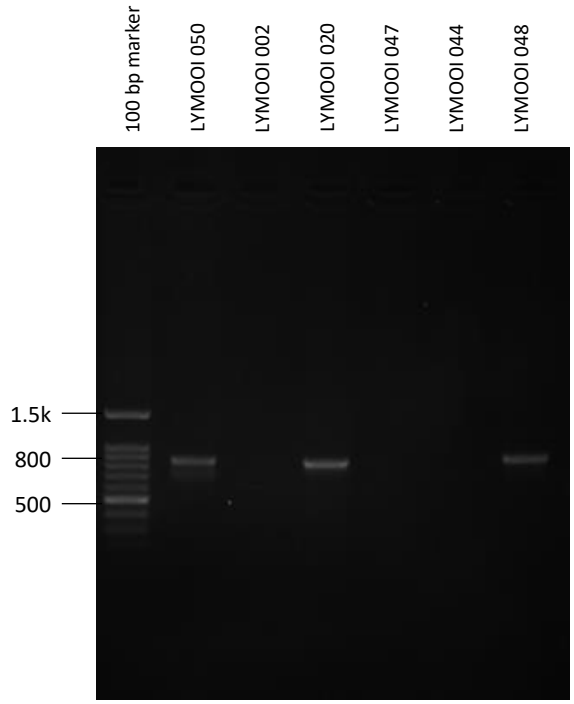
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 12:1% Agarose gel electrophoresis of PCR product resulting from amplification of matK_390F/matK_1326r. Lanes labelled 100bp marker represent molecular weight marker (DM2100 ExcelBand™); sizes (in base pairs) are indicated on the left. Samples include *Mikania cordata* (Burm.f) B.L.Rob (LYMOOI 022), *Lobelia chinensis* Lour (LYMOOI 023), *Laurentia longiflora* (L.) Peterm. (LYMOOI 026), *Ricinus communis* L. (LYMOOI 027), *Jatropha podagrica* (LYMOOI 042), *Malpighia coccigera* (LYMOOI 052), and *Sauropus spatulifolius* Beilla (LYMOOI 054).

APPENDIX A

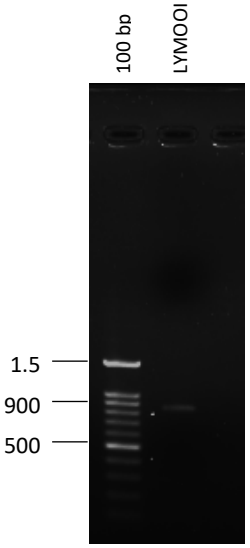
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 13:1% Agarose gel electrophoresis of PCR product resulting from amplification of matK_390F/matK_1326r. Lanes labelled 100bp marker represent molecular weight marker (DM2100 ExcelBand™); sizes (in base pairs) are indicated on the left. Samples include *Morus alba* Y.B Wu (LYMOOI 050), *Melia azedarach* L. (LYMOOI 002), *Brucea javanica* (Linn) Merr. (LYMOOI 020), *Toona sinensis* (A. Juss.) (LYMOOI 047), *Piper sarmentosum* Roxb (LYMOOI 044), and *Annona muricata* L. (LYMOOI 048).

APPENDIX A

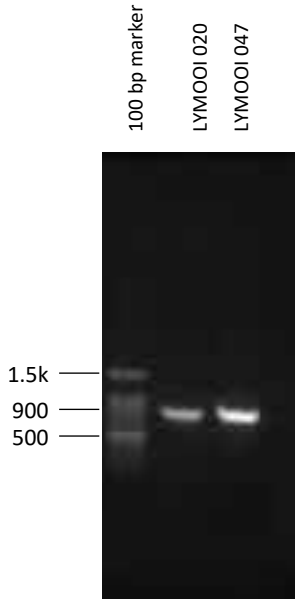
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 14:1% Agarose gel electrophoresis of PCR product resulting from amplification of ITS_5P/ITS_8P. Lanes labelled 100bp marker represent molecular weight marker (DM2100 ExcelBand™); sizes (in base pairs) are indicated on the left. Sample is *Persicaria chinensis* (L.) H. Gross var.chinensis (LYMOOI 037).

APPENDIX A

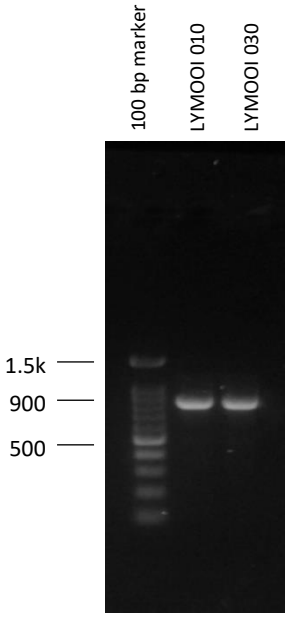
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 15:1% Agarose gel electrophoresis of PCR product resulting from amplification of ITS_5P/ITS_8P. Lanes labelled 100bp marker represent molecular weight marker (DM2100 ExcelBand™); sizes (in base pairs) are indicated on the left. Samples include *Brucea javanica* (Linn) Merr. (LYMOOI 020), and *Toona sinensis* (A. Juss.) (LYMOOI 047).

APPENDIX A

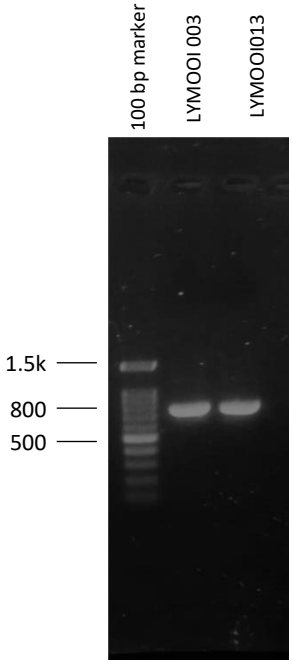
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 16:1% Agarose gel electrophoresis of PCR product resulting from amplification of ITS_5P/ITS_8P. Lanes labelled 100bp marker represent molecular weight marker (DM2100 ExcelBand™); sizes (in base pairs) are indicated on the left. Samples include *Senna tora* (L.) Roxb (LYMOOI 010), and *Senna occidentalis* (L.) Link (LYMOOI 030).

APPENDIX A

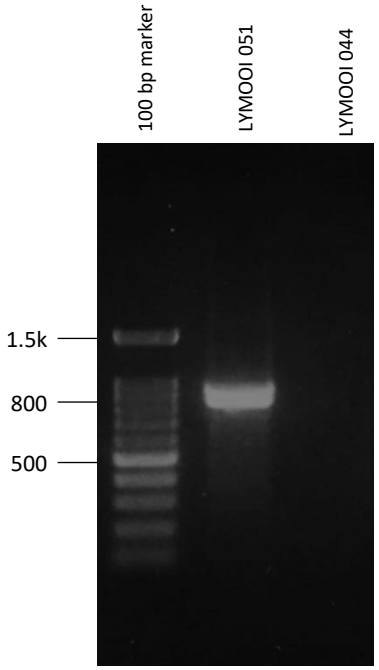
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 17:1% Agarose gel electrophoresis of PCR product resulting from amplification of ITS_5P/ITS_8P. Lanes labelled 100bp marker represent molecular weight marker (DM2100 ExcelBand™); sizes (in base pairs) are indicated on the left. Samples include *Solanum nigrum* L. (LYMOOI 003), and *Solanum torvum* Sw. (LYMOOI 013).

APPENDIX A

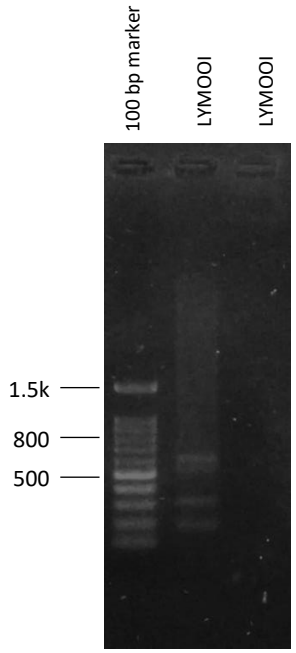
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 18:1% Agarose gel electrophoresis of PCR product resulting from amplification of ITS_5P/ITS_8P. Lanes labelled 100bp marker represent molecular weight marker (DM2100 ExcelBand™); sizes (in base pairs) are indicated on the left. Samples include *Peperomia pellucida* (LYMOOI 051), and *Piper sarmentosum* Roxb (LYMOOI 044).

APPENDIX A

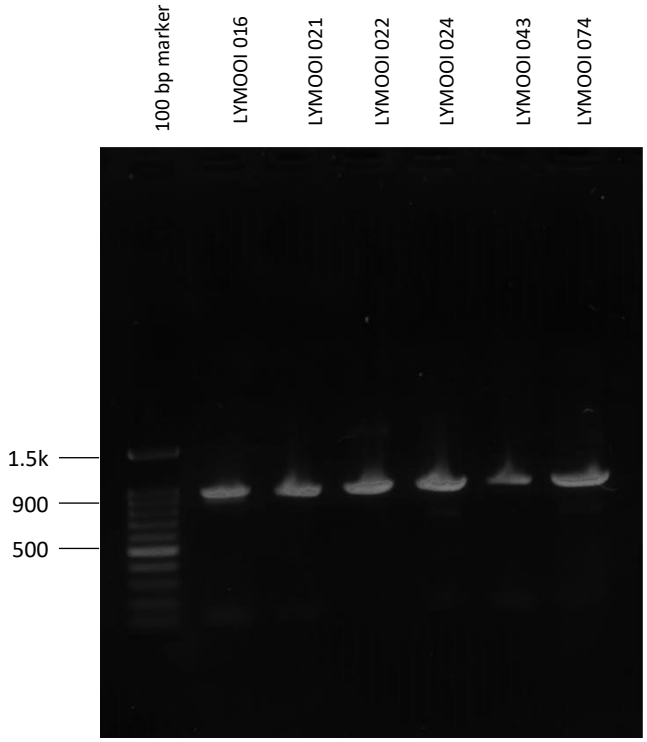
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 19:1% Agarose gel electrophoresis of PCR product resulting from amplification of ITS_5P/ITS_8P. Lanes labelled 100bp marker represent molecular weight marker (DM2100 ExcelBand™); sizes (in base pairs) are indicated on the left. Samples include *Pereskia bleo* (LYMOOI 059), and *Epiphyllum oxypetalum* (LYMOOI 071).

APPENDIX A

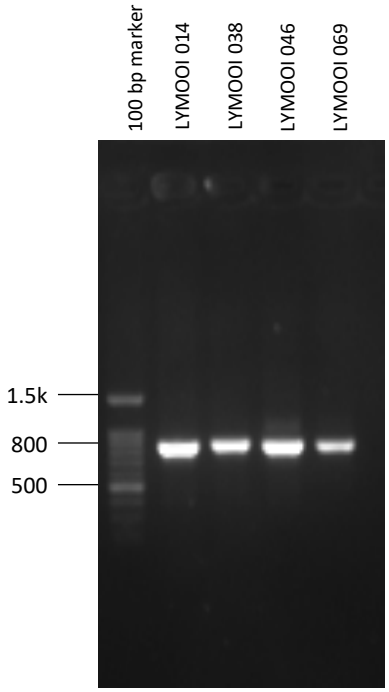
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 20:1% Agarose gel electrophoresis of PCR product resulting from amplification of ITS_5P/ITS_8P. Lanes labelled 100bp marker represent molecular weight marker (DM2100 ExcelBand™); sizes (in base pairs) are indicated on the left. Samples include *Ageratum conyzoides* L. (LYMOOI 016), *Elephantopus tomentosus* L.(LYMOOI 021), *Mikania cordata* (Burm.f) B.L.Rob (LYMOOI 022), *Vernonia esculenta* Hems.Ex. Hemsl (LYMOOI 024), *Blumea balsamifera* (L.) DC (LYMOOI 043), and *Elephantopus scaber* L. (LYMOOI 074).

APPENDIX A

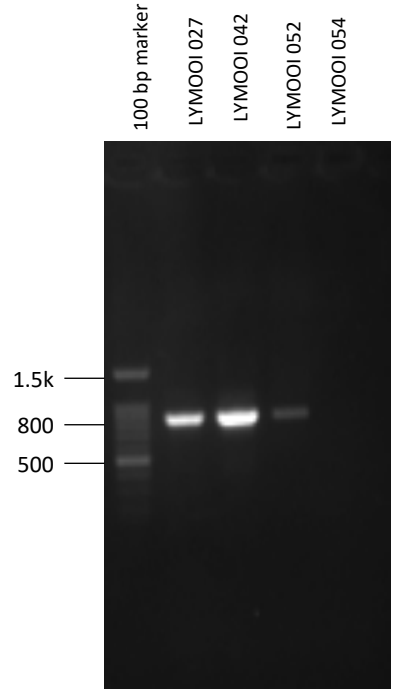
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 21:1% Agarose gel electrophoresis of PCR product resulting from amplification of ITS_5P/ITS_8P. Lanes labelled 100bp marker represent molecular weight marker (DM2100 ExcelBand™); sizes (in base pairs) are indicated on the left. Samples include *Acanthopanax trifoliatus* (L.) S.Y.Hu (LYMOOI 014), *Eryngium foetidum* L. (LYMOOI 038*), Centella asiatica* (L.) Urb (LYMOOI 046), and *Hydrocotyle sibthorpioides* Lam. (LYMOOI 069).

APPENDIX A

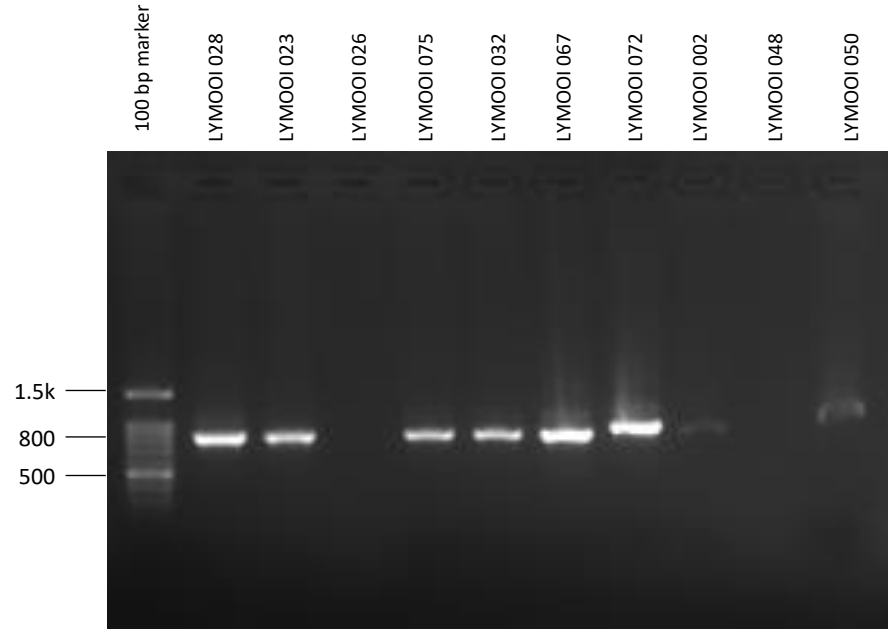
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 22:1% Agarose gel electrophoresis of PCR product resulting from amplification of ITS_5P/ITS_8P. Lanes labelled 100bp marker represent molecular weight marker (DM2100 ExcelBand™); sizes (in base pairs) are indicated on the left. Samples include *Ricinus communis* L. (LYMOOI 027), *Jatropha podagrica* (LYMOOI 042), *Malpighia coccigera* (LYMOOI 052), and *Sauropus spatulifolius* Beilla (LYMOOI 054).

APPENDIX A

Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 23:1% Agarose gel electrophoresis of PCR product resulting from amplification of ITS_5P/ITS_8P. Lanes labelled 100bp marker represent molecular weight marker (DM2100 ExcelBand™); sizes (in base pairs) are indicated on the left. Samples include (LYMOOI 028), Lobelia chinensis Lour (LYMOOI 023), Laurentia longiflora (L.) Peterm.(LYMOOI 026), *Cosmos sulphureus* (LYMOOI 075), *Gomphrena globosa* L. (LYMOOI 032), *Althernanthera sessilis* (LYMOOI 067), *Celosia argentea* L. (LYMOOI 072), *Melia azedarach* L. (LYMOOI 002), *Annona muricata* L. (LYMOOI 048), and *Morus alba* Y.B Wu (LYMOOI 050).

APPENDIX B

Sequences per sample based on bidirectional primer

Althernanthera sessilis LYMOOI 067

>LYMOOI067_rbcLa_F/rbcLajf635R
ACAGAGACTAAAGCAAGTGTTGGATTTAAAGCTGGTGTTAAAGATTACAAATTGA
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GTAACTCCTCAACCTGGAGTTCCACCTGAAGAAGCAGGGGCTGCAGTAGCTGCCG
AATCTTCTACTGGTACATGGACAACTGTATGGACTGACGGACTTACCAGTCTTGAT
CGTTACAAAGGACGATGCTACCATATCGAGCCTGTTGCTGGTGAAGAAAACCAAT
ATATTTGTTATGTAGCGTATCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACTAACA
TGTTTACTTCCATTGTAGGTAACGTATTTGGGTTCAAAGCCCTGCGTGCTCTACGTT
TGGAGGATTTGCGAATTCCTGTTGCTTATATAAAAACTTTCCAAGGCCCGCCTCAC
GGTATCCAAGTTGAAAGAGATAAATTGAACAAGTATGGTCGTCCCCTATTGGGAT
GCACTATTAAACCTAAATTGGGGTTATCCGCTAAAAACTACGGTCGAGCATGTTAT
GAATGTCTTCGTGGTGGACTTGATTTTACCAAAGATGATGAAAACGTGAACTCTCA
GCCGTTTATGCGTTG

>LYMOOI067_matK_390f/matK_1326r
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TGCATTTTTTACGATTCTTTCTTTATGAGTGTCGGAATTGGACTAGTTTTATTACTC
CAAAAGAATCCATTTCCTTTTTTTCAAAAAGGAATCGAAGATTATTCTTGTTCCTAT
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>LYMOOI067_ITS_5P/ITS_8P
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AACGACTCTCGGCAACGGATATCTCGGCTCTCGCATCGATGAAGAACGTAGCAAA
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CGGACTCGTCGGACCCTTGAAAACCTTTGCGACCCCAGGTCAGGCGGGATTACCC
GCTGAGTTTAAGCATATCAATAAGCGGAGGAAAAGAAACTTACAAGGATTCCCCT
AGTAACGG

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Celosia argentea LYMOOI 072
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AACAGAGACTAAAGCAAGTGTTGGATTTAAAGCTGGTGTTAAAGATTATAAATTG
ACTTATTATACTCCTGAGTATGAAACCCTAGATACTGATATCTTGGCAGCATTCCG
AGTAACTCCTCAACCTGGAGTTCCACCCGAAGAAGCAGGGGCTGCAGTAGCTGCC
GAATCTTCTACTGGTACATGGACAACTGTATGGACCGACGGACTTACCAGCCTTGA
TCGTTACAAAGGACGATGCTACCACATCGAGCCTGTTGCTGGAGAAGAAAATCAA
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TTGGAAGATTTGAGAATCCCTGTTGCTTATATAAAAACTTTCCAAGGTCCGCCTCA
CGGTATCCAAGTTGAAAGAGATAAATTGAACAAGTATGGTCGTCCCCTATTGGGA
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AACCATTTATGCGTT

>LYMOOI072_matK_390f/matK_1326r
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GCATTTATTACGATACTTTCTTTATGAGTATCGTAATTGGAAGACTCTTATTACGCC
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TCAAG

>LYMOOI072_ITS_5P/ITS_8P
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CAGAACGACCAGCGAACATGTTTATACTCATGGGTTGGGCGTGCTTTCACGAAGCC
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TTCGACAAAATAACTCAATCCGGCGCGGTATGCGCCAAGGAACATAAACACTAGT
GTGCCTGTCTCGTGCCCGGTTTTCCGGTGCATGGATGTGGCATCCAGTATTAATAA
AACAACGACTCTCGGCAACGGATATCTTGGCTCTCGCATCGATGAAGAACGTAGC
GAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAAC
GCAAGTTGCGCCCGAAGCTTCGGCCAGGGCACGTCTGCCTGGGCGTCACACAGCG
TCTCCCCCACCCCACCACATCGTGGGGAGGGGCGAGGAGGATGGTCTCCCATGTCT
CACCGGACATGGTTGGCCGAAAATGGGAGCCCGTGGTTGCGAATGCCTCGGCGAT
TGGTGGACTATATGTTGATCAAATTGCGTCGTGAGCACGTAGCCTATGTGGACTTG
TAGGACCCTGAAAAGTTGCCTTCTTGGCGACATACCTTTGCGACCCCAGGTCAGGC
GGGATTACCCGCTGAGTTTAAGCATATCAATAAGCGGAGGAAAAGAAACTTACAA
GGATTCCCCTAGTAACGGCGAGCGAACCGGGAATAGCCCAGCTTTAAAATCGGGC
GGCCTCGCCGTCCGAATT

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Gomphrena globosa LYMOOI 032
>LYMOOI032_rbcLa_F/rbcLajf634R
AACAGAGACTAAAGCAAGTGTTGGATTTAAAGCTGGTGTTAAAGATTACAAATTG
ACTTATTATACTCCGGAGTATGAAACCCTAGATACTGATATCTTGGCAGCATTCCG
AGTAACTCCTCAACCTGGAGTTCCACCCGAAGAAGCAGGGGCTGCAGTAGCTGCC
GAATCTTCTACTGGTACATGGACAACTGTATGGACCGACGGGCTTACCAATCTTGA
TCGTTACAAAGGACGATGCTATCATATCGAGCCCGTTGCTGGTGAAGAAAATCAA
TATATTTGTTATGTAGCGTATCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACTAAC
ATGTTCACTTCCATTGTAGGTAACGTATTTGGGTTCAAAGCCCTTCGTGCTCTACGT
TTGGAGGATTTGCGAATCCCTGTTGCTTATGTAAAAACTTTCCAAGGCCCACCTCA
TGGTATCCAAGTTGAAAGAGATAAATTGAACAAGTATGGCCGTCCTCTATTAGGAT
GCACTATTAAACCGAAATTGGGGTTATCCGCTAAAAACTACGGTCGAGCATGTTAT
GAATGTCTTCGTGGTGGACTTGATTTTACCAAAGATGATGAAAACGTGAACTCCCA
GCCGTTTATGCGTTGG

>LYMOOI032_matK_390f/matK_1326r
TAGAAGACAAATTCTTATATTTAAATTATGTGTTAGATATATTAATACCTTACCCC
GCCCATCTAGAAATCTTGGTTCAAACTCTCCGATACTGGTTGAAAGATGCTTCTTC
TTTGCATTTATTACGATTCTTTCTTTATGAGTGTCGTAATTGGACTAGTCGTATTAC
TTCAAAAGAATCCATTTCCTTTTTGAAAACAAGGAATCGAAGATTATTCTTGTTCC
TATATAATTTCTATGTATGTGAATACGAATCCTTTTTTGTTATTCTCCGCAATCAAT
CCTCTTATTTAAGATCAACATCTTTTGGAGCTCTTCTTGAACGAATACATTTCTACA
GAAAGTTCAAATATCTAGTTAACGTTAAGGCTTGTGCGGTTATCCTATGTTTTTTCA
AAGAACCTTTCCCACATTATGTTAGGTATCAAGGAAAAGCCCTTCTGGCATCAAAA
GGGACATCTCTTCTGATGCATAAATGGAAATATTACTTTATCTCTTTCTGGCAATGT
TATTTTTCTGTGTGGTCTCAACCAAGAAGAATCTATATCAATCAATTATCAAACTA
CTCCCTCGACTTTATGGGTTTTCTTTCAAGTGTGCGATTCAACTCGTCAGTAATACG
GAGTCAAATGTTAGAAAATTCATTTCTATTAGAGAATATTCGTAACAAGTTCGATA
CCATAGTTCCAATTAGTCCTCTAGTTGGCTCGTTGGCTAAGTCGAAATTTTGTAAC
GTATTAGGACATCCTATTGGTAAGTCGGTTTGGACTGATTTATCTGATTCTGATATT
ATTGACCGATTTGGGCGTATTTGTAGAAATCTTTCTCATTATTATAGTGGTTCCTCA
AGA

>LYMOOI032_ITS_5P/ITS_8P
ACAAGGTTTCCGTAGGTGAACCTGCGGAAGGATCATTGTCGAAACCTGCATAGCA
GAACAACCAGTGAACATGTTTTATCATCCACGGGGGAGGCGTGTTGGCTTGCCAA
CTCCCTTCCTTAAATGTCACGGGGCTTTCCGCTATGGTTGCCACGTGACACAATAA
CCAACCCCCGGCGCGTTATGCGTCAAGGAATATAATCATGAGTTTGTCCATCCATA
TGATCGGGTTTCCGGTGTATGGGTGTGGCACCAATGTAAGTCATAAAATGACTCTC
GGCAACGGATATCTCGGCTCTCGCATCGATGAAGAACGTAGCGAAATGCGATACT
TGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCC
GAAGCCTTCTGGCCAGGGCACGTCTGCCTGGGCGTCACGCATAGCGTCTCACCTAT
CCCACCAAAACTTGGGTAAGGAGAGGATGATGGCCTCCCATGTCACACCTGGCGT
GGATGGCCTAAAAAAGGAGCCTTGGGTTACTAGATGCCGTGGCGATTGGTGGTAT
AAACATCTCGTCACGGAATAAGTAGCTTAATTGGCCTCGTAGGACCCTTTGATAAC
CTTTGCGACCCCAGGTCAGGCGGGGTAACCCGCTGAGTTTAAGCATATCAATAAG
CGGAGGAAAAGAAACTTACAAGGATTCCCCTAGTAACGGCGAGCGAACCGGGAA
TAGCCCAGCTTTAAAATCGGGCGGCCTCGCTGTCCGAATTGTA

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Annona muricata LYMOOI 048
>LYMOOI048_rbcLa_F/ rbcLajf634R
CAGAGACTAAAGCAAGTGTTGGATTCAAAGCGGGTGTTAAAGAGTACAAATTGAC
TTATTATACTCCTGAATATGAAACCAAAGATACTGATATCTTGGCAGCATTCCGAG
TAACCCCTCAACCTGGAGTTCCGCCCGAGGAAGCAGGGGCTGCGGTAGCTGCCGA
ATCTTCTACCGGTACATGGACAACCGTGTGGACCGATGGACTTACCAGCCTTGATC
GTTACAAAGGACGATGCTACCACATCGAGCCTGTTGCTGGAGAGGAAAATCAATA
TATTGCTTATGTAGCTTACCCTTTAGATCTTTTTGAGGAGGGTTCTGTTACTAACAT
GTTTACTTCCATTGTAGGTAATGTGTTTGGGTTCAAAGCTCTACGAGCTCTACGCCT
AGAGGACTTGCGAATTCCTACTTCTTATATCAAGACTTTCCAGGGCCCGCCCCACG
GCATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGCCGTCCCCTATTGGGATG
TACTATTAAACCCAAATTGGGGTTATCCGCCAAGAACTACGGTAGGGCGGTTTATG
AATGTCTCCGCGGTGGACTTGATTTTACCAAGGATGATGAGAACGTGAACTCCCAA
CCATTTATGCGTTG

>LYMOOI048_matK_390f/matK_1326r
CATGTGTCACATATACTAATACCTTACCCCGCCCATCTGGAAATCTTGGTTCAAAT
ACTTCGCTCTTGCATACAAGATGCTCCCTCTTTACATTTATTGCGATTCTTTCTCCA
CGACTATCAGAATTCGAATAGTCTCAAAGCTCGAAAGAAATCCATTTTTGTTTGTT
CAAAAGAGAATCGAAGATTCTTCTTGTTCCTATATAATATTCATGTATATGAATGT
GAATCGGTATTTGTTTTTCTCCGTAAACAATCTTTTCATTTACGATCAACATCCTTT
AGAACTGTTCTTGAGCGAACACATTTCTATGGAAAAATAGAACATCTTGTAGTAGT
GCTTCGGAATGATTTTCAGAAGACCTTATGGATGTTCAAAGACCCCTTTATGCATT
ATGTCAGATATCAAGGAAATTCTCTTCTGGCGTCAAAGGGGACTCATCTTCGTATG
AAGAAATGGAAATCTTACCTTGTCCATTTTTGGCAATCTCATTTTTACTTGTGGTCT
CAACCGAACAGGATCCATATAAACCAATTATACAATCATTCTTTCTATTTTATGAG
CTATCTTTTAAGTGTACGCCAAAATTCTTCGGCAGTAAGGAGTCAAATGTTAGAGA
ATTCATTTCTAATAGATACTTCTATAAAGAAATTTGAGACCCTAGTTCCAACAATT
CCTCTGATTGGATTATTGGCTAAGGCGAAATTTTGTAATGTATTTGGGCACCCTATT
AGTAAGCCGGCCCGGGCCGATTCGTCCGATTCTGATATTATCAGTCGATTTGGGCG
CATATACAGAAATCTTTCTCATTATTACAGTGGATCC

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Eleutherococcus trifoliatus LYMOOI 014
>LYMOOI014_rbcLa_F/ rbcLajf634R
CAACAGAGACTAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGATTACAGATT
GACTTATTATACTCCTGACTATGAAACCAAAGATACTGATATCTTGGCAGCATTCC
GAGTAACTCCTCAACCTGGAGTTCCACCTGAAGAAGCAGGGGCCGCGGTAGCTGC
CGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGACTTACCAGCCTTG
ATCGTTACAAAGGGCGATGCTACGGAATCGAGCCCGTTGCTGGAGAAGAAAGTCA
ATTTATTGCTTATGTAGCTTACCCATTAGACCTTTTTGAAGAAGGTTCTGTTACTAA
CATGTTTACTTCCATTGTAGGTAATGTATTTGGGTTCAAAGCCCTGCGTGCTCTACG
TCTGGAAGATCTGCGAATCCCTGTTGCTTATGTTAAAACTTTCCAAGGCCCGCCTC
ATGGCATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGTCGTCCCCTGTTGGG
ATGTACTATTAAACCTAAATTGGGGTTATCTGCTAAAAACTACGGTAGAGCGGTTT
ATGAATGTCTCCGTGGTGGACTTGATTTTACCAAAGACGATGAGAACGTGAACTCC
CAACCATTTATGCGT

>LYMOOI014_matK_390f/matK_1326r
CTTTTTAGAGGACAAAATTTCACATTTAATTTATGTGTTAGAGATACTAATACCCT
ACCCAGTCCATCTGGAAATCTTGGTTCAAACTCTTCGCTACTGGGTAAAAGATGCT
TCTTCTTTGCATTTATTACGATTCTTTCTCCACGAGTATTGTAATTGGAATATTCCA
AATAAAGCCGGTTCTTCTTTTTCAAAAAGAAATCAAAGACTATTCTTCTTCCTATAT
AATTCTCATCTATGTGAATACGAATCCATCTTCATCTTTCTCCGTAACCAATCTTCT
CATTTACGCTCAACATCTTCTGGAACCCTTCTTGAACGAATATATTTCTATGGAAA
AATCAAATATCTTGTAAAAGTCTTTGTTAAGGCTTTTCAAGTCAATCTATTGTTGTT
GAAGGATCCTTTCATGCATTATGTTAGGTATCAAGGAAAATCAATTCTCGCTTCAA
AAGGGACGCCCTTTTTGATGAAAAAATGGACATATTACTTTGTTAATTTATGGCAA
TGTCATTTTTACCTGTGGTCTCAACCGGGAAGGATCTGTATAAACCAATTATACAA
TCATTCCCTCGACCTTCTGGGTTATCTATCAAGTGCGCGGCTAAACCCTTCAATGGT
ACGCGGTCAAATGCTAGAAAATTCATTTCTAATTGATAATGCTATTAATAAGTTCG
ATACTATTGTTCCAATTATTCCTCTGATTGGATCATTGGCTAAAGCGAAATTTTGTA
ACGTATTGGGGCATCCTATTAGTAAGGCGGTTTGGACCGATTTATCAGATTCTGAT
ATTATTGACCGATTTGGGCGTATATGCAGAAATCTTTCTCATTATCATAGTGGATC
CTCACAAAAAAAGAGTTTGTATCGAATAAAGTATATACTT

>LYMOOI014_ITS_5P/ITS_8P
CGTAGGTGAACCTGCGGAAGGATCATTGTCGAAACCTGCACAGCAGAACGACCCG
CGAACACGTTACCATACCGGGTGAGGGACGTGGGGTGCGAAAGTTCCCCAAGTCG
CGAACCCATGGTCGGGGATCGCCCTCGGGTGGTCCTCGACTGAACAACGTCACCC
CGGCGCGGAATGCGCCAAGGAAATCAAACTGAACTGAACGCGTCCCACCCGTTCG
CGGGCTGTGGAGGCGTCTTTTTAAAACACAAACGACTCTCGGCAACGGATATCTCG
GCTCTCGCATCGATGAAGAACGTAGCGAAATGCGATACTTGGTGTGAATTGCAGA
ATCCCGTGAACCATCGAGTCTTTGAACGCAAGTTGCGCCCGAAGCCATTAGGCCG
AGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCCAACCCTGCACTCCCC
TCGTGGGAGTCATGACTGAGGGGCGGATACTGGCCTCCCGTGTCTCACCGCGCGGT
TGGCCCAAATGTGAGTCCTTGGCTACGGGCGTCACGACAAGTGGTGGTTGTAAAA
AGCCCTCTTCTCCTGTCGTGCGGTGGCCCGTCGCCAGCAAAAGCTCATGCGACCCT
GTTGTGCCGTCCTCGACGAGCACTCCGACCGCGACCCCAGGTCAGGCGGGACTAC
CCGCTGAGTTTAAGCATATCAATAAGCGGAGGAAAAGAAACTTACAAGGATTCCC
CTAGTAACGGCGAGCGAACCGGGAATAGCCCAGCTTGAAAATCGGGCGACCTCGT
C

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Epiphyllum oxypetalum LYMOOI 071
>LYMOOI071_rbcLa_F/ rbcLajf634R
AGAGACTAAAGCAAGTGTTGGATTTAAAGCAGGTGTTAAAGATTACAAATTGACT
TATTATACTCCTGAATATCAACCCCAGGATACCGATATCTTGGCAGCATTCCGAGT
AACTCCTCAACCTGGAGTTCCGTCAGAAGAAGCAGGAGCCGCAGTAGCTGCCGAA
TCTTCTACTGGTACGTGGACAACTGTATGGACCGACGGACTTACCAGTCTTGATCG
TTACAAAGGACGGTGCTACCACATCGATGCCGTTCCTGGAGAAGACAATCAATAT
ATTTGTTATGTAGCTTACCCCTTAGACCTTTTTGAAGAAGGTTCTGTCACAAATATG
TTTACTTCCATTGTGGGGAATGTATTTGGGTTCAAAGCCCTGCGTGCTCTACGTTTG
GAGGATTTGCGAATCCCTGTTGCTTATATCAAAACTTTCCAAGGCCCGCCTCACGG
TATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGCCGTCCTCTACTGGGATGC
ACTATTAAGCCGAAATTAGGGTTATCCGCTAAAAACTATGGTCGAGCAGTTTATGA
ATGTCTTCGCGGTGGACTTGATTTCACCAAAGATGACGAAAACGTGAACTCCCAAC
CATTTATGCGTTG

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Pereskia bleo LYMOOI 059
>LYMOOI059_rbcLa_F/ rbcLajf634R
CAGAGACTAAAGCAAGTGTTGGATTTAAAGCAGGTGTTAAAGATTACAAATTGAC
TTATTATACTCCTGAATATCAACCCCAGGATACCGATATCTTGGCAGCATTCCGAG
TAACTCCTCAACCTGGAGTTCCGTCAGAAGAAGCAGGAGCCGCAGTAGCTGCCGA
ATCTTCTACTGGTACATGGACAACTGTATGGACCGACGGACTTACCAGTCTTGATC
GTTACAAAGGACGATGCTACCACATCGATGCCGTTCCTGGAGAAGACAATCAATA
TATTTGTTATGTAGCTTACCCCTTAGACCTTTTTGAAGAAGGTTCTGTTACTAATAT
GTTTACTTCCATTGTGGGTAATGTATTTGGGTTCAAAGCCCTGCGTGCTCTACGTTT
GGAGGATTTGCGAATCCCTGTTTCTTATATAAAAACTTTCCAAGGCCCGCCTCACG
GTATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGCCGTCCTCTACTGGGATG
CACTATTAAGCCGAAATTGGGGTTATCTGCTAAAAACTATGGTCGAGCAGTTTATG
AATGTCTTCGCGGTGGACTTGATTTTACCAAAGATGACGAAAACGTGAACTCCCAA
CCATTTATGCGTTG

>LYMOOI059_matK_390f/matK_1326r
GAGGACAAATTCTTACATTTAAATTATGTGTTAGAAATATTAATACCTTACCCCAT
CCATCTAGAAATCTTGGTTCAAACTCTTCGTTACTGGGTGAAAGATGCTTCTTCTTT
GCATTTATTACGATTCTTTCTTTATGAGTATCGTAATTGGAATAGTCTTATTACTCC
CCAAAAATCCATTTCTATTTTTTCAAAAAGGAATCAACGATTATTCTTGTTCCTATA
TAATTTCCATGTATGTGAATACGAATCCATTTTCGTTTTTCTCTGTAACCAATCCTC
TCATTTACGATCAACATCTTTTGGAGTCCTTCTTGAACGAATCTATTTTTATGGAAA
GCTAGAATATCTAGTAAAAGTTTTTACTTTTACTAAGGATTTTCGCGTTATCTTATG
GCTTTTCAAAGACCCTTTCCTGCATTATGTTAGGTATCGAGGAAAATCAATTCTGG
CTTCAAAAGGGACATCTCTTCTGATGCATAAATGGAAATATTATCTTATAAATTTT
TGGCAATGTCATTTTTCCCTGTGGTCTCAACCAAGAAGAATCTATATCAATCGATT
ATCAAAGCATTCTCTCGACTTTATGGGTTTTTTTTCAAGTGTTCGACTCAATTCTTC
AGTGGTACGGAGTCAAATGGTAGAAAATTCATTTCTAATAGATAATCCTATTAAGA
AATTCGATACCATAGTTCGAATTATTCCTCTGGTTGGATCGTTGGCTAAAGCGAAA
TTTTGTAACGTATTAGGACATCCCATTAGTAAGTCGGTCTGGACCGATTTATTAGA
TTCTGATATTATTGATCGGTTTGGGCGCATATGCAGAAATCTTTCTCATTATTATAG

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Laurentia longiflora LYMOOI 026
>LYMOOI026_rbcLa_F/ rbcLajf634R
AACAGAGACTAAAGCAAATGTTGGATTCAAAGCTGGTGTTAAAGATTATAAATTA
ACTTATTATACTCCTGACTATGAAACCAAGGATACTGATATTTTGGCAGCCTTCCG
AGTAACTCCTCAACCTGGAGTTCCGCCTGAAGAAGCCGGAGCTGCAGTAGCTGCC
GAATCTTCGACTGGTACATGGACAACTGTGTGGACCGATGGACTTACGAGTCTTGA
TCGTTACAAAGGGCGATGCTATCACATCGAGCCCGTTGCCGGAGAAGAAAATCAA
TTTATTGCTTATGTAGCTTACCCATTAGACCTTTTTGAAGAAGGTTCTGTTACTAAC
ATGTTTACTTCCATTGTGGGTAATGTATTTGGATTTAAAGCACTGCGTGCTCTACGT
CTCGAAGATTTGCGAATCCCGCCTGCGTATGTTAAAACTTTCCAGGGCCCGCCTCA
TGGCATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGTCGTCCCCTGTTGGGA
TGTACGATTAAACCTAAATTGGGGTTATCTGCTAAAAACTACGGTAGAGCAGTTTA
TGAATGTCTTCGTGGTGGCCTTGATTTTACCAAAGATGATGAGAACGTGAACTCCC
AACCATTTATGCGTTG

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Lobelia chinensis LYMOOI 023
>LYMOOI023_rbcLa_F/ rbcLajf634R
CCCCAACAGAGACTAAAGCAAGTGTTGGATTCAAAGCGGGTGTTAAAGATTATAA
ATTAACTTATTATACTCCTGATTATGAAACCAAAGATACTGATATTTTGGCAGCCT
TCCGAGTAACTCCTCAACCTGGAGTTCCGCCTGAAGAAGCAGGGGCGGCAGTAGC
TGCCGAATCTTCGACTGGTACATGGACAACTGTGTGGACTGATGGACTTACGAGTC
TTGATCGTTACAAAGGGCGATGCTATCACATCGAGCCCGTTGCCGGAGAAGAAAA
TCAATTTATTGCTTATGTAGCTTACCCATTAGACCTTTTTGAAGAAGGGTCTGTTAC
TAATATGTTTACTTCCATTGTGGGTAATGTATTTGGATTTAAAGCACTGCGTGCTCT
ACGTCTCGAAGATTTGCGAATCCCCGTTTCGTATGTTAAAACGTTCCAGGGCCCGC
CTCATGGTATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGTCGTCCCCTGTTG
GGATGTACGATTAAACCTAAATTGGGGTTATCTGCTAAAAACTACGGCCGAGCAG
TTTATGAATGTCTTCGTGGTGGCCTTGATTTTACCAAAGATGATGAGAACGTGAAC
TCCCAACCATTTATGCGTTG

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Ageratum conyzoides LYMOOI 016
>LYMOOI016_rbcLa_F/ rbcLajf634R
CCCCAACAGAGACTAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGATTATAA
ATTGACTTATTATACTCCTGAATATGAAACCAAGGATACTGATATCTTGGCAGCAT
TTCGAGTAACTCCTCAACCTGGAGTTCCGCCTGAAGAAGCAGGGGCCGCCGTAGC
TGCCGAATCTTCTACTGGTACATGGACAACTGTATGGACCGATGGACTTACGAGCC
TTGATCGTTACAAAGGCCGATGCTATGAAATCGAGCCTGTTCCTGGAGAAGACAA
TCAATATATTGCTTATGTAGCTTATCCATTAGACCTTTTTGAAGAAGGTTCTGTTAC
TAACATGTTTACTTCCATTGTAGGTAATGTATTTGGGTTCAAAGCCCTGCGTGCTTT
ACGTCTGGAAGATTTGAGAATCCCTATTGCGTATATTAAAACTTTCGAGGGTCCGC
CTCACGGTATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGTCGTCCCCTGTTG
GGATGTACTATTAAACCTAAATTGGGGTTATCCGCTAAAAACTACGGTAGAGCTTG
TTATGAATGTCTTCGTGGTGGCCTTGATTTTACTAAAGATGATGAGAACGTAAACT
CCCAACCGTTTATGCGT

>LYMOOI016_ITS_5P/ITS_8P
TTTCCGTAGGTGTAACCTGCGGGAAGGATCATTTGTCGAAACCCTGCATGGCAGAA
CAACCCGTGAAACGTGTATCAAACAAGACGGCTTGGCGGGCCGTCGAAGCTTTTTT
GTTTTCGAGAGCCTCGTTAAGCCTGTCGACGTGCAACCGGGGTGCCTCCTTTTGTC
ACCTCCGGCCGCACGTCGACCCCATTAACAACCCCCGGCACGGAACGTGCCAAGG
AAAACCGAACATAAGAGCGCCCTAGTGGCGATGCCCCGTATTTGGTGGCAACGTT
GCGTGCGGCCGCTTTTATAAATCATAAACGACTCTCGGCAACGGATATCTCGGCTC
ACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGTGAATTGCAGAATCC
CGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCTGAGGCCTCCCGGCTGAGGGC
ACGTCTGCCTGGGCGTCACGCATCACGTCGCCTGCAACAAACGTCCTTGCTTGGAT
TGTGATGTATGCGGGCGGAGACTGGTCTCCCGTGCCCATGGCGCGGCTGGCCTAA
ATACGAGTCCGGTTAAGAGTGACGCACGACTTCTGGTGGTTGACTACGCGGTCGTC
TCGTGTCGTGTGTTTCGATTCTTAAAGGGAAACGCTCTTGAACTACCCTGATGCGC
CGTCTTGTGACGGCCCTTCGATCGCGACCCCAGGTCAGGCGGGACTACCCGCTGAG
TTTAAGCATATCAATAAGCGGAAGGAAAAGAAACTTACAAGGATTCCCTTAGTAA
CGGCAAGCGAACCGGGAAACAGCCCCAGCTTGAAAAATCGG

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Artemisia vulgaris LYMOOI 028
>LYMOOI028_rbcLa_F/ rbcLajf634R
CAACAGAGACTAAAGCAAGTGTTGGATTCAAAGCTGGGGTTAAAGATTATAAATT
GACTTATTATACTCCTGAGTATGAAACCAAGGATACTGATATCTTGGCAGCATTTC
GAGTAACTCCTCAACCTGGAGTTCCGCCTGAAGAAGCAGGGGCCGCAGTAGCTGC
CGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGACTTACGAGCCTTG
ATCGTTACAAAGGGCGATGCTATGGAATTGAGCCTGTTCTTGGAGAAGAGAATCA
ATATATTTGCTATGTAGCTTACCCATTAGACCTTTTTGAAGAAGGTTCTGTTACTAA
CATGTTTACTTCCATTGTAGGTAACGTATTTGGTTTCAAAGCCCTGCGTGCTCTACG
TCTGGAAGATTTGCGAATTCCTACTGCGTATGTTAAAACTTTCCAAGGTCCGCCTC
ACGGTATCCAAGTTGAAAGAGATAAATTGAACAAGTATGGTCGTCCTCTGTTGGG
ATGTACTATTAAACCTAAATTGGGGTTATCCGCTAAAAACTACGGTAGAGCTGTTT
ATGAATGTCTTCGTGGTGGCCTTGATTTTACTAAAGATGATGAGAACGTAAACTCC
CAACCATTTATGCGTTG

>LYMOOI028_matK_390f/matK_1326r
TAGAGGACAACTTTTCACATTTAAATTATGTATTAGATATACTAATACCTTACCCA
GCCCATCTGGAAATCTTGGTTCAGGCTCTTCGCTATTGGATAAAAGATGCTTCCTC
TTTGCATTTATTAAGATTCTTTCTCCATGAGTGTCATAATTGGGATAGTCTTATTAC
TTCAAATTCAAAGAAAGTTAGTTCTTCTTTTTCAAAAAGAAAAAACAGATTATTCT
TCTTCCTATATACTTTTCATGTATGTGAATATGAATCTGGCTTCCTCTTTCTCCGTA
ACCAGTCTTCTCACTTACGATCAACATCTTCTGGAGCCCTTATTGAACGAATAAAT
TTCTATGGAAAAATAGAGCATGTCTTTGTCAGGTCTTTTCAAGCAAATTTATGGTT
GTTCAAAGATCCTTTCATGCATTATGTTAGGTATCAAGGAAAATCCATTCTTGCTTC
AAAAGGGACGTTTCTTTTGATGAATAAATGGAAATATTACTTTGTCAATTTCTGGA
AATATTATTTTTACCTGTGGCCTCAACCAGGAAGGATTTATATAAACCAATTATCC
AATCATTCCCTTGACTTTCTGGGTTATCGTTCAAGTGTGCGGCTAAATCCTTCAACG
GTACGCAGTCAAATGCTAGAAAATGCATTTCTAATCGATAATGCTATTAAGAAGTT
TGATACTCTTGTTCCAATTATGCCTCTGATTGGATCACTGGCTAAATCGAAATTTTG
TAACGCATTGGGGCATCCTATTGGCAAGGCGATTTGGACCGATTTATCAGATTCTG
ATATTATTGAGCGCTTTGGGCGTATATACAGAAATCTTTCTCATTAAATGGATCTTC
AAAAAAAGAGTTGGATCGAGTAA

>LYMOOI028_ITS_5P/ITS_8P
AACAAGGTTTCCGTAGGTGAACCTGCGGAAGGATCATTGTCGAACCCTGCAAAGC
AGAACGACCCGTGAACACGTAAAAACAACCGAGCGTCGGTTGGACCAAGCGCTTG
TTTGGTCCTCTCGACGCTTTGTCGACGCGCGTTCACTTGAGTTCTTTTGGACCTTGT
GAATGCGTCGTTGGCGCATTAACAACCCCCGGCACAATGTGTGCCAAGGAAAACT
AAACTCTAGAAGGCTCGTTTTCATGTTGCCCCCGTTCGCGGTGTGCTCATGGGACG
CGGCTTCTTTATAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATC
GATGAAGAACGTAGCAAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAAC
CATCGAGTTTTTGAACGCAAGTTGCGCCCGAAGCCTTTTGGCCGAGGGCACGTCTG
CCTGGGCGTCACGCATCGCGTCGCCCCCCACAATTCTCCGCAAAGGGAACCTGTGT
TTTGGGGGCGGATATTGGTCTCCCGTGCTCATGGCGTGGTTGGCCGAAATAGGAGT
CCTTTCGACGGACGCACGAACTAGTGGTGGTCGTAAAAACCCTCGTCTTTTGTTTC
GTGCCGTCAGTCGCAAGGGAAACTCTTAGAAAACCCCAACGTGTTGTCTCTTGACG
ACGCTTCGACCGCGACCCCAGGTCAGGCGGGACTACCCGCTGAGTTTAAGCATAT
CAATAAGCGGAGGAAAAGAAACTTACAAGGATTCCCTTAGTAACGGCGAGCGAAC
CGGGAACAGCCCAGCTTGAAAATCGGGCGGCTTCGCTGTCCGAATTGT

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Blumea balsamifera LYMOOI 043
>LYMOOI043_rbcLa_F/ rbcLajf634R
AACAGAGACTAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGATTATAAATTG
ACTTATTATACTCCTGACTATAAAACCAAGGATACTGATATCTTGGCAGCATTTCG
AGTAACTCCTCAACCCGGAGTTCCGCCTGAAGAAGCAGGGGCCGCAGTAGCTGCC
GAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGACTTACGAGCCTTGA
TCGTTACAAAGGGCGATGCTATGGAATCGAGCCTGTTCCTGGAGAAGAGTCTCAA
TTTATTGCTTTTGTAGCTTACCCATTAGACCTTTTTGAAGAAGGTTCTGTTACTAAC
ATGTTTACTTCCATTGTAGGTAATGTATTTGGGTTCAAAGCCCTGCGTGCTCTACGT
CTGGAAGATTTGCGAATCCCTATTTCGTATGTTAAAACTTTCCAAGGTCCGCCTCA
CGGGATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGTCGTCCCCTGTTGGGA
TGTACTATTAAACCTAAATTGGGGTTATCCGCTAAAAACTACGGTAGAGCTGTTTA
TGAATGTCTTCGTGGTGGCCTTGATTTTACTAAAGATGATGAGAACGTGAACTCCC
AACCATTTATGCGTT

>LYMOOI043_matK_390f/matK_1326r
GAGGACAAATTATCACATTTAAATTGTATATCAGATATACTAATACCTTATCCCGT
ACATCTAGAAATCTTGGTTCAAATTCTACAATGCTGGATACAAGATGTTCCTTATT
TACATTTATTACGATTTTTTTTTCACGAATATTATAATTGGAATAATCTCATTACTC
CAAAGAAATCTAACTATTATGGTTTTTCGAAAGAGAATCCAAGACTTTTTTTGTTC
CTATATAATTCTTATGTAGTTGAATGCGAATTCATATTAGTTTTTCTCCGTAAACAA
TCCTCTTATTTACGATCAACATCTTCTGGAACCTTTCTTGAGCGAACACATTTCTAT
GAAAAAATAGAACAACATCTCGTAGTACTTTGTTGTAATGATTTTCAGAAAACCCT
ATGGTTGTTCAAGGATCCTTTCATACATTATGTTAGATATCAAGGAAAATTAATTC
TGGCTTCAAAAGGGACTCATCTTCTGATGAAGAAATGGAAATCTTACTTTGTCAAT
TTTTGGCAATGTCATTTTCACTTTTGGTCTCAACCCAGTAGGATCCACATAAGCCA
ATTCTCAAACTTTTCTTTCTATTTTCTGGGTTATCTTTCAAGTGTCCTAATAAATCCT
TCAGCGGTAAAGAGTCAAATGCTAGAGAGTTCTTTTTTAATAGATACTGTTACTAA
AAAATTCGAAACTATAGTTCCAATTATTCCAATGATTGGATCATTGTCAAAAGCTA
AATTTTGTAACGTATCGGGGAATCCTATTAGTAAGCCAGTTTGGGCCGATTTGTCG
GATTCTGATATTATTGATCGATTTGGTCGGATATGTAGAAATCTTTCTCATTATTAC
AGTGGGTCTTCAAAAAAACAAAGTTTGTATCGAATAAAGTATATACTTCGACT

>LYMOOI043_ITS_5P/ITS_8P
CAAGGTTTCCGTAGGTGAACCTGCGGAAGGATCATTGTCGAAGCCTACAAAACGA
AACGACCCTGTGAACTTGTAACAATAGCGGAGGGTCATAGGGATCGAGCTTGTGT
TCATGACCTATGGCCTTTTGTCAATTTGTCCTTATGGTCGTCTTTTACAAGCGTCCA
TGATGTCAGGTTGACGCAACAACAAACCCCGGCACGGCACGTGCCAAGGATAACT
AAAGTTTAGGAAGGCCTGATGCCATGTTGCCCCGTTTGCGGTGTGCGCATGGGATT
TGGCTTCTTATATAACAAGAAACGACTCTCGGCAACGGATATCTCGGCTCACGCAT
CGATGAAGAACGTAGCAAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAA
CCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAGCCATTCGGTCGAGGGCACATCT
GCCTGGGCGTCACGTCTCGCGTCGCTCCTAAACCATGTCTCCTCAAAAAGGATGTG
CGAGATAGGGGCGGATACTGGTCTCCCGTGCCTATGGTGTGGTTGGCCGAAATTAC
GAGTCTCCTTTTCATGGACACACGGCAAGTGGTGGTTGAGCTGACCTTAGTTTCGT
GTTTGTGTGTTCGTAGATGTATTGGAAGACCTAGCAAAAGTACCCTAGTGCGTCGT
CTTGCGGCGGTGCTTCGACCGCGACCCCAGGTCAGGTGGGACTACCCGCTGAGTTT
AAGCATATCAATAAGCGGAGGAGAAGAAACTTACAAGGATTCCCTTAGTAACGGC
GAGCGAACCGGGAATAGCCCAGCTTGAAAATCGGACAGTTTTGCTGTCTGAATTG
T

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Cosmos sulphureus LYMOOI 075
>LYMOOI075_rbcLa_F/ rbcLajf634R
CAGAGACTAAAGCAAGTGTTGGATTCAAAGCCGGTGTTAAAGATTATAAATTGAC
TTATTATACTCCTGAATATGACCCCAAGGATACTGATATCTTGGCAGCATTTCGAG
TAACTCCTCAACCTGGAGTTCCGCCTGAAGAAGCAGGGGCCGCAGTAGCCGCCGA
ATCTTCTACTGGTACATGGACAACTGTATGGACCGATGGACTTACGAGCCTTGATC
GTTACAAAGGCCGATGCTATGGCATCGAACCTGTTCCTGGAGAAGAAAGTCAATT
TATTGCTTATGTAGCTTACCCATTAGACCTTTTTGAAGAAGGTTCTGTTACTAACAT
GTTTACTTCCATTGTAGGTAATGTATTTGGGTTCAAAGCCCTGCGTGCTCTACGTCT
GGAAGATTTGCGAATTCCTATTGCGTATGTTAAAACTTTCGAAGGTCCGCCTCACG
GTATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGTCGTCCCCTGTTGGGATGT
ACTATTAAACCTAAATTGGGGTTATCCGCTAAAAACTACGGTAGAGCTTGTTATGA
ATGTCTTCGTGGTGGCCTTGATTTTACTAAAGATGATGAGAACGTGAACTCCCAAC
CATTTATGCGTTG

>LYMOOI075_ITS_5P/ITS_8P
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GAACGACTCGTGAACTTGTAAAATCACTCGGCCTTGCTTGGATCGGAGCTTATGCT
TGCAGACTTGTAAGGCCTCGCCGGCCTGTGTTCATGGTCGCCCCTTTGGGTGCCTT
GGATGTCAGGCTAGCACAACTAACAATTCGGCACAACACGTGCCAAGGAAAACAA
AACTTGAAGGGCCCGTGCCACGTCGCCCCGTTTACGGTAAGCGCGTTGTTCGTGGC
CTCTTTGAAACACTAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATG
AAGAACGTAGCAAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATC
GAGTTTTTGAACGCAAGTTGCGCCCGAAGCCTTCTGGCCGAGGGCACGTCTGCCTG
GGCGTCACGCATCACGTCGCCCCCACCAACCATCCTGTCTTGGGACTTGTTGGACT
GGGGCGGAGATTGGTCTCCCGTGCCCATGGCGCGGTTGACCTAAATAGAAGTCCC
CGCATGAGTGACGCACGACTAGTGGTGGTTGATAAGACTGTCGTATCGTGTCGTGC
GCTCGGTTCATGCGGGTAGAACTCTTCAAAGACCCTTACGTGTTGTCCTGTGACGA
CGCTTCGATCGCGACCCCAGGTCAGGCGGGACTACCCGCTGAGTTTAAGCATATCA
ATAAGCGGAGGAAAAGAAACTTACAAGGATTCCCTTAGTAACGGCGAGCGAACCG
GGAACAGCCCAGCTTGAAA

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Elephantopus scaber LYMOOI 074
>LYMOOI074_rbcLa_F/ rbcLajf634R
CAACAGAGACTAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGATTATAAATT
GACTTATTATACTCCTGAGTATGAAACCAAGGATACTGATATCTTGGCAGCATTTC
GAGTAACTCCTCAACCTGGAGTTCCGCCTGAAGAAGCAGGGGCCGCAGTAGCTGC
GGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGACTTACGAGCCTTG
ATCGTTACAAAGGGCGATGCTATGGAATCGAGCCTGTTCCTGGTGAAGAAAGTCA
ATTTATTGCTTATGTAGCTTACCCATTAGACCTTTTTGAAGAAGGTTCTGTTACTAA
CATGTTTACTTCCATTGTAGGTAATGTATTTGGGTTCAAAGCGCTGCGTGCTCTACG
TCTGGAAGATTTGCGAATCCCTATTTCGTATGTTAAAACTTTCCAAGGTCCGCCTC
ACGGCATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGTCGTCCCCTGTTGGG
ATGTACTATTAAACCTAAATTGGGGTTATCCGCTAAAAACTACGGTAGAGCTGTTT
ATGAATGTCTTCGCGGTGGCCTTGATTTTACTAAAGATGATGAGAACGTGAACTCC
CAACCATTTATGCGTTG

>LYMOOI074_ITS_5P/ITS_8P
AAGGTTTCCGTAGGTGAACCTGCGGAAGGATCATTGTCGATGCAATTCAAAACGA
ACCGTGAACACGTATTGAAAATCTTGGGCTAGGTGAGACGGCCTTGTGCTCGTCAA
GCCCATGCCCTGCCAATGGATTTTTATGATGCCTATAAGTAGGCGTCGTAGAAGTC
CTGCCGGCAACGTAACAAACCCCGGCACGGAACGTGCCAAGGAACGTAAAAACTC
AAGAAGGGTGTGGCGTGGCACATTTCGACATCGGACTTGTGCCCGATTCCACTGCC
TTTCAAAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAA
GAACGTAGCAAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGA
GTTTTTGAACGCAAGTTGCGCCCGAAGCCATTCGGTCGAGGGCACGTCTGCCTGGG
CGTCACGCATCGCGTCGCCCCCATCACGGCATGTTGAATCGTCAGCATGCCGTCGG
GGGCGGAGATTGGTCTCCCATGCCTTTGTGTGTGGTTGGCCCAAATTGAAGGCCGC
CTTGATTGGCACATGACTATTGGTGGTTGAAAAGACCTTCGTTTAAAGTCATGCTG
TGAGTCACTGGTAAAATGCCTCATTTAGAACCCTGATGCATCGTGTTTTGATGTCT
CGGACGCGACCCCAGGTCAGGCGGGACTACCCGCTGAGTTTAAGCATATCAATAA
GCGGAGGAAAAGAAACTTACAAGGATTCCCTTAGTAACGGCGAGCGAACCGGGAT
CAGCCCAGCTTGAAAATCGAGCGGCTTTGTCGTTCGAATTGTAGT

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Elephantopus tomentosus LYMOOI 021
>LYMOOI021_rbcLa_F/ rbcLajf634R
CAACAGAGACTAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGATTATAAATT
GACTTATTATACTCCTGAGTATGAAACCAAGGATACTGATATCTTGGCAGCATTTC
GAGTAACTCCTCAACCTGGAGTTCCGCCTGAAGAAGCAGGGGCCGCAGTAGCTGC
GGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGACTTACGAGCCTTG
ATCGTTACAAAGGGCGATGCTATGGAATCGAGCCTGTTCCTGGTGAAGAAAGTCA
ATTTATTGCTTATGTAGCTTACCCATTAGACCTTTTTGAAGAAGGTTCTGTTACTAA
CATGTTTACTTCCATTGTAGGTAATGTATTTGGGTTCAAAGCGCTGCGTGCTCTACG
TCTGGAAGATTTGCGAATCCCTATTTCGTATGTTAAAACTTTCCAAGGTCCGCCTC
ACGGCATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGTCGTCCCCTGTTGGG
ATGTACTATTAAACCTAAATTGGGGTTATCCGCTAAAAACTACGGTAGAGCTGTTT
ATGAATGTCTTCGCGGTGGCCTTGATTTTACTAAAGATGATGAGAACGTGAACTCC
CAACCATTTATGCGTTG

>LYMOOI021_ITS_5P/ITS_8P
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ACGAACCGTGAACACGTATTGAAAATCTTGGGCTAGGTGAGACGGCCTTGTGCTC
GTCAAGCCCATGCCCTGCCAATGGATTTTTATGATGCCTATAAGTAGGCGTCGTAG
AAGTCCTGCCGGCAACGTAACAAACCCCGGCACGGAACGTGCCAAGGAACGTAAA
AACTCAAGAAGGGTGTGGCGTGGCACATTTCGACATCGGACTTGTGCCCGATTCCA
CTGCCTTTCAAAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCG
ATGAAGAACGTAGCAAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACC
ATCGAGTTTTTGAACGCAAGTTGCGCCCGAAGCCATTCGGTCGAGGGCACGTCTGC
CTGGGCGTCACGCATCGCGTCGCCCCCATCACGGCATGTTGAATCGTCAGCATGCC
GTCGGGGGCGGAGATTGGTCTCCCATGCCTTTGTGTGTGGTTGGCCCAAATTGAAG
GCCGCCTTGATTGGCACATGACTATTGGTGGTTGAAAAGACCTTCGTTTAAAGTCA
TGCTGTGAGTCACTGGTAAAATGCCTCATTTAGAACCCTGATGCATCGTGTTTTGA
TGTCTCGGACGCGACCCCAGGTCAGGCGGGACTACCCGCTGAGTTTAAGCATATC
AATAAGCGGAGGAAAAGAAACTTACAAGGATTCCCTTAGTAACGGCGAGCGAACC
GGGATCAGCCCAGCTTGAAAATCGAGCGGCTTTGTCGTTCGAATTGTA

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Mikania cordata LYMOOI 022
>LYMOOI022_rbcLa_F/ rbcLajf634R
CAACAGAGACTAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGATTATAAATT
GACTTATTATACTCCTCAATATGAAACCAAGGATACTGATATCTTGGCAGCATTTC
GAGTAACTCCTCAACCTGGAGTTCCGCCTGAAGAAGCAGGGGCCGCAGTAGCTGC
CGAATCTTCTACTGGTACATGGACAACTGTATGGACCGATGGACTTACGAGCCTTG
ATCGTTACAAAGGCCGATGCTATGGAATCGAGCCTGTTCCTGGAGAAGACAATCA
ATATATTGCTTATGTAGCTTACCCATTAGACCTTTTTGAAGAAGGTTCTGTTACTAA
CATGTTTACTTCCATTGTAGGTAATGTATTTGGGTTCAAAGCCCTGCGTGCTCTACG
TCTGGAAGATTTGCGAATCCCTATTGCGTATGTTAAAACTTTCGAAGGTCCGCCTC
ACGGTATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGTCGTCCCCTGTTGGG
ATGTACTATTAAACCTAAATTGGGGTTATCCGCTAAAAACTACGGTAGAGCTTGTT
ATGAATGTCTTCGTGGTGGCCTTGATTTTACTAAAGATGATGAGAACGTGAACTCC
CAACCGTTTATGCGTT

>LYMOOI022_ITS_5P/ITS_8P
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AGAACAACCTGTGAACATGTAACAACAAAATGGCTTCACTGGGGGTGATGCTTGT
GTTTCAGACCCTGTGAAGCCTTTTCAGCGCGTGTTTGTGGTTGCCTCTTTTGGTCGC
TCATTGACGTCGTGCTGATCTAACAACCCCCCGGCACAACATGTGCCAAGGAAATC
AAATCTCAAGAGGGCGCGTGCTATGACACCCCGTACGTGGTGTGTTCATTGTATGT
TGCCGCTATGTAAAATCTTAAAACAACTCTCGGCAACGGATATCTTGGCTCACGCA
TCGATGAAGAACGTAGCAAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGA
ACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAGGCCACTTGGCTGAGGGCACGTC
TGCCTGGGTGTCACGCATCATGTCGCCCAAATCAAACTTACCTTACGGTACTGTGT
TGCATGTTGGGCGGAGACTGGTCTCCCGTGCCCGTGGCGTGGTTGGCCGAAATACG
AGTCCCTTGACGAGTGACGCATGACTGGTGGTGGTTGATTAGACAGTCGTCCTGTG
TCGTGCGTTTATCACTTTGATGGGAAAAGGCTCTTAAAATACCCTGATGTTTGTTGT
CTTTTGACAAACGTTTGATTGCGACCCCAGGTCAGGCGAGACTACCCGCTGAGTTT
AAGCATATCAATAAGCGGAGGAAAAGAAACTTACAAGGATTCCCTTAGTAACGGC
GAGCGAACCGGGAACAGCCCAGCTTGAAAATCGGACGGCCTAGTCGTTTGAATTG
TA

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Vernonia esculenta LYMOOI 024
>LYMOOI024_rbcLa_F/ rbcLajf634R
CCCAACAGAGACTAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGATTATAAA
TTGACTTATTATACTCCTGAATATGAAACCAAGGATACTGATATCTTGGCAGCATT
TCGAGTAACTCCTCAACCTGGAGTTCCGCCTGAAGAAGCAGGGGCCGCAGTAGCT
GCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGACTTACGAGCCT
TGATCGTTACAAAGGGCGATGCTATGGAATCGAGCCTGTTCCTGGAGAAGAAAAT
CAATATATTGCTTATGTAGCTTACCCATTAGACCTTTTTGAAGAAGGTTCTGTTACT
AACATGTTTACTTCCATTGTAGGTAATGTATTTGGGTTCAAAGCCCTGCGTGCTCTA
CGTCTGGAAGATTTGCGAATCCCTACTGCGTATGTTAAAACTTTCCAAGGTCCGCC
TCACGGCATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGTCGTCCCCTGTTG
GGATGTACTATTAAACCTAAATTGGGGTTATCCGCTAAAAACTACGGTAGAGCTGT
TTATGAATGTCTTCGTGGTGGCCTTGATTTTACTAAAGATGATGAGAACGTGAACT
CCCAACCATTTATGCGTT

>LYMOOI024_ITS_5P/ITS_8P
GGTTTCCGTAGGTGAACCTGCGGAAGGATCATTGTCGATTAAAGCATTTCAGAATA
ACCTGTGAACATGTATTATTATTTGGGTGTTGGGAGGACGGGCTAATGCTCTCACC
CTCTTTGCATCGTGTTGACATACACTTGTATAGCCTCTTTTTGGGTCGTACATGTGT
CTTGTTAGCATTTAAACAAACCCCCGGCACAGAACGTGCCAAGGATGAACAAAAC
ATTAAAAGGGTGCGACTTGTGATGCCCCGTTCGCGGTATGCATTCAGGTCGTGGCT
TTTTTGTAATTACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGA
AGAACGTAGCAAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCG
AGTTTTTGAACGCAAGTTGCGCCCGAAGCCATTTGGTCGAGGGCACGTCTGCCTGG
GCGTCACGCATTGCATCGCCTCCTTCAATGCCTCCTTCCTTAGTAGGCTTGTTGTTC
GGGGCGGAGATTGGTCTCCCATGCTGATGGTGTGGTTGGCCTAAACGTAACTCCCT
TTCGGTGGATACATGACTAGTGGTGGTTGACAAGACCTTCGTTTGGAGTTGTGTGT
CGTTAACCGTAAGGAAAGGTTTGTAAAAATCCCTTAATGAGTCGTCTTATGATGAC
GCTTCGATCGCGACCCCAGGTCAGGCGGGATTACCCGCTGAGTTTAAGCATATCAA
TAAGCGGAGGAAAAGAAACTTACAAGGATTCCCTTAGTAACGGCGAGCGAACCGG
GATCAGCCCAGCTTGAAAATCGGGTGGCCTTGCTGCCTGAATTGT

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Jatropha podagrica LYMOOI 042
>LYMOOI042_rbcLa_F/ rbcLajf634R
AACAGAGACTAAAGCAAGTGTTGGATTTAAGGCTGGTGTTAAAGATTATAAATTG
ACTTATTATACTCCTGAGTATCAAACCAAAGATACTGATATCTTGGCAGCATTCCG
AGTAACTCCTCAACCTGGAGTTCCGCCTGAGGAAGCAGGAGCTGCGGTAGCTGCT
GAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGGCTTACCAGTCTTGA
TCGTTATAAAGGACGATGCTACGACATCGAGCCCGTTGCTGGAGAAGAAAATCAA
TATATTGCTTATGTAGCTTACCCCTTAGACCTTTTTGAAGAAGGTTCTGTTACTAAC
ATGTTTACTTCCATTGTAGGTAATGTATTTGGGTTCAAAGCCCTACGCGCCCTACGT
CTGGAGGATTTGCGAATCCCTACTTCTTATACTAAAACTTTCCAAGGGCCGCCTCA
TGGTATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGTCGCCCCCTATTGGGTT
GTACTATTAAACCTAAATTGGGGCTATCCGCTAAGAATTATGGTAGAGCGGTTTAT
GAATGTCTTCGCGGTGGACTTGATTTTACCAAAGATGATGAGAACGTGAATTCCCA
ACCATTTATGCGT

>LYMOOI042_matK_390f/matK_1326r
AGAGGACAAATTTCCACATTTAATTTATGTGTCAGATGTATTAATACCTTACCCCA
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TTGCATTTATTACGACTCTTTCTTCATGAATATTGGAATAGGAACAGTCTTATTATT
CAAAAGGGATCTATTTCTATTTTTACAAAAAGTAATCCAAGATTTTTCTTGTTCCTA
TATAATTCTCATGTATATGAATACGAATCAATCCTCTTTTTTCTTCGTAACCAATCC
TTTCATTTACGATCAACATTTTCTCGAGTCCTTCTTGAACGAATTTTTTTCTATGGA
AAAATAGAACATTTTGCAGAAGTCTTTGCTAATGATTTTCAGACTATCCTATGGTT
GATCAAGGATCCTTTCATGCATTATGTTAGATATCAAGGAAAATCCATTCTGGCTT
CAAAAGATGGGCCTCTTCTGATGAAAAAATGGAAATATTACCTTGTCAATTTATGT
CAATGTCATTTTTATGTGTGGTTTCAACCAGAAAAGATCTATATAAATTCATTATCC
AAGCATTCTCTCAACCTTTTGGGCTATCTTTCAAATGTAAAATTAAATCCTTCGGTC
GTACGAAGTCAAATGCTAGAAAATTCATTTCTAATAGATAAAGATAATACTATGA
AGAAACTCGATACAATAGTTCCAATTATTCCTTTGATTGGATCATTGTCAAAAACG
AAATTTTGTAAGGCAGTAGGACATCCCATTAGTAAACCGGTCCGGACTGATTCATC
GGATTCTGATATTATCGACCGATTTGTGTGTATATGCAGAAATCTTTCTCATTATTA
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>LYMOOI042_ITS_5P/ITS_8P
TACACTCGAGGGCGACCTCAGGGGCCTCGGCCCCCGGGCGAGCCCTTAAAGGCTG
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GAGCAGGACGCGCCAAGGAAACACGAAACGAGAAGGGCGAGCTCCCGTCGGCCC
CGGAAACGGGCAGCCGCAGGGACGTGCCGTCCTCTGTCTATATAGCCAAAACGAC
TCTCGGCAACGGATATCTCGGCTCTCGCATCGATGAAGAACGCAGCGAAATGCGA
TACTTGGTGTGAATTGCAGAATCCCGCGAACCATCGAGTCTTTGAACGCAAGTTGC
GCCCAAAGCCTTTCGGCCGAGGGCACGCCTGCCTGGGTGTCACGCAACGTCGCCC
CCACCCCATAAGGGGGGGCGGATTCTGGCCTCCCGTGCGCCGGTCGGCCGCGGTT
GGCCCAAAAGCCCGGTTCCCGGCTGCGAACGCCACGACGATCGGTGGTTGCAAGA
CCCTCGGACACGGTCGTGCGCGGACGCGCGCCTCGGAACAGCGAGACCCCGTTCG
CGTCCCTAAGGGCGCGCTACCATCGCGACCCCAGGTCAGGCGGGACTACCCGCTG
AGTTTAAGCATATCAATAAGCGGAGGAAAAGAAACTTACCAGGATTCCCCTAGTA
ACGGCGAGCGAA

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Ricinus communis LYMOOI 027
>LYMOOI027_rbcLa_F/ rbcLajf634R
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GAGTAACTCCTCAACCTGGAGTTCCGCCTGAGGAAGCAGGAGCTGCAGTAGCTGC
TGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGGCTTACCAGTCTTG
ATCGTTATAAAGGACGATGCTACCACATTGAGCCCGTTGCCGGAGAAGAAACTCA
ATTTATTGCTTATGTAGCTTACCCCTTAGACCTTTTTGAAGAAGGTTCTGTTACTAA
CATGTTTACTTCCATTGTGGGTAATGTATTTGGGTTCAAAGCCCTACGCGCCCTAC
GTCTGGAGGATTTGCGAATCCCTCCTGCTTATACAAAAACTTTCCAAGGGCCGCCT
CATGGCATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGTCGCCCTCTATTGG
GTTGTACTATTAAACCTAAATTGGGGCTATCCGCTAAGAATTACGGTAGAGCAGTT
TATGAATGTCTACGCGGTGGACTTGATTTTACCAAAGATGATGAGAACGTGAACTC
CCAACCATTTATGCGTTGGAG

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AGAGGACAAATTTCCACATTTAAATTATGTGTCAGATGTATTAATACCTTACCCCA
TCCATCTAGAAAAATTGGTTCAAATCCTTCGCTATTGGGTGAAAGATCCCTCTTCTT
TGCATTTATTACGACTCTTTCTTCATGAGTATTGGAATTGGAACAGTTTTATTATTC
CAAAGAAATCAATTTCTATTTTTACAAAAAGTAATCCAAGATTTTTCGTGTTCCTAT
ATAATTCTCATGTATATGAATATGAATCCCTCTTCTTTTTTCTCCGTAACCAATCCT
TTCATTTACGATCAACATTTTCTCGAGTACTTCTTGAACGAATTTTTTTCTATGGAA
AAATAGAACATTTTGCGGAAGTCTTTGCTAATGATTTTCAGGCCATCCTATGGTTG
TTCAAGGACCCTTTCATGCATTATGTTAGATATCAAGGAAAATCTGTTTTGGCTTC
AAAAGATGGGCCTCTTCTGATGAAAAAATGGAAATATTACCTTGTCCATTTATGTC
AATGTCATTTTTATGTGTGGTTTCAACCGGAAAAGATCTATATAAATTCATTATCTA
AGCATTCTCTCAACTTTTTGGGCTATCTTTCAAATGTACAATTTAATCCTTCGTTGG
TACGGAGTCAAATGATAGAAAATTCATTTATAATAGATAAAGATAATACTATGAA
GAAACTCGATACAATAGTTCCAATTATTCCTTTAATTAGATCATTGGCAAAAATGA
AATTTTGTAACGCAGCAGGACATCCCATTAGTAAACCGACCTGGGCGGATTCGGC
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TAGCGGATCCTCAAAAAAAACGAATTTGTATCGAATA

>LYMOOI027_ITS_5P/ITS_8P
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GCCCCAGTCCCCCGATGTCGGCGAGAGGGGTGGGGTGGGGCCTTGCCCCCTCATCT
CTGCCGTCGGCCGTACAACCAACCCCGGCGCAGGACGCGCCAAGGAAAATTAAAT
GAAAAGAGCACGCTGCTGTAGGCCTCGGAAACGATGCGCCTTAGGCACGCGTCGC
CCTCTTTCGAGAACCATAACGACTCTCGGCAACGGATATCTCGGCTCTCGCATCGA
TGAAGAACGCAGCAAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAATCA
TCGAGTTTTTGAACGCAAGTTGCGCCCGAAGCCTTTCGGCCGAGGGCACGCCTGCC
TGGGTGTCACGCAATCGTCGCCCCCAACCCTTTCGATACATCGAGAGGGGGGCGG
ATTATGGCCTCCCGTGCGCCTCGTGCATGCGGTTGGCCTAAAAATTGAGTCCCCGG
CGACTATCGCCACGACAATCGGTGGTTGTAAGACTCTCTGAAACTGCCGTGCGCGC
TCGTCTGCCAAGAGGGAACCCTCGAGACCCCGATGCTGCTGTAAAGGGCATGCTC
CAACTGCGACCCCAGGTCAGGCGGGATTACCCGCTGAGTTTAAGCATATCAATAA
GCGGAGGAAAAGAAACTTACCAGGATTCCCCTAGTAACGGCGAGCGAACCGGGA
ATAGCCCAGCTTGAGAATCGGGCGCCCTCGGCGTTCGAATTGTAGTCTGAA

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Senna occidentalis LYMOOI 030
>LYMOOI030_rbcLa_F/ rbcLajf634R
ACAGAGACTAAAGCAAGTGTTGGGTTCAAAGCTGGTGTTAAAGATTATAAATTGA
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GTAACTCCTCAACCTGGAGTTCCGCCTGAAGAAGCAGGTGCCGCGGTAGCTGCTG
AATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGGCTTACCAGTCTTGAT
CGTTACAAAGGACGATGCTACCACATCGAGCCCGTTGCTGGAGAAGAAAATCAAT
ATATTGCTTATGTAGCGTATCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACTAACA
TGTTTACTTCCATTGTGGGTAATGTATTTGGGTTCAAGGCCCTGCGCGCTCTACGTC
TGGAGGATTTGCGAATCCCTACTTCTTATATTAAAACTTTCCAAGGTCCGCCTCAC
GGCATCCAAGTTGAGAGAGATAAATTGAACAAGTACGGCCGTCCCCTATTGGGAT
GTACTATTAAACCTAAATTGGGGTTATCCGCTAAGAATTACGGTAGAGCAGTTTAT
GAATGTCTCCGCGGTGGACTTGATTTTACCAAAGATGATGAGAATGTGAATTCCCA
ACCATTTATGCGTTGG

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GAGGAAAAAGTTCCATATTTAAATTATGTGTCAGATGTACAAATACCCTACCCTAT
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TTCATTTATTAAGGCTTTTTCTTTATGAGTATTTTAATTGGAATAGTTTTATTACTCA
AAAAAAATGGATTTCTACTTTTTCAAAAAAGAATCCAAGATTTTTCCTGTTCCTAT
ATAATTTTTATGTATGTGAATACGAATCTATCTTTCTTTTTCTCCGTAACAAATCTT
CTTATTTACGATTAACATCTTCTGGAATCCTTTTTGAGCGAATCAATTTCTATGCAA
AAATAGAACATTTTGTAGAAGTCTTTGATAAAGATTTTCCGTCCACTCTATGGTTCT
TCAAGGACCCTTTCATTCATTATGCTAGATATCAAGGAAAATCCATTCTGGCTTCA
AGGAATACGCCCTTTTTGATGAATAAATGGAAATACTATCTTATCCATTTTTGGCA
ATGTCATTTTTATGTTTGGTTTCAACCGGAAAAGATCCATCTAAACCAATTATCCG
AGCATTCATTTTACTTTATGGGTTATTTTTCAAATATGCGGCTAAATCCTTCAGTGG
TACGGAGTCAAATGCTGGAAAATTCATTTCTAATTGAAAATGTTATGAAAAGGTTT
GATACAATAATTCCAATTATTCCACTAATTAGATCATTGGCTAAAGCGAAATTTTG
TAATGTATTAGGGCATCCCATTAGTAAGCCGGTCTGGGCCGATTCATCCGATTTGG
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TCCTCAAC

>LYMOOI030_ITS_5P/ITS_8P
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CCCACTTAGTTGCCCGCCTCGTGTCGGGGGTGTGACGGTGGCCTAGTTGCTGCCTC
GCACCCCCGGCAACCCAACAACTATAACCCCGGCGCCGGATGCGCCAAGGAACCA
AAACCAACGTGCGTGGCCTCGGCGAACCGGAGACGGATCTCGCCATGGCCCGTCG
CGAAAACGATGTCTAAAACGACTCTCGGCAACGGATATCTCGGCTCTCGCATCGAT
GAAGAACGTAGCGAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCAT
CGAGTCTTTGAACGCAAGTTGCGCCCGAAGCCACTAGGCCGAGGGCACGTCTGCC
TGGGTGTCACGCATCGTTGCCCCAAACCACGTCGTCCCTCCGGTATGTCGGAGCGG
GCGAGGTGCTTGGGCGGAAGTTGGCCTCCCGTGAGCAATGCCTCGTGGATGGTTG
AAAAAGGAGCCTGTGGGGGGGCGACCGCCACGTTCCACGGTGGATGAGCGCTAGC
CTCGAGACCGAACGTGCGCGAGCTGTCCCTCCGACTAGGCTGCGAGACCCTTGCG
AGCGAGGAATCGCTCCCAACGCGACCCCAGGTCAGGCGGGGCTACCCGCTGAGTT
TAAGCATATCAATAAGCGGAGGAAAAGAAACTAACAAGGATTCCCCTAGTAACGG
CGAGCGAACCGGGAAGAGCCCACCATGAGAATCGGTCGCCCTCGGCGTCCGAATT
G

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Senna tora LYMOOI 010
>LYMOOI010_rbcLa_F/ rbcLajf634R
CCCAACAGAGACTAAAGCAAGTGTTGGGTTCAAAGCTGGTGTTAAAGATTATAAA
TTGACTTATTATACTCCTGACTATGAAACCAAAGATACTGATATCTTGGCAGCATT
CCGAGTAACTCCTCAACCTGGAGTTCCGCCTGAAGAAGCAGGTGCCGCGGTAGCT
GCTGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGGCTTACCAGTCT
TGATCGTTACAAAGGACGATGCTACCACATCGAGCCCGTTACTGGAGAAGAAAAT
CAATATATTGCTTATGTAGCTTATCCCTTAGACCTTTTTGAAGAAGGTTCTGTTACT
AACATGTTTACTTCCATTGTGGGTAATGTATTTGGGTTCAAGGCCCTGCGCGCTCT
ACGTCTGGAGGATTTGCGAATCCCTACTTCTTATACTAAAACTTTCCAAGGTCCGC
CTCACGGCATCCAAGTTGAGAGAGATAAATTGAACAAGTACGGCCGTCCCCTATT
GGGATGTACTATTAAACCTAAATTGGGGTTATCCGCTAAGAATTACGGTAGAGCA
GTTTATGAATGTCTCCGCGGTGGACTTGATTTTACCAAAGATGATGAGAATGTGAA
TTCCCAACCATTTATGCGTT

>LYMOOI010_matK_390f/matK_1326r
TTTCCTTTTTTGGAGGAAAGATTTCCATATTTAAATTATGTGTCAGATGTACGAATA
CCTTACCCTATCCATCTGGAAATCTTGGTTCAAACCCTTCGATACTGGGTGAAAGA
TGCCTCTTCTTTTCATTTATTAAGGTTCTTTCTTTATGAGTATTTTAATTGGAATAGT
CTTATTATTCCAAAAAAATGGATTTCTACTTTTTCAAAAAGGAATCCAAGATTATT
CCTGTTCCTATATAATTTTTATGTATGTGAATACGAATCTATCTTTCTTTTTCTCCGT
AACAAATCTTCTTATTTACGATTAACATCTTCTAGAGTCCTTTTTGAGCGAATTTAT
TTCTATGCAAAAATAGAACATTTTGTAGAAGTCTTTGATAAAGATTTTCGGTCCAC
CCTATGGTTCTTCAAGGACCCTTTCATTCATTATGTTAGATATCAAGGAAAATCCA
TTCTGGCTTCAAAGAATACGCCCTTTTTGATGAATAAATGGAAATACTATCTTATC
CATTTATGGCAATGTCATTTTTATGTTTGGTCTCAACCAGAAAAGATCCATATAAA
CCAATTATCTGAGCATTCATTTTACTTTTTTGGCTATTTTTCAAATGTGCGGCTAAA
TCCTTCAGTGGTACGGAGTCAAATGCTGGAAAATTCATTTCTAATTGAAAATGTTA
TGAAAAGGCTTGATATAATAATTCCAATTATTCCACTAATTAGATCATTGGCTAAA
ACGAAATTTTGTAATGTATTAGGGCATCCCATTAGTAAGCCGGTCTGGGCCGATTC
ATCCGATTTGGATATTATTGACCGATTTTTGCGGAGATGCAGAAATCTTTCTCATTA
TTACAATGGATCCTCAACAAAAAAGAGTTTGTATCGAATAAAATATATACTTCG

>LYMOOI010_ITS_5P/ITS_8P
AACAAGGTTTCCGTAGGTGAACCTGCGGAAGGATCATTGTCGTTGCCTCACAAAC
GGGACCACTCGCGAATTGGTTGAAACACTCCCGAGGTGGTAGACGAGCGGCGTGC
GTCGCCCTGAGTCCCCCGCTCGGTGCCCGGGTGCTAACTATAGCTTCGGGCAACCC
CAATAAAAACCCCGGCGCTGGTTGCGCCAAGGAAATGAAACTTACGTGTGTGGCC
TCGGCGAACCGGAGACGGTTCTTGTCCGGGGCCGTGACGAAAATGAAATTAAAAA
TGACTCTCGGCAACGGATATCTCGGCTCTCGCATCGATGAAGAACGTAGCGAAAT
GCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTCTTTGAACGCAAG
TTGCGCCCGAAGCCACTAGGCCGAGGGCACGTCTGCCTGGGTGTCACGCATCGTA
GCCCCAAGCCACGTCCACCCCCCGATTGATCAGGGGCGACGAGGTGCTTGGGGGG
AATTTGGCCTCCCGTGATCCGTGCATTGCGGATGGCCGAAAAAGGAGCCTGTGCG
GGGCAATCGCCACGTTCCACGGTGGATGAGCAGATGCCTCGAGACCGACCTTGTG
TTGGTTGTCCCTACGGATGGGCTGTCAGACCCTTTGGGAGCGACGAAGCTTTCCCG
AAGCGACCCCAGGTCAGGCGGGGCTACCCGCTGAGTTTAAGCATATCAATAAGCG
GAGGAAAAGAAACTAACAAGGATTCCCCTAGTAACGGCGAGCGAACCGGGAATA
GCCCACCATGAGAATCGGCCGCCCTCGGCGTCTGAATTGTA

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Malpighia coccigera LYMOOI 052
>LYMOOI052_rbcLa_F/ rbcLajf634R
AACAGAGACTAAAGCAAGTGTTGGATTCAAGGCTGGTGTTAAAGATTATAAATTG
ACTTATTATACTCCTGACTATGAAACCAAAGATACTGATATCTTGGCAGCATTCCG
AGTAACTCCTCAACCTGGAGTTCCGCCTGAGGAAGCAGGTGCTGCGGTAGCTGCT
GAATCTTCTACTGGTACATGGACAGCTGTGTGGACCGATGGGCTTACCAGTCTTGA
TCGTTATAAAGGGCGATGCTACCACATCGAGCCCGTTGCTGGAGAAGAAAGTCAA
TTTATTGCTTATGTAGCTTACCCCTTAGACCTTTTTGAAGAAGGTTCTGTTACTAAC
ATGTTTACTTCCATTGTGGGTAATGTATTTGGGTTCAAAGCCCTACGCGCTCTCCGT
CTGGAGGATTTGCGAATCCCTACTGCTTATACGAAAACTTTCCAAGGCCCGCCTCA
TGGTATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGTCGCCCCCTATTGGGCT
GTACTATTAAACCTAAATTGGGGTTATCCGCTAAGAATTACGGTAGAGCTGTTTAT
GAATGTCTACGCGGTGGACTTGATTTTACCAAAGACGACGAGAACGTGAACTCCC
AACCATTTATGCGTT

>LYMOOI052_matK_390f/matK_1326r
CATTTAAATTATGTGTCTGATCCACTAATACCTTACCCCATCCATCTAGAAAAATT
GGTTCAAATCCTTCGTTACTGGATGCAAGATCCCTCTTCTTTGCATTTATTACGACT
CTTTCTTCACGAGTATTGGAATTGGAATAGTTTTATTATTTCAACGAAATCCATTTC
CATTTTTTTTAATTTAAAAAGGAATCTAAGATTATTGTTGTTCCTATATAATTCTCA
TGTATATGAATACGAATCCATCTTCTTTTTTCTCCGTAACCAATCCTTTTATTTCCG
ATCAACATTTTCGCGGGTGCTTCTTGAACGAATATATTTCTATGGAAAAATACAAG
ATTTTGTAGAACTTTTTACTAATGATTTTAAGGCTAACCTACGGTTCTTCAAGGATC
CTTTCATGCATTATGTTAGATATCAAGGAAAAGGCATTCTGGCTTCAAAAAGTACA
CTTCTTCTGATGAAAAAATGGAAATATTTCTTTGTCAATTTATGTCAATTTCATTTT
TATGTGTGGTTTCATCCAGAATCGATCTATATGAAGTCATTATCCAACCATTCTCTT
GACTTTTTGGGTTATCTTTCAAGTATACGAAAAAATCTTTCAGTGGTACGGAGTCA
AATGCTAGAAAATTCATTTCTAATAGATAATATTAGAAAGAAACTTGATTCAAGA
GTTCCAATTATTCCTTTGATTGGATCATTGTCAAAAACAAAATTTTGTAACGCAGT
AGGGCATCCCATTAGTAAACCGAGCTGGGCGGATTCACCCGATTCTGATATTATCG
ACCAATTTTTGCGTATATCCAGAAATCTTTCTCGTTACTATAGC

>LYMOOI052_ITS_5P/ITS_8P
CAAGGTTTCCGTAGGTGAACCTGCGGAAGGATCATTGTCGAAACCTGCCCAGCAG
AACGACCTGCGAATCGTTGTCAAAACGCGTCGGGAAGTGTGCAGGGTAGAAGGCC
CTGCAAACTCTCTCGATGCCCCCTGTTCGGTGATGTCCGCGTTCGCGGTCTCGCCGT
CGACAGGAACAACATCCACCCCCGGCGCAGAACGCGCCAAGGAAAACAAACGTA
GGAGGAACGTTCGGATGCTCCCGAACACGGACAGCATCCGGGTGTTTCCGACTGA
AGTCGAAAAGAACGACTCTCGGCAACGGATATCTCGGCTCTCGCATCGATGAAGA
ACGTAGCAAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGT
CTTTGAACGCAAGTTGCGCCCGAAGCCTTTCGGTTGAGGGCACGTCTGCCTGGGTG
TCACACAACGTCGTCCCCAAACCCAACGCTCTCTCTTAAGGGAGACGTCGGGAGG
GACGGAGACTGGTCTCCCGTGGCGATACACCGCGGTTGGCCGAATCTCGAGTCCG
GGCACGAAAAGCCATAACAACCGGTGGTTGGAAGATCCTCGATCGATTTGTTGTG
GTGCATTCGATGCTTGTAACCGGGCCAAGGACCCACGCGCTCGGCGCCTTCGATCG
CGACCCCAGGTCAGGCGGGACTACCCGCTGAGTTTAAGCATATCAATAAGCGGAG
GAAAAGAAACTTACCAGGATTCCCCTAGTAACGGCGAGCGAACCGGGAAGCGCCC
AGCTTGATAATCGAGCGCTTTTGGCGTTCGAATTGTA

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Melia azedarach LYMOOI 002
>LYMOOI002_rbcLa_F/ rbcLajf634R
AACAGAGACTAAAGCAAGTGTTGGATTCAAAGCCGGTGTTAAAGATTATAAATTG
ACTTATTATACTCCTGACTATGTAACCAAAGATACTGATATCTTGGCAGCATTCCG
AGTAACTCCTCAACCAGGAGTTCCGCCCGAGGAAGCAGGGGCTGCGGTAGCTGCG
GAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGGCTTACTAGCCTTGA
TCGTTACAAAGGACGATGCTACAACATTGAGCCCGTTGCTGGAGAAGAAAATCAA
TATATATGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACTAAC
ATGTTTACGTCCATTGTGGGTAATGTATTTGGGTTCAAAGCCCTGCGTGCTCTACGT
CTAGAGGATCTACGAATCCCTCCCGCGTATTCTAAAACTTTCCAAGGACCACCTCA
TGGGATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGCCGTCCTCTATTGGGA
TGTACTATTAAACCTAAATTGGGGTTATCCGCTAAGAATTACGGTAGAGCTGTTTA
TGAATGTCTACGCGGTGGACTTGACTTTACCAAAGATGATGAGAACGTGAATTCCC
AACCATTTATGC

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Toona sinensis LYMOOI 047
>LYMOOI047_rbcLa_F/ rbcLajf634R
ACAGAGACTAAAGCAAGTGTTGGATTCAAAGCCGGTGTTAAAGATTATAAATTGA
CTTATTATACTCCTGACTATGTAACCAAAGATACTGATATCTTGGCAGCATTCCGA
GTAACTCCTCAACCCGGAGTCCCGCCCGAGGAAGCAGGGGCTGCGGTAGCTGCGG
AATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGGCTTACTAGCCTTGAT
CGTTACAAAGGACGATGCTACAACATTGAGCCAGTTGCTGGAGAAGAAAATCAAT
ATATATGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACTAACA
TGTTTACGTCCATTGTGGGTAATGTATTTGGGTTCAAAGCCCTGCGCGCTCTACGTC
TAGAGGATCTACGAATCCCTCCCGCGTATTCTAAAACTTTCCAAGGCCCGCCTCAT
GGCATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGTCGTCCCCTATTGGGAT
GTACTATTAAACCTAAATTGGGGTTATCCGCTAAGAATTACGGTAGAGCTGTTTAT
GAATGTCTACGCGGTGGACTTGACTTTACCAAAGATGATGAGAACGTGAACTCCC
AACCATTTATGCGTT

>LYMOOI047_ ITS_5P/ITS_8P
TAACAAGGTTTCCGTAGGTGAACCTGCGGAAGGATCATTGTCGAAACCTGCCCAG
CAGAACGACCCGCGAACCCGTGAACGCGCACGCGGGGGCGAGCGCCCGGCGCCA
GCCCCCGCCCGCCGCGGGGGGCGAGCAACGTCTCGCCCGCCTCGGCGAAACAACG
AACCCCGGCGCGAGCTGCGCCAAGGAAAATCAAACGAGGGAGCGCGCTCCCGCC
GCCCCGGACACGGAGCGCGAGCGGGATGCGTCGCCTTCTTTCAACGAAAATCCAA
AACGACTCTCGGCAACGGATATCTCGGCTCTCGCATCGATGAAGAACGTAGCGAA
ATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTCTTTGAACGCA
AGTTGCGCCCCAAGCCGTCAGGCCGAGGGCACGTCTGCCTGGGTGTCACGCATCG
CTGCCCCTCCCACAGCCACCCCGCCTCGCGGGGCGCTGTCGGGCGGGCGGAGACT
GGCCTCCCGCGCGCTCCCCGCTCGCGGTTGGCCCAAATTAGAGTCTTCGGCGGCCG
CGCCGCGACGATCGGTGGCGAGAAAGAAAGAAAAACTCTCGAGCTCCCGTCGCGC
GCTCGCGCCTCCGAGTTCACGGCTCGCGGACCCTTTGCGCGCCCCGTACGCGGGCG
CTCGCTTCGCGACCCCAGGTCAGGCGGGACTACCCGCTGAGTTTAAGCATATCAAT
AAGCGGAGGAAAAGAAACTTACCAGGATTCCCCTAGTAACGGCGAGCGAACCGG
GAAGAGCCCAGCTTGAAAATCGGGCGTCCGCGACGTCCGAATTGTAG

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Morus alba LYMOOI 050
>LYMOOI050_rbcLa_F/ rbcLajf634R
AGAGACTAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGATTATAAATTGACT
TATTACACTCCTGAATATGAAGTCAAAGATACTGATATCTTGGCAGCATTTCGAGT
AACTCCTCAACCTGGAGTTCCCCCTGAAGAAGCAGGGGCTGCGGTAGCTGCTGAA
TCTTCTACTGGTACATGGACAACTGTATGGACTGACGGGCTTACCAGTCTTGATCG
CTACAAAGGTCGATGCTACAACATCGAGCCCGTTGCTGGAGAAGAAAGTCAATTT
ATTGCTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACTAACATG
TTTACTTCCATTGTGGGTAATGTATTTGGGTTCAAGGCCCTGCGTGCTCTACGTCTG
GAAGATTTGCGAATCCCTAATGCTTATATTAAAACTTTCCAAGGACCACCTCATGG
TATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGCCGCCCACTATTGGGATGT
ACTATTAAACCTAAATTGGGGTTATCCGCTAAGAATTACGGTAGAGCAGTTTATGA
ATGTCTTCGCGGTGGACTTGATTTTACCAAAGATGATGAGAACGTGAATTCCCAAC
CCTTTATGCGTT

>LYMOOI050_matK_390f/matK_1326r
TCTTAGTTCAAACCCTTCGCTACTGGGTAAAAGATGCCTCCTCTTTGCATTTATTAC
GGTTTTTTCTTCACGACTATTATAATTGGAATACTCTTATTATTCCAAATAAATATA
TTTCTATTTTTTCAAAAAGTAATCCAAGATTATTCTTGTTCCTATATAATTCTCATG
TTTGCGAATACGAATCCATCTTACTCTTTCTACGTAACCAATCTTCTCATTTACGAT
TAACATCTTCTGGGGGTTTTTTTGAGCGAATATATTTCTATGGAAAAATAAAACAT
CCCGTAGAAGAAGTCTTTGCTAATGATTCTCCGACTAGCTTATGGTTCCTCGAGGA
TCTCTTCATGCATTATGTTAGATATCAAGGAAAATCAATTCTGGCTTCAAAGGATA
CGCCTCTTTTCATGAATAAATGGAAATATTACCTTGTCCTTTTATGGCAATGTCATT
TTTATGTGTGGTCTCAACCAGGAAGGATGTATATAAACCAATTATGCAAACATTCC
TTCAGCTTTTTGGGCTATCTTTCAAGTATGCAAATAAATCTTTCAGTAGTACGGAGT
CAAATGCTAGAAAATTCGTTTCTAATGGATAATGCTATGAAGAAGATTGATACATT
AGTTCCAATTAGTCTTCTGATTGGATCGTTGGATAAAATGAAATTTTGTAACGTAT
TAGGACATCCCGTTAGTAAGTCGACCTGGGCCGATTCGTCGGATTTTGATATTATC
GACCGATTTGTGTGTATATGCAGAAATCTTTTTCATTATTACAGTGGATCCTC

>LYMOOI050_ITS_5P/ITS_8P
AACAAGGTTTCCGTAGGTGAACCTGCGGAAGGATCATTGTCGAAACCTGCAAAGC
AGAAAGACCAGCGGACCCATTACAACACCCAGGGGTGACCCCAACCCCTGACGCT
GAGTGTGTGCAGCCCTGCCTTGCGCCCTCAGCATAAAACGAACCCAGGCGCGGAA
CGCGTCAAGGAATCATAACGAAACGAGCTCCTGCCGTGGCCCCGGGGACGGTGAT
CGCCGCAGCAGCTGTGTTGTGCTTGGTTAAGTCTAAAATGACTCTCGGCAACGGAT
ATCTCGGCTCTCGCATCGATGAAGAACGTAGCGAAATGCGATACTTGGTGTGAATT
GCAGAATCCCGTGAACCATCGAGTCTTTGAACGCAAGTTGCGCCTGAAGCCATCA
GGCTGAGGGCACGTCTGCCTGGGCGTCAAACACCGATGCCCCCCCCAAATCCCCTC
GTCACTCTCCCCTGAGTGCCCGGGGAGTGTGGGGGTCGGATGATGGCCTCCCGTGT
CTTGGCTCGCGGTTGGCCCAAAGTCGAGTCCTCGGTCACGGTTACCGTGGTGACAG
GTGGTTGTCGGTCGCTCGGTACCCCGTCACGTGCGCCGGACACGAATCGAGACTCT
CTTGATTACCCCAACGCATCCCCGTTTGGGTGCCTCTGATGTGACCCCAGGTCAGG
CGGGGCTACCCGCTGAGTTTAAGCATATCAATAAGCGGAGGAAAAGAAACTTACG
AGGATTCCCCTAGTAACGGCGAGCGAACCGGGAAAAGCCCAGGTTGAGAATCGAT
CGCC

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Sauropus spatulifolius LYMOOI 054
>LYMOOI054_rbcLa_F/ rbcLajf634R
ACAGAGACTAAAGCAAGTGTTGGATTCAAGGCTGGTGTTAAAGAGTATAAATTGA
CTTATTATACTCCTGACTATGAAACCAAAGATACTGATATCTTAGCAGCATTCCGA
GTAACTCCTCAACCTGGAGTTCCGCCTGAGGAAGCGGGGGCTGCGGTAGCTGCTG
AATCTTCTACTGGTACATGGACAACTGTGTGGACCGACGGACTTACCAGTCTTGAT
CGTTATAAAGGACGATGCTACCACATCGAGCCCGTTGCTGGAGAAGAAAATCAAT
ATATTGCTTATGTAGCTTATCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACTAATA
TGTTTACTTCCATTGTGGGTAATGTATTTGGGTTCAAAGCCTTACGCGCTCTGCGTC
TGGAAGATTTGCGAATCCCTCCTGCTTATTCTAAAACTTTCCAAGGCCCGCCTCAT
GGCATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGCCGCCCTCTATTAGGCT
GTACTATTAAACCGAAATTGGGGTTATCCGCTAAGAATTACGGTAGAGCTGTTTAT
GAATGTCTTCGCGGTGGACTTGATTTTACCAAAGACGATGAAAACGTAAACTCCCA
ACCATTTATGCGTT

>LYMOOI054_matK_390f/matK_1326r
AGAGGACAAATTTTCCCATTTAACTTATGTATCAGATGTACAAATATCTTACCCCA
TCCATCTAGAAAAATTGGTTCAAACTCTTCGCTACTGGGTCAAAGATACTTCTTCTT
TGCATTTATTACGGTTTTTTCTTCACGAGTATTGGAATTGGAACAGTCTTAGTTTTC
CAAATAATTTGATTTCTTTTTTTGCAAAAAGGAATCCACGATTATTCTTGTTTCTAT
ATAATTCTCATGTATATGAATATGAATCCATTTTCTTTTTTCTCCGTAAGCAATCCT
TTCATTTACGATCAACATTTTTTCGGGTCCTTCTTGAACGAATATATTTTTATGGAA
AAATAGAACATTTTGCAGAAGTCTTTGCTAATGATTTTCAGGCCATTCTATGGTTG
TACAAAGATCCTTTCATGCATTATGTTAGATATCAAGGAAAGTCAATCTTGGCTTC
AAAGGATACCCCTCTTCTATTAAAAAAATGGAAAAATTACCTTGTCAATTTATGTC
AATGTCATTTTTCTGTGTGGTTTCAACCAGCAAAGATCTGGATAAAGCCATTATCG
AAGCAGTCCCTCGACTTTTTGGGCTATCTTTCAAGTCTACGACTCAATCTTTCAGTG
GTACGGAGTCAAATGCTAGAAAATACCTTTTTAATAGATAATGCTATGAAGAAAG
TTGATACAAAAATTCCAATTATTCCTTTGATTCGATCATTGGCAAAAACGAAATTT
TGTAACGCAGCAGGACATCCTATTAGTCAACCTATTTGGGCTGGTTCATCGGATTC
TTATATTATCAACCGATTTGTGCGCATATGCAGAAATCTTTCTCATTATTATAGTGG
GTCTTC

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Peperomia pellucida LYMOOI 051
>LYMOOI 051_rbcLa_F/ rbcLajf634R
CAACAGAGACTAAAGCTTATGTTGGATTCAAAGCTGGTGTTAAAGATTACAAATT
AACTTATTATACTCCTGAGTATGAAACCAAAGATACTGATATCTTGGCAGCATTCC
GAGTAACTCCGCAACCAGGGGTTCCGCCCGAGGAAGCAGGGGCTGCAGTAGCTGC
CGAATCTTCTACTGGTACATGGACGACCGTATGGACCGACGGACTTACTAGCCTTG
ATCGTTACAAAGGGCGGTGCTACCACATTGAGCCTGTTGCTGGGGAAGAAAATCA
ATATATTTGCTATGTAGCTTATCCTTTAGACCTTTTTGAAGAAGGTTCCGTTACTAA
CATGTTTACTTCCATTGTGGGTAATGTATTTGGATTCAAAGCCCTACGAGCTTTACG
TCTGGAAGATCTACGAATTCCTCCTGCTTATTCCAAAACTTTTCAAGGCCCACCCC
ATGGAATCCAAGTTGAAAGAGATAAATTGAACAAGTATGGTCGTCCTCTATTGGG
ATGTACTATTAAACCAAAGTTGGGGTTATCGGCTAAGAACTACGGTAGGGCGGTTT
ATGAATGTCTCCGCGGTGGCCTTGATTTCACCAAGGATGATGAAAATGTGAACTCC
CAACCATTTATGCGTTG

>LYMOOI051_ITS_5P/ITS_8P
TAACAAGGTTTCCGTAGGTGAACCTGCGGAAGGATCATTGTCGATACCTAACAAA
AACAGCCCAGACCCAGCGAACATGTTAAACCACAGCGCCGACGGCCGCTAACCCG
GTCCCGACGCGCACAAAAACAATCCCGGCGCAGCAAGCGCCAAGTAAGTTGCATA
CGACCGCACACGCACCTCCCCGCTCGGGGAGGACGCGGGTGCGTCGAAACACGTA
CAATAAGTCAATATGACTCTCGGCAACGGATATCTCGGCTCTCGCATCGATGAAGA
ACGCAGCAAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAATCATCGAGT
CTTTGAACGCAAGTTGCGCCCGAGGCCCTACGGCCGAGGGCACATCTGCTTGGGC
GTCGACAGTGGTTGGGGCGCGGTGTTGATTAGCAGGTCAACCCGCGCCCGTGCAC
GTTGGTCGTCCGTGCGCCGTATGTAGCGCGCGGTTGGCTGAAATTGATCGGGTGCG
AGGCGTTGGAGCCCCAACAAGTCGGTGGTTGTGAAGGCCGCAAGGCCGCGATTGT
CGGAAAGTTGCGAAGCTCCACCACCCCGCCGCCCCATTAGTACCCCGACGTGCAT
GCCATGCGTGCATGCACATGGATCCCGACCCCAAGTCAGGTGGGACTACCCGCTG
AGCTTAAGCATATCAATAAGCGGAGGAAAAGAAACTTACAAGGATTCCCCTAGTA
ACGGCGAGCGAACCGGGAACAGCCCAGCTTGAAAATCGTGCGACCACGTCGTTCG
AATTGTAGTCT

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Piper sarmentosum LYMOOI 044
>LYMOOI044_rbcLa_F/ rbcLajf634R
AACAGAGACTAAAGCTTACGTTGGATTCAAGGCTGGTGTTAAAGATTACAAATTA
ACTTATTATACTCCTGAGTATGAAACCAAAGATACTGATATCCTGGCAGCATTCCG
AGTAACTCCGCAACCCGGAGTTCCGCCCGAAGAAGCAGGGGCTGCAGTAGCTGCC
GAATCCTCTACTGGTACATGGACAACTGTATGGACCGACGGACTTACCAGCCTTGA
TCGTTACAAAGGACGATGCTACCACATCGAGCCCGTTGCTGGGGAGGAAAATCAA
TATATTTGCTATGTAGCTTATCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACTAAC
ATGTTTACTTCCATTGTGGGTAATGTATTTGGCTTCAAAGCCCTACGAGCCCTACGT
CTGGAAGATCTACGAATTCCTCCTGCTTATTCCAAAACTTTCCAAGGCCCACCCCA
TGGAATCCAAGTTGAAAGAGATAAATTGAACAAGTATGGTCGTCCTTTATTGGGAT
GTACTATTAAACCAAAGTTGGGGTTATCGGCTAAGAACTACGGTAGGGCGGTTTAT
GAATGTCTCCGCGGTGGCCTTGATTTCACCAAGGATGATGAAAATGTGAACTCCCA
ACCATTTATGCGTT

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Persicaria chinensis LYMOOI 037
>LYMOOI037_rbcLa_F/ rbcLajf634R
AACAGAGACTAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGAATATAAATTG
ACTTATTATACTCCTGACTATGAACCTCATGACCATGATATCTTGGCAGCATTTCG
AGTAACTCCTCAACCTGGAGTTCCACCAGAAGAAGCAGGGGCCGCGGTAGCTGCC
GAATCTTCGACTGGTACATGGACAGCTGTGTGGACCGATGGACTTACCAGCCTTGA
TCGTTACAAAGGACGATGCTACAACATCGAGCCTGTTCCTGGAGAAGAAAGTCAA
TTTATTGCTTATGTAGCTTACCCATTAGACCTTTTTGAAGAAGGTTCTGTTACTAAC
ATGCTTACTTCCATTGTGGGTAATGTATTTGGGTTCAAAGCCCTGCGTGCTCTACGT
TTGGAGGATTTGCGAATCCCTCCTGCTTATACTAAAACTTTCCAAGGCCCGCCTCA
TGGTATCCAAGTTGAGAGAGATAAATTGAACAAATACGGACGTCCCCTATTGGGA
TGTACTATTAAACCTAAATTGGGGTTGTCCGCTAAGAACTACGGTCGAGCAGTTTA
TGAGTGTCTTCGCGGCGGGCTTGATTTTACCAAAGATGATGAAAACGTGAACTCCC
AACCATTTATGCGTT

>LYMOOI037_matK_390f/matK_1326r
GAGGACAAATTTTCACGTTTAACTTATGTGTTAGATATATTGATACCTCACCCTATC
CATTTTGAAATCTTGGTTCAAACTATTCGTTACTGGATAAAAGATACTTCCTGTTTG
CATTTATTGCGCTTTTTTCTTTATGAGTATTGTAATAGTGTTATTACTCTAAAGAGA
TCTGTTTCAAAAAAAAAAGAATAAAAGATTCTTATTGTTCCTATACAATTCCCATGT
GTGTGAATGCGAATCCATCTTCGTTTTTCTCCGGAACCAATCTTCTCATTTACGATC
AACATCTTACGGAACCTTTCTTGCGAGAGTATATTTCTACCGAAAGTTAGAACATT
TTGTAAGGGTATTTACTAAGTATTTTCGGGTTATCCTTTGGGTCTTCAAGGATCCTT
TTCTGCATTATGTTAGGTATCAAGGAAAATGGATTCTGGCTTCAAGAGGCACATTT
CTTATGATGATTAAACTAAAATATTACCTTGTCAATTTCTGGCAATGTACTTTTTCT
CTGTGGTTGCAACCAAGAAGAATCTATATCAATCAATCATCAAATCAGCCTGTTGA
CTTTATGGGTTTTCTTTTAAGTGTGCGACTAAATACACGCGTGGTACGAAGTCAAA
TGTTAGAAAATGCATTCTTAATAGATAATGGTATAAAGAAGTTTGAGACCCTAGTT
CCACCTCTAGTTGTATCATTGGCTAAAGCGAAATTTTGTAACGTATTAGGACATCC
CATTAGTAAACCGGCCTGGGCGGATTTTTCGGATTCTGATATTATTCGCCGATTTG
GGCGTATGTGTAGAAACCTTTCTCATTATTACAGCGGATCCTCAAAAA

>LYMOOI037_ITS_5P/ITS_8P
ACAAGGTTTCCGTAGGTGAACCTGCGGAAGGATCATTGTCGAAACCTGCACTAGC
AGAAAGACCCGCGAACCCGTTTAAAACACAAGGGGGGCAGCGTTCGGCCTTAGGC
CAGCGATGCCCCTCGAGTCCGGGGAGAGCCCCCCTCATCGCGAGCTGGGTTCTTCC
CCGGCACAAACGAACCCCGGCGCGGATTGCGCCAAGGACCATGAACAATAGCGCG
TCCCACGTCACTCGGTTAGCCCGAAGTGTGCGTGGGACGACGTGTCGTTTCGATTT
ACTTGAACGACTCTCGGCAACGGATATCTCGGCTCTCGCATCGATGAAGAACGTA
GCGAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTCTTTGA
ACGCAAGTTGCGCCCAAAGCCTTCGGGCCAAGGGCACGTCTGCCTGGGCGTCACG
CACCGCGTCGCCCCCCTCCCCCATACAATGGGAGTGGTGGGGCGGATTCTGGCCCC
CCGTGCGCTGCCCGCTCGCGGTCGGCCTAAATAAAGACCCCGTGGCCGCGAAATG
CCGCGACGATTGGTGGTGTCCTTGTGGCCTCGTGCCTCGAGCATCGCGTCGCGCCT
TTGGCGGCCCATGGTAGGTCAAAGGACCCTGAAGGAGACCCCCATCGGCGTCGTC
CATCAATGTGTGGATGCCGATGGGATCCCCTAACCGTTGCGACCCCAGGTCAGGC
GGGACTACCCGCTGAGTTTAAGCATATCAATAAGCGGAGGAAAAGAAACTTACAA
GGATTCCCCTAGTAACGGCGAGCGAACCGGGAAGAGCCCAGCTTTAGAATCGGTC
GACTTCGTTGTCCGAATTGTAG

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Brucea javanica LYMOOI 020
>LYMOOI020_rbcLa_F/ rbcLajf634R
GACTAAAGCAAGTGTTGGATTCAAAGCCGGTGTTAAAGATTATAAATTGACTTATT
ATACTCCTGAATATGTAACCAAAGATACTGATATCTTGGCAGCATTCCGGGTAACT
CCTCAACCCGGAGTTCCGCCTGAGGAAGCGGGGGCAGCGGTAGCTGCGGAATCTT
CTACTGGTACATGGACAACTGTGTGGACCGATGGGCTTACCAGCCTTGATCGTTAC
AAAGGACGATGCTACAACATTGAGCCCGTTGCTGGAGAAGAAAATCAATATATAT
GTTATGTAGCATACCCCTTAGACCTTTTTGAAGAAGGTTCTGTTACTAACATGTTTA
CTTCGATTGTGGGTAATGTATTTGGGTTCAAAGCCCTGCGCGCTCTACGTCTAGAG
GATCTACGAGTCCCTCCTGCGTATTCTAAAACTTTCCAAGGCCCGCCTCATGGTAT
CCAAGTTGAGAGAGATAAATTGAACAAGTATGGCCGTCCCCTATTGGGATGTACT
ATTAAACCTAAATTGGGGTTATCCGCTAAGAATTATGGTAGAGCAGTTTATGAATG
TCTACGTGGTGGACTTGACTTTACCAAAGATGATGAAAACGTGAACTCCCAACCAT
TTAT

>LYMOOI020_matK_390f/matK_1326r
TTTTTGAGGACAAATTCTTACATTTAAATTATGTGTTAGAGGTACTAATACCCCAC
CACATTTGCCCCGAAATCCTGGTTCAAGCCCTTCACTACTGGGTAAAAGATGCCTC
TTCTTTACATTTATTACGGTTCTTTCTACACGAGTATTTTAATTGCAATAGTCTTATT
ACCAAAAAAGAACTCTATTTCCTTTTTTTCAAAAAGTAATCCAAGATTCTTATTGTTT
CTATATAATTCTCATGTATATGAATATGAATCCATCTTTTTTTTTCTCTGTAACCAA
TCTTCTCATTTACGATCAATATCCTTTGGAGTCCTTATTGAGCGAATATATTTCTAT
CGAAAAGTCGAACATCTTGTTGAAGTCTTTGCTAATGATTTTAAGGGCATCTTATG
GTTGTTCAAGGATCCTTTCATGCATTATGTTAGATATCAAGGAAAATCTTATCTAG
CATCAAAAGATAGGCCTCTTCTGATGAATAAATGGAAATATTATCTTGTCAATTTA
TGGCAATGGAATTTTCACGTGTGGTCTCAACCAGGAAGGTTTCATATAAACCGCTT
AGACAAGTACTCTATCAACTTTCTGGGTTATCTTTCCAGTGTGCGACTAAATCCTTT
GGTGGTACGGAGTCAAATGCTAGAAAATTCATTTATAATAGATAATTCTATGAAG
AAAGTTGATCCAACTGTTTCAATTATTCATCTAATTGGATCGTTGATTAAGGCACG
GTTTTGTAACGCATTAGGGCATCCCATCAGTAAGGAGACTTGGACCTATTTTTCAG
ATTCTCATATTATCGACCGATTTGTGCGTATATGCAGAAATCTTTCTCATTATTACA
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>LYMOOI020_ITS_5P/ITS_8P
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GTTAGCTCGCGTCCCCGTCCCCCCCCTCGTCGCCGTGGGGCTCGTCCCCAGGGCGCG
CCAACGAACCCCGGCGCGGATTGCGCCAAGGAAAACCAACGAGAGAGCGCGCTC
CCCTGCCCCGAACACGGGTGTACGTGCGGGGGCGCCGCCTTCTTTCTGTAGTAGTC
TATAACGACTCTCGGCAATGGATATCTCGGCTCTCGCATCGATGAAGAACGTAGCG
AAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTCTTTGAACG
CAAGTTGCGCCCCAAGCCGTTAGGCCGAGGGCACGTCTGCCTGGGTGTCACGCAT
CATCGCCCCCTCCATCTTTCGCCTCTTCTTCGAGGCGCAGGGATACGTTGAGGGCG
GATACTGGCCTCCCGTGTGCGTCTCGCTCGCGGTTGGCTCAAATTCGAGTCCTCGG
CGACAGCGGCCGCGACCATCGGTGGCAAAAATTCTCATCGTGGTCCCGTCGCGGA
AGCGCCTGTCCCCGAATCAAGGGCTCCTCGGACCCAGACGCGCCATGCGCTAGCTT
TGCGACCCCAGGTCAGGCGGGACTACCCGCTGAGTTTAAGCATATCAATAAGCGG
AGGAAAAGAAACTTACCAGGATTCCCTTAGTAACGGCGAGCGAACGGGAAGAGC
CCGCTTGAGAATCGGCGTCCGCGA

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Solanum nigrum LYMOOI 003
>LYMOOI003_rbcLa_F/ rbcLajf634R
CCCCAACAGAGACTAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGAGTACAA
ATTGACTTATTATACTCCTGAGTACCAAACCAAGGATACTGATATATTGGCAGCAT
TCCGAGTAACTCCTCAACCTGGAGTTCCACCTGAAGAAGCAGGGGCCGCGGTAGC
TGCCGAATCTTCTACTGGTACATGGACAACTGTATGGACCGATGGACTTACCAGTC
TTGATCGTTACAAAGGGCGATGCTACCGCATCGAGCGTGTTGTTGGAGAAAAAGA
TCAATATATTGCTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCCGTTAC
CAATATGTTTACTTCCATTGTAGGTAATGTATTTGGGTTCAAAGCCCTGCGCGCTCT
ACGTCTGGAAGATCTGCGAATCCCTACTGCTTATGTTAAAACTTTCCAAGGTCCGC
CTCATGGGATCCAAGTTGAAAGAGATAAATTGAACAAGTATGGTCGTCCCCTGTTG
GGATGTACTATTAAACCTAAATTGGGGTTATCTGCTAAAAACTATGGTAGAGCTGT
TTATGAATGTCTTCGCGGTGGACTTGATTTTACCAAAGATGATGAGAACGTGAACT
CACAACCATTTATGCGTT

>LYMOOI003_matK_390f/matK_1326r
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CCGTTCATCTGGAAATCTTGGTTCAAACTCTTCGCTATTGGGTAAAAGATGCCTCTT
CTTTACATTTATTACGATTCTTTCTCCACGAATATTGTAGTCTTATTACTTCAAAGA
AGCCCGGTTACTCCTTTTCAACAAAAACTCAAAGATTCTTCTTCTTCTTATATAATT
CTTATGTATATGAATGCGAATCCACTTTCGTCTTTCTACGGAACCAATCTTCTCATT
TACGATCAACATCTTTTGGAGCCCTTCTTGAACGAATATATTTCTATGGAAAAATA
GAACGTCTTGTAGAAGTCTTTGCTAAGGATTTTCAGGTTACCCTCTGGTTATTCAA
GGACCCTTTCATCCATTATGTTAGGTATGAAGGAAAATCAATTCTGGCTTCAAAAG
GGACGTTTCTTTTGATGAATAAATGGAAATTTTACCTTGTCAATTTTTGGCAATGTC
ATTTTTCTATGTACTTTCACACAGGAAGGATCCATATAAACCAATTATCCAACCAT
TCCCGTGACTTTATGGGCTATCTTTCAAGTGTGCGACTAAATCATTCAATGGTACG
TAGTCAAATGTTAGCAAATTCATTTCTAATCAATAATCCAATTAAGAAGTTCGATA
CCCTTGTTCCAATTATTCCTTTGATTGGATCATTAGCTAAAGCACACTTTTGTACCG
TATTAGGGCATCCCATTAGTAAACCGGTTTGGTCCGATTTATCAGATTCTGATATT
ATTGACCGATTTGGGCGTATATGCAGAAATCTTTTTCATTATTATAGCGGATCTTGC
AAAAAAAAGACTTTATATCGAATAAAGTATATACTT

>LYMOOI003_ITS_5P/ITS_8P
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CGGCGCCCCTCCGCGCGTGTTCCCTCTCGTCCCCGGCTCGTTCCGGGCGACTAACG
AACCCCGGCGCGGAAAGCGCCAAGGAATACTTAAATTGAGAGCCCTCCCCTCGCG
CCCCGTCCGCGGAGTGTGCGGGGGGATGCGCGCTTCTTTTGAAACCAAAACGACT
CTCGGCAACGGATATCTCGGCTCTCGCATCGATGAAGAACGTAGCGAAATGCGAT
ACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTCTTTGAACGCAAGTTGCG
CCCGAAGCCATTAGGCCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCC
CCCCGCACGCCGCAAGGCGTCGTGGGGCGGATACTGGCCTCCCGTGCGCCTCGAG
CTCGCGGCTGGCCTAAATGCGAGTCCACGTCGACGGACGTCGCGGCAAGTGGTGG
TTGAAACTCAACTCTCTTTGTGTCGCGGCTACAGCCCGTCGCGCGTCCGGACTCCA
GACCCTCTAAGCGCTTAGGCGCTCCGACCGCGACCCCAGGTCAGGCGGGATTACC
CGCTGAGTTTAAGCATATCAATAAGCGGAGGAAAAGAAACTTACAAGGATTCCCT
TAGTAGCGGCGAGCGAACCGGGAACAGCCCAGCCTTAGAATCGGGCGGCTCCGTC
GTCCGAATTGTA

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Solanum torvum LYMOOI 013
>LYMOOI013_rbcLa_F/ rbcLajf634R
CCCCAACAGAGACTAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGAGTACAA
ATTGACTTATTATACTCCTGAGTACCAAACCAAGGATACTGATATATTGGCAGCAT
TCCGAGTAACTCCTCAACCTGGAGTTCCACCTGAAGAAGCAGGGGCCGCGGTAGC
TGCCGAATCTTCTACTGGTACATGGACAACTGTATGGACCGATGGACTTACCAGTC
TTGATCGTTACAAAGGGCGATGCTACCGCATCGAGCGTGTTATTGGAGAAAAAGA
TCAATATATTGCTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCCGTTAC
CAATATGTTTACTTCCATTGTAGGTAATGTATTTGGGTTCAAAGCCCTGCGCGCTCT
ACGTCTGGAAGATCTGCGAATCCCTACTGCTTATGTTAAAACTTTCCAAGGTCCGC
CTCATGGGATCCAAGTTGAAAGAGATAAATTGAACAAGTATGGTCGTCCCCTGTTG
GGATGTACTATTAAACCTAAATTGGGGTTATCTGCTAAAAACTACGGTAGAGCTGT
TTATGAATGTCTTCGCGGTGGACTTGATTTTACCAAAGATGATGAGAACGTGAACT
CACAACCATTTATGCGTT

>LYMOOI013_matK_390f/matK_1326r
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CCCGTTCATCTGGAAATCTTGGTTCAAACTCTTCGCTATTGGGTAAAAGATGCCTC
TTCTTTACATTTATTACGATTCTTTCTCCACGAATATTGTAATTTGAATAGTCTTATT
ACTTCAAAGAAGCCCGGTTACTCTTTTTCAAAAAAAAAATCAAAGATTCTTCTTCTT
CTTATATAATTCTTATGTATATGAATGCGAATCTACTTTCGTCTTTCTACGGAAACA
ATCTTTTCATTTACGATCAACATCTTTTGGAGCCCTTCTTGAACGAATATATTTCTA
TGGAAAAATGGAACGTCTTGTAGAAGTCTTTGCTAAGGATTTTCAGGTTACCCTAT
GGTTATTCAAAGATCCTTTGATGCATTATGTTAGGTATGAAGGAAAATCAATTCTG
GCTTCAAAAGGGACGTTTCTTTTGATGAATAAATGGAAATTTTACCTTGTCAATTTT
TGGCAATGTCATTTTTCTATGTACTTTCACACAGGAAGGATCCATATAAACCAATT
ATCCAACCATTCCCGTGACTTTATGGGCTATCTTTCAAGTGTGCGACTAAATCATTC
GATGGTACGTAGTCAAATGTTCGAAAATTCATTTCTAATCAATAATCCAATTAAGA
AATTCGATACCCTTGTTCCAATTATTCCTTTGATTGGATCATTAGCTAAAGCACACT
TTTGTACCGTATTAGGGCATCCCATTAGTAAACCGGTTTGGTCCGATTTATCAGATT
CTGATATTATTGACCGATTTGGGCGTATATGCAGAAATCTTTTTCATTATTATAGCG
GATCTTCCAAAAAAAAGACTTTATATCGAATAAAGTATATACTTC

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Centella asiatica LYMOOI 046
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TGACTTATTATACTCCTGACTATGAAACCAAAGATACTGATATCTTGGCAGCATTC
CGAGTAACTCCTCAACCTGGAGTTCCACCTGAAGAAGCAGGGGCCGCGGTAGCTG
CCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGACGGACTTACCAGCCTT
GATCGTTACAAAGGGCGATGCTACGGAATCGAGCCCGTTCCTGGAGAAGAAAATC
AATTTATTGCTTATGTAGCTTACCCATTAGACCTTTTTGAAGAAGGTTCTGTTACTA
ACATGTTTACTTCCATTGTTGGTAATGTATTTGGGTTCAAAGCCCTGCGTGCCCTAC
GTCTGGAAGATCTGCGAATCCCTGTTGCTTATGTGAAAACTTTCCAAGGCCCGCCT
CATGGTATCCAAGTTGAAAGAGATAAATTGAACAAGTATGGTCGTCCCCTGTTGG
GATGTACTATTAAACCTAAATTGGGGTTATCCGCTAAAAACTACGGTAGAGCGGTT
TATGAATGTCTCCGCGGTGGACTTGATTTTACCAAAGACGATGAGAACGTGAACTC
CCAACCATTTATGCGTT

>LYMOOI046_matK_390f/matK_1326r
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CCAGTCCATCTGGAAATCTTGGTTCAAATTCTTCGCTACTGGTTAAAAGATGCTTCT
TCTTTGCATTTATTACGACTCCTTCTCTACGAGTATCGTAATTGGAATACTTCAAAT
AAAGCCAGTTCTTCTTTTTCAAAAAGATCTCAAAGATTCTTCTTCTTCCTATATAAT
TCTTATCTATGTGAATACGAATCCATCTTCGTCTTTTTCCGCAACCAATCTTCTCAT
TTACGCTCAACATCTTCTAGAACCCTTCTTGAACGAGTATATTTCTATGGAAAAAT
AGAACATCTTGGAGAAGTCTTTGCTAAGGCTTTTCAAGTCAATCTATGGTTATTGA
AGGATCCTTTCATGCATTACGTTAGGTATCAAGGAAAATCAATTCTCACATCAAAA
GGGACGCCTCTTTTGATGAAAAAATGGGTATATTACTTTGTTAATTTATGGCAATG
TCATTTTTACCTGTGGTCTCAACCGAGAAGGATCTGTATAAACCAATTATCTAATT
ATTCGCTCGACTTTCTGGGCTATCTATCAAGTGCACGGCTAAACCCTTCAATGGTA
CGCGGTCAAATGCTAGAAAATTCATTTCTAATTGATAATACTATTAATAAGTTCGA
TACTCTTATTCCAATTATTCCTCTGATTGCATCATTGGCTAAAGCGAAATTTTGTAA
CATGTTGGGGCATCCTATTAGTAAGGTGGTTTGGGCCGATTTATCAGATTCTGATA
TTATTGACCGATTTGGGCGTATATGCAGAAATCTTTCTCATTATCATAGTGGATCCT
CACAAAAAAAGAGTTTGTATCGAATAAAGTATATACTTC

>LYMOOI046_ITS_5P/ITS_8P
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GCCCCTCGGGCCGCGAACCCACGGACGGGGTCCTCCCTCGGGCGTCCCCCGTCCG
GCTAACCAACCCCGGCGCGGCAAGCGCCAAGGAATTAAAAACCGAACGAGGCCG
TCTCTCCCCCGTTCGCGGGCGGCGGAGGCGTCTTGTCCTAAAAACAAAACGACTCT
CGGCAACGGATATCTCGGCTCTCGCATCGATGAAGAACGTAGCGAAATGCGATAC
TTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTCTTTGAACGCAAGTTGCGCC
CGAAGCCACTCGGCCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCC
CCCCCACCCGTCGACCTCGAAAGGGGTCGGGGCGGAGGGGCGGAGAATGGCCTCC
CGTGCCTCGGGGCGCGGTTGGCCCAAACGTCAGCCCGCGGCGACGGACGTCACGA
CAAGTGGTGGTTTGACAAAGGCCCTCGCATGTTGTCGTGCGGTGATCCGTCGTCGG
CGTGAGCTCGTGCGACCCTGTTGCCACGCCGTGCTCGGCGCGCGCTCCGACCGCGA
CCCCAGGTCAGGCGGGACTACCCGCTGAGTTTAAGCATATCAATAAGCGGAGGAA
AAGAAACTTACAAGGATTCCCCTAGTAACGGCGAGCGAACCGGGAACAGCCCAGC
TTGAAAATCGGGCGGCCTCGCCGTCCGAATTGTA

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Eryngium foetidum LYMOOI 038
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TTGACTTATTATACTCCTGACTATGAAACCAAAGATACTGATATCTTGGCAGCATT
CCGAGTAACTCCTCAACCTGGAGTTCCACCTGAAGAAGCAGGGGCCGCAGTAGCT
GCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGACTTACCAGCCT
TGATCGTTACAAAGGGCGATGCTACGACATCGAGCCTGTGGCTGGAGAAGAAAAT
CAATTTATTGCTTATGTAGCTTACCCATTAGACCTTTTTGAAGAAGGTTCTGTTACT
AACATGTTTACTTCCATTGTAGGTAATGTATTTGGGTTCAAAGCCCTGCGCGCTCT
ACGTCTGGAAGATCTGCGAATCCCTATTTCTTATGTTAAAACTTTCCAAGGACCGC
CTCATGGTATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGTCGTCCCCTGTTG
GGATGTACTATTAAACCTAAATTGGGGTTATCTGCTAAAAACTACGGTAGGGCGGT
TTATGAATGTCTCCGTGGTGGACTTGATTTTACCAAAGACGATGAGAACGTGAACT
CCCAACCATTTATGCGTTG

>LYMOOI038_matK_390f/matK_1326r
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AGACGCCTCTTCTTTGCATTTATTACGATTCTTTCTTCACGAGTATCGTAGTTGGAA
TACTCCAAATAAAGCCAGTTCTTTTTTTGCAAAAAGAAATCAAAGATTATTCTTCG
TCCTATATAATTCTCATCTATGTGAATATGAATCCATCTTCGTCTTTCTCCGTAACC
AATCTTCTCATTTACGCTCAACATCTTCTGGAACCCTTCTTGAACGAATCTTTTTCT
ATGGAAAAACAGAACATTTTGTAGAAGTTTTTGCTAAGGCTTTTCAGGCCAATCTG
TGGTTGTTGAGGAATCCTTTCATGCATTATGTTAGGTATCAAGGAAAATCGATTCT
TGCTTCAAAAGGGACACCCCTTTTGATGAAAAAATGGACATATTACTTTGTAAATT
TATGGAAATTTCATTTTGATCTGTGGTATCAACCAGGAAGGATCTGTCTAAACCAA
TTATCTAATCATTCCCTCGACCTTCTGGGCTATCTATCAAGTGCGCGGCTAAACCCT
TCAATGGTACGCGGTCAAATGCTGGAAAATGCATTTCTAATTGATAATGCTATTAC
TAAGTTCGATACTATTGTTCCAATTATTTCTCTGATTGGATCATTGGCTAAGGCGAA
ATTTTGTACCGTATTGGGACATCCTATTAGCAAAGCTGTTTGGTCGGATTTCTCAG
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TAGAACCGGACTGAACGTTCTCGCCCCCGTTCGCGGGTGGCGACGGCGTCTTTCAG
AAACACAAACGACTCTCGGCAACGGATATCTCGGCTCTCGCATCGATGAAGAACG
TAGCGAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTCTTT
GAACGCAAGTTGCGCCCGAAGCCATTAGGCGGAGGGCACGTCTGCCTGGGCGTCA
CGCATCGCGTCGCCCCCCAGCCCACGCACCTCTTGGAGTGATGCGTCGGATGCGGG
GCGGATAATGGCCTCCCGTGCTTCGCGGCGCGGTTGGCCCGAACGCGAGTCCCCG
GCGACAGGATGTCGCGGCATGTGGTGGTTGTAAAAAGGCCGTCTCGTAGTGTCGC
GTCGTCGCCCTGTCTTCGGTGCGAGCTCCTGTGACCCTCTGGCGCCACCAACGGTG
TGCGCCTCGACCGCGACCCCAGGTCAGGCGGGGACTACCCGCTGAGTTTAAGCAT
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APPENDIX B

Sequences per sample based on bidirectional primer (continued)

Hydrocotyle sibthorpioides LYMOOI 069
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AGTAACTCCTCAGCCTGGAGTTCCGCCCGAAGAAGCAGGGGCCGCGGTAGCTGCT
GAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGACTTACCAGCCTTGA
TCGTTACAAAGGGCGATGCTACGAAATCGAGCCCGTTCCTGGAGAAGAAAATCAA
TTTATTGCTTATGTAGCTTATCCATTAGACCTTTTTGAAGAAGGTTCTGTTACTAAC
ATGTTTACTTCCATTGTAGGTAATGTATTTGGGTTCAAAGCCTTGCGTGCTCTACGT
CTGGAAGATCTTCGAATCCCTGTTGCTTATGTTAAAACTTTCCAAGGCCCGCCTCA
TGGCATCCAAGTTGAAAGAGATAAATTAAACAAGTATGGTCGTCCCCTTTTGGGAT
GTACTATTAAACCTAAATTGGGGTTATCGGCTAAAAACTACGGTAGAGCGGTTTAT
GAATGTCTACGTGGTGGACTTGATTTTACCAAAGACGACGAGAACGTGAACTCCC
AACCATTTATGCGTT

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CACATTTAATTTATGTGTTAGAGATACTAATACCCTACCCAGTCCATTTAGAAATC
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TTCTTTCTCCACGAGTATTGTAATTGGAGTACCCCAAATAAAGTCGGTTTTTCTTTT
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GAATCCATCTTCGTCTTTCTCCGTAACCAATCTTCTCGTTTACGCTCAACATCTTCT
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CTTTGTTAAGGTTTTTCAGGTCAATCTATGTTTGTTGAAGGAGCCTTTCATGCATTA
TGTTAGGTATCAAGGAAAATCAATTCTCGCTTCAAAAGAGACGCCCCTTTTGATGA
AAAAATGGACATATTATTTTGTTAATTTCTGGCAATGTAATTTTTATCTGTGGTCTC
AACCGGGACGTATCTATATAAACCAATTCTACAACCATTCCCTTTATTTTTTGGGCT
ATTTATCAAGTGCGCGTCTAAACCCTTCAATGATACGTGGTCAAATGCTAGAAAAT
GTATTTCTAATTGATAATGCTATTAAAAGGGTTGAGACTATTGTTCCAATTAGTCCT
CTGATTGGATCATTGGCTAAAGCTAAATTTTGTAATGTATTGGGGCATCCTATTAG
TAAGACGGTTTGGTCTGATTTATCAGATTCTGATATTATTGACCGGTTTGGTCGGAT
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GAATAAAGTATATACTTC

>LYMOOI069_ITS_5P/ITS_8P
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ACGACCCCCCGGCGCGGAATGCGCCAAGGAAATCTAACTGAGCGGATCGCGTCCC
CCCCGTTCGCGGGCGGCGGAGGCATCTCTTCTAAAACACAAACGACTCTCGGCAA
CGGATATCTCGGCTCTCGCATCGATGAAGAACGTAGCGAAATGCGATACTTGGTGT
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CATTAGGCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTCGCCCCCCAAAC
CTCGCACTTCCGCAAGGGAGTCCCGGTAGGGGGCGGATATTGGTCTCCCGTGCATC
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GGTCGTAAAAAGCCTTCTGTTCATGTCGTGTTTGCGAACGTCGTCGGTTGAAGCTC
TTGTGACCCTATTGCGCCGTCCTCGACGCGCGCTCCGACCGCGACCCCAGGTCAGG
CGGGACTACCCGCTGAGTTTAAGCATATCAATAAGCGGAGGAAAAGAAACTTACA
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CGACCCCGTCGTCCGAATTGT