METABOLITE PROFILING AND DNA BARCODING ANALYSIS OF 35 MALAYSIAN MEDICINAL PLANTS

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By

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ABSTRACT

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Lai Mei Wei

Medicinal plants have been used in traditional medicine all over the world. Today, Malaysian medicinal plant species are rarely documented in scientific literature. The purpose of this research was to collect 35 selected medicinal plants, prepared herbarium voucher, the supplement scientific information, complete DNA barcode and metabolite profile analysis of selected local medicinal plants. Medicinal plants must be identified correctly to be effective as medicine. Unrelated species can lead to impaired downstream experiments. Morphology approach is still at the forefront of measuring plant identity because the starting material is important to avoid undesirable results. The 35 medicinal plants were collected from Selangor, Negeri Sembilan and Johor. Three barcode regions including ribulose 1,5-biphosphate carboxylase (*rbc*L), maturase K (*mat*K), and internal transcribed spacer (ITS) were tested for their DNA barcoding's suitability. Public software and databases were utilized to retrieve the information of LC-MS/MS experiment. The 35 species were successfully collected and macroscopic photographs of 35 species were recorded. Plant identification confirmed by taxonomist. Dried specimen was mounted on

herbarium paper with herbarium label. Herbarium vouchers were deposited at Perdana Botanical Garden Kuala Lumpur, Malaysia. BLAST result of *mat*K successfully matched 52.4% of the queries against the reference database, tentatively proposed the identification rate of *mat*K was higher compared to *rbc*L (34.3%) and ITS (35.8%). Three single loci were not likely to provide 100% species identification because it is impossible to use a single barcode fixed to all plant taxa. There were 44 N-containing compounds, 142 Phenolics, 87 Terpenes, 59 others's putative compounds detected in the 35 medicinal plants. Majority of the putative compounds were known as "known unknown". This study confirmed the proper scientific names of 35 local medicinal plants and provided the herbarium vouchers, DNA barcoding and putative compounds to achieve mutual benefit for present and future generations.

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APPROVAL SHEET

This thesis/dissertation entitled "**METABOLITE PROFILING AND DNA BARCODING ANALYSIS OF 35 MALAYSIAN MEDICINAL PLANTS**" was prepared by LAI MEI WEI 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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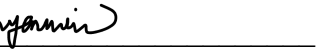

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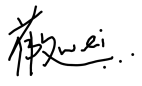

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DECLARATION

I LAI MEI WEI hereby declare that the thesis/dissertation is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UTAR or other institutions.

(LAI MEI WEI)

Date 24th July 2022

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LIST OF ABBREVIATIONS

BLAST	Basic Local Alignment Search Tool
BOL	Barcode of life
BRAHMS	Botanical Research and Herbarium Management System
CBOL	Consortium for the Barcode of life
DNA	Deoxyribonucleic acid
E	East
GC	Gas chromatography
GC-MS	Gas chromatography - mass spectrometry
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
mtDNA	Mitochondrial DNA
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

UV	ultraviolet
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

Nature has been used as the source of medicine for a thousand years (Alsarhan et al., 2014). Among the materials, medicinal plants play a key role, and it is explained as the plants that have therapeutic effect or consist of valuable pharmacological effect on the body of an animal or human (Namdeo, 2018). According to previous reports, 15% of the 300,000 plants in the world have pharmacological activity studies. However, only around 25% of modern drugs are come from raw materials such as medicinal plants (De Luca et al., 2012). In Malaysia, Food and Agriculture Organisation (FAO) statistics indicated that there are 15,500 plants in nature that have medicinal properties, but only 7.7% of them are exploited (Aziz and Zakaria, 2013). Malaysia is rich in flora and ranks at 12^{th} in the world (Rao, 2010). Thus, plant species found in the tropical rainforest of Malaysia are expected to offer valuable and beneficial uses for medicinal plants as a result of their great diversity (Kodoh et al., 2017). At least 80% of the world's population uses medicinal plants in their health care approaches for maintaining general health and curing minor illnesses (Raal et al., 2013; Ekor, 2014). In Malaysia, people used herb therapy including herbal-based applications (23.6%) for health issue and pure herbal medicine (29.6%) to maintain general health (Siti et al., 2009). The widespread use may be because they are culturally acceptable, more compatible with the human body, and have fewer side effects (Jayaraj, 2010).

It was proposed that preparation of medicinal plants for experimental purposes is the first step and the key to achieving high-quality research results. Correct identification of species, proper collection and storage of medicinal plants were essential requirements for the preparation of medicinal plants for experiment purposes to ensure the necessary quality of plant-containing materials or extracts (Abubakar and Haque, 2020). In this study, the collected medicinal plants were prepared for plant DNA extraction and metabolite extraction. In a previous study, Saw and Chung (2015) highlighted the lack of a comprehensive and up-to-date checklist of Malaysia's medicinal plant, and specimens are crucial to the documentation. Traditionally, the process of plant identification is done by taxonomists (Pathak, Mohamed and Farooq, 2018). Plant morphology refers to the phenotypic appearance or "form" of the plant (Claßen-Bockhoff, 2001) and morphology is the basis for identifying medicinal plants (Croom, 2007). This approach is able to visually discriminate quality, and it required no specific instruments, nor any specialized biochemical and molecular techniques (Nadeem et al., 2017). Plant photography is important, especially using techniques such as macroscopic photography, which provides a close-up photograph of plant characteristics, and when good pictures are available, plus descriptive plant keywords, allows for more accurate plant identification (Swan and Burrill, 1990). As an aid to identification, photographs could easily capture some taxonomic information that was difficult to preserve in a herbarium voucher, and with a set of photographs, it can adequately represent the gross of a species, especially if enough plant characteristics are taken such as photos of flowers, leaves, stems, and whole plants, it is more likely to help correctly identify medicinal plants (Baskauf and Kirchoff, 2008).

In botany, plant genus and species identification has rapidly become possible with DNA barcoding (Hebert et al., 2004), probably because it is easy to repeat even for non-taxonomist experts (Armenise et al., 2012). Recently, DNA barcoding is recommended as a tool used to get taxonomic information about unknown organisms (Wilson, Sing and Jaturas, 2018). For DNA barcoding to achieve reasonable levels of discrimination, Santos and Pereira (2018) noted that two or three different genomic regions must be analyzed. Standard plant DNA barcodes *rbc*L and *mat*K has been proposed by de Vere et al. (2015) to identify species, but additional markers may be needed to enhance the plant identity.

Various combination of plant identification investigations have been developed to study Malaysian medicinal plant such as morphology and DNA analysis (Aziz, Ahmad and Naim, 2017), macroscopic and microscopic analysis (Nur Fatihah et al., 2014; Shunmugam et al., 2021), DNA analysis and chemical analysis (Tarmizi et al., 2021), etc., but less comprehensive studies have been conducted on combination of plant identification with metabolites analysis and reviewed the biological activities of potential compounds detected. Mbuni et al. (2020) stated that biologically active compounds are extracted from medicinal plants, and it is important to correctly identify the medicinal plants that are used because different plant species possess different medicinal value with its existence of unique types of compounds (Patel, 2015). Metabolite profiling measures hundreds or possibly thousands of metabolites (Kopka et al., 2004) and mainly used for untargeted metabolite analysis (Pinu, 2018). Plant secondary metabolite studies have proven or searched for compounds with bioactive or

protective properties in several reports (Pavarini et al., 2012). However, it was found that most of the metabolites of Malaysia local medicinal plants have not been fully explored, especially the study of secondary metabolites. Therefore, this study hypothesizes that several putative compounds of local medicinal plants in Malaysia can be detected, and the medicinal value of the medicinal plants can be revealed by reviewing the studies of known putative compounds.

The objectives of this study are as follows:

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

CHAPTER 2

LITERATURE REVIEW

2.1 Medicinal Plants

Historically, medicinal plants have been recognised for their therapeutic capabilities. The earliest evidence of it on land can be traced back to the past 500 million years, and it has spread to almost all habitable niches on land (Li and Weng, 2017). In 2018, the World Health Organization and WHO Expert Committee reported on pharmaceutical preparation specifications which claimed that medicinal plants are plants that are utilised for medicinal purposes, whether they are wild or cultivated.

In Malaysia, the usage of medicinal plants is informed by practical experiences, observations, and rituals influenced by religion and social beliefs handed down from generation to generation (Kim Sooi and Lean Keng, 2013). In 2014, there are over 1300 medicinal plant species recorded in Peninsular Malaysia alone (Alsarhan et al., 2014). Over time, Malaysia gradually has a record of about 2,000 medicinal plant species that have been documented to have beneficial health properties (Abu Bakar et al., 2018). Medicinal plants may lead to adverse effects if improperly used, so it is necessary to identify both the raw material and the final product (Suesatpanit et al., 2017).

In general, the medicinal herb is another term for the medicinal plant. An "herb" refers to any plant, plant product, or plant product mix in any form. (Winslow and Kroll, 1998). The herbs consists of compounds that may be used to treat illness and is composed in one or more organs or parts of medicinal plants. In a more modern idea, these compounds can be used as precursors in the preparation of synthetic drugs. However, there is lack of scientific proof to back up the efficacy of the medicinal plants used in traditional medicine. Those medicinal plants (whole or part of plant) with healing properties are called natural crude drugs or biological origin when they exhibit therapeutic qualities (Josephine Ozioma and Antoinette Nwamaka Chinwe, 2019).

Although medicinal plants have a long history of effective use, they are still not the mainstream medicine. Interestingly, things change as time passes (Pan et al., 2014). It led to significant return to traditional medicine because of increased prices of modern medicine, their unavailability in remote areas, and negative effects of some medicines (Chapman and Chomchalow, 2004). Sheng-Ji (2001) stated that traditional medicinal knowledge of medicinal plants and their application in practice was useful for conservation of cultural traditions and biodiversity and for promoting current and future health system and medicine development. Accurate knowledge about plant identity and geographical distribution of plants is essential for sustainable human development in the future (Joly et al., 2014). Therefore, the development of fast and accurate plant identification is very important for medicinal plant research (Wäldchen and Mäder, 2018). Besides, metabolite profiling is a crucial step in the drug development process. LC-MS-based metabolite profiling plays a crucial role as

the resulting metabolite profile could provide therapeutically beneficial metabolites (Muhamad and Na-Bangchang, 2020; Krishna, Padmalatha and Madhavi, 2021).

2.2 Identification Methods

Ideally, morphological and molecular methods should be used for identification of medicinal plants (Mehle and Trdan, 2012). Latter, the idea was discussed by the paper of Sophie (2016), compared the two methods of morphological feature analysis and DNA barcoding. In general, the whole plant is the unit for morphology identification (Hagemann, 1992). If morphological characteristics are absent or not well developed, identification keys that rely on morphological traits will not be useful. When a species cannot be identified morphologically, species investigations become more difficult. To address this problem, using DNA barcoding might complement the morphological features and speeding up the identification of species (Amandita et al., 2019). According to Rubinoff (2006), DNA barcoding is essentially a technique for identifying taxa previously described. It quickly becomes a research hotspot and has been recognized as a powerful tool for species identification (Hajibabaei et al., 2005; Hebert and Gregory, 2005; Pang and Chen, 2014). Last but not least, the importance of correctly and scientifically identifying medicinal plants is immeasurable, because it is the only key to ethnobotanical information obtained by linking existing biological and chemical knowledge in the literature (Joharchi and Amiri, 2012).

In terms of plant morphology, shape of style, margin and size of stipule, tendrils, leaflets, length of flower, peduncles, hairs, etc, were regarded as important characteristics for species identification (Kupicha, 1976; Jalilian et al., 2014). In terms of DNA barcoding, chloroplast or nuclear regions are implemented as universal barcodes for the identification of botanical medicine (Gogoi and Bhau, 2018).

2.2.1 Traditional Method

Plant morphology studies medicinal plants' physical form and external structure (Carrillo-López and Yahia, 2019). In 2017, Begue and the researchers stated that the most successful approach for correctly identifying medicinal plants is a manual-based method based on morphological traits. The manual-based method based on morphological characteristics relies significantly on the internal knowledge of human experience and the process of manual identification is figured as “depends on the accumulation and skills of human knowledge” (Begue et al., 2017). According to the description in Narina (2020), visible morphological features such as size, shape, and colour of medicinal plants can be compared with the naked eye. It is important to note that plant leaves are widely used for plant identification, among all relevant plant parts. They are usually the richest form of data in plant reference collections and are the easiest to obtain in field work. This is because flowers and fruits are produced relatively short of time in medicinal plants, while leaves are present in most of their lives (Le, Tran and Hoang, 2014).

2.2.1.1 Herbarium Voucher

Herbarium voucher has been used in science since 1556 and it was designed as official and permanent records from dried medicinal plants using sheets of thick paper tied together and kept vertically (Stearn, 1971). Today, a herbarium voucher is defined as a collection of plant specimens that have been gathered, dried, and mounted on handcrafted paper sheets. Mounting of the medicinal plant on a sheet of stiff herbarium (11.5 by 16.5 inches) with a specimen label printed enables convenient storage (Carter, Bryson and Darbyshire, 2007) and it was noted that when the medicinal plant is small, the entire plant must be collected; for large medicinal plants, plant parts that demonstrate the plant's growth habit should be collected; extra flowers, fruit, and some roots to demonstrate the plant's growth habit are desirable (Tucker et al., 2005). The plant specimens will be organised in plant families' recognised classification system and preserved in pigeonholes of steel or wooden cupboards for present and future study. It serves as a resource for plant name, identification, and classification (Kottapalli et al., 2016). A herbarium voucher must be attached with an identifying label that includes the plant's accepted scientific name, recognized taxonomic authority, name of the person who verified the plant sample, name of collectors, collection date, collection site's habitat, site's geographical location (ideally consisting of GPS coordinates) and there may also be a collection number assigned by the collector (Culley, 2013). Among these label detail, only the scientific name was associated with the voucher specimen that accurately link to the existing literature (Bennett and Balick, 2013). Lately, the use of photographs has been proposed to supplement herbarium voucher; these photographs have been used

to provide record details not available on dried specimens or to illustrate the habitat where the medicinal plants were collected (Gómez-Bellver et al., 2020).

The herbarium voucher was introduced as the "dictionary" of the plant kingdom (Petruzzello, 2018). It lays the foundation for plant illustration and offers a permanent record confirming the occurrence of the species at a particular locality and time (Deo et al., 2017). It was known that medicinal plant identification is often done manually by herbarium taxonomists utilising the taxonomy guidebook (Herdiyeni et al., 2013). Recently, researchers have proposed that preserved specimens are most successful when correctly collected and pressed to provide the essential species characteristics, despite fresh material best for identification (Smith and Chinnappa, 2015). However, it is sometimes hard to collect fresh specimens of relevant kinds simultaneously because they will not last long, and memories soon become blurry and incorrect (Tucker et al., 2005). In 1971, Smith expressed that words or pictures cannot substitute a real plant sample as a benchmark for comparison. Therefore, conducting a herbarium voucher on living medicinal plants was essential for permanent records, especially if there is a need for follow-up work on the same material or doubts about the initial identification of medicinal plants.

In short, if there are no herbarium vouchers, the investigated value will be reduced, and determination cannot be checked. The herbarium voucher can give a valid means of identifying and distinguishing among species, particularly if the specimen has a common name. Besides, herbarium vouchers offer a unique

chance to study medicinal plants and other preserved species across time. It works as snapshots, and researchers can examine and provide an opportunity to view phenotypes, genotypes, and chemotypes in a specific time window (Culley, 2013; Willis et al., 2017; Kao et al., 2018).

2.2.2 Molecular Method

DNA barcoding has been used by researchers in an increasing number of biological fields, owing to the fact that DNA sequence information can be obtained cheaply and easily, allowing researchers to assign taxonomic names to organisms without requiring them to be familiar with intricate morphological features (Wilson, Sing and Jaturas, 2018). In the DNA barcoding project, reference sequences are the core; any species identification using DNA barcoding should only be performed where available reference sequences allow (Meyer and Paulay, 2005; Begerow et al., 2010; Zhang et al., 2011). In this case, if there is no verification reference sequence for the voucher specimens certified by a qualified taxonomist, there is no reliable library to compare with the newly generated query sequence (Taylor and Harris, 2012). In short, DNA barcodes do not replace traditional taxonomies, but by generating sequence data that needs to be paired with verified morphological type specimens, it strengthens the demand for qualified taxonomists (Packer et al., 2009; Hoy, 2013).

2.2.2.1 Development of DNA Barcoding

A conference "Taxonomy and DNA" was held at Cold Spring Harbor Laboratory in 2013. The aim of the conference is to enable a practical method for species identification (Stoeckle, 2003). Afterward, Alfred P. Sloan Foundation granted the Smithsonian Institution to set up a Consortium for the Barcode of Life (CBOL) to promote the growth and use of DNA barcoding in 2004 (Schindel and Miller, 2005). The 1st international conference on 'Barcoding Life' got the attention of scientists and received considerable media coverage was organized in 2005. Meanwhile, the National Center for Biotechnology Information (www.ncbi.nlm.nih.gov) builds partner relationships with CBOL whereby barcode standard DNA sequences and relevant supporting data can now be achieved in GenBank (Savolainen et al., 2005). In 2007, the proposed various combinations of plastid markers for medicinal plants were introduced and discussed at the 2nd International Barcode of Life conference in Taipei, but no agreement was reached (Hollingsworth, Graham and Little, 2011). At the 3rd barcode conference in 2009, researchers have decided to recommend regions of *rbc*L and *mat*K as core DNA barcode loci for medicinal plants and point out trnH-psbA and ITS also represent a useful supplementary barcode in taxonomic groups (Kress et al., 2005; Kress and Erickson, 2007). Up-to- date, DNA barcode technology continues to expand into a wide range of scientific fields (Kress, 2017).

2.2.2.2 DNA Barcoding of Medicinal Plant

DNA barcoding is generation of universal standards for species identification, and their standard gene regions can be accurately sequenced in a short time (Gogoi and Bhau, 2018). It was a promising method to effectively use short regions of specific DNA sequences to correctly identify species (Hebert et al., 2003; Meyer and Paulay, 2005). In 2003, Hebert ("the father of barcodes") and his team published a paper on the use of DNA sequences to identify species. In the article uses the mitochondrial cytochrome oxidase I (COI) gene to provide a unique fingerprint for animal identification (Hebert et al., 2003; Marshall, 2005). Although the COI gene is universally accepted in animal genomes, but this region in medicinal plants shows insufficient variability due to its low mutation rate and hence requiring alternative barcoding regions (Kress et al., 2005; Chase et al., 2005; Fazekas et al., 2009). Recently, many landmark articles on DNA barcodes have been published and provide a new method for the identification of medicinal materials (Guo et al., 2016). When going further to select plant DNA barcodes, some factors should be considered: (i) universal PCR amplification, (ii) range of taxonomic diversity, (iii) power of species differentiation, and (iv) bioinformatic analysis and application (Kress and Erickson, 2008). Up to now, DNA barcoding has been used to identify different kinds of plant species such as lichens (Xu et al., 2017b), fungi (Oberlies, 2017; Raja et al., 2017), weeds (Tang et al., 2016), trees (Yu et al., 2016; Nithaniyal and Parani, 2016; Han et al., 2016; Enan and Ahmed, 2016), and economically important plants such as crops (Ghosh, Mahadani and Sharma, 2013) and

medicinal and aromatic plants (Hirsch and Moraes, 2014; Lv et al., 2015; Moon et al., 2016; Kim et al., 2016; Zhang et al., 2016b; Liu et al., 2018).

2.2.2.3 Universal Barcodes for Medicinal Plants

The Gene region of mtDNA has been used for many animal groups and algae is not suitable for land plants. There is a high base-substitution rate in animals, but the gene content and order are highly conserved. Whereas in medicinal plants, the base substitution rates are much lower, and there are frequent genome rearrangements, transfers of genes between different genomes (plastid, mitochondrial, and nuclear) and across species (Palmer et al., 2000; Mower et al., 2004). Therefore, finding a universal DNA barcode for medicinal plants is more challenging if compared to animals, however, an appropriate alternative is required (Cowan and Fay, 2012).

In 2007, Chase and colleagues stated that the most important features of the universal barcode can be amplified across all taxa using standardized primers and ease to be sequenced. In order to facilitate analysis, the barcode should be easily aligned, and consists of a few insertions and deletions, as these complicate the comparison and can be hard to interpret. However, universally acceptable barcodes are yet to be well established in medicinal plants because they are difficult to identify (Vijayan and Tsou, 2010). Several candidate gene regions were proposed as potential DNA barcodes for medicinal plants, including code genes and non-coding genes in the nuclear and plastid genomes (Kress and

Erickson, 2007). Li et al. (2011) indicated that Consortium for the Barcode of life (CBOL) has approved that the *mat*K and *rbc*L are the main barcode markers for accurate identification of medicinal plants and trees and later on, in order to consider the tradeoffs between universality, sequence quality, discrimination, rate of throughput, and cost efficiency, China Plant BOL Group et al. (2011) was proposed ITS should be added into the core barcode for land plants for further study.

2.2.2.4 Ribulose 1,5-biphosphate carboxylase (*rbc*L)

The *rbc*L gene region is used for DNA barcodes due to its universality, ease of amplification and comparability (Hollingsworth et al., 2016). This gene region provided greater success in PCR-amplification (Bafeel et al., 2011) and getting clean sequence (Kuzmina et al., 2012). Hollingsworth, Graham and Little (2011) reported that *rbc*L serves as a good DNA barcoding region for the discrimination of medicinal plants at both family and genus levels. It was reported that the *rbc*L is easy to be amplified, loci were relatively conservative (Meyer and Paulay, 2005). However, *rbc*L considered as modest in the discrimination at the species level (Arolla et al., 2015). Nevertheless, the *rbc*L is still recommended as a core barcode, not because of its ability in barcode species, but because of its historical popularity and possible experimental convenience (Dong et al., 2015).

2.2.2.5 Maturase K (*mat*K)

The *mat*K gene has been widely used as barcode in angiosperms plants (Yu et al., 2011). Although some reports found that *mat*K gene was hard to amplify (Wicke, 2009), there are about 90% of the angiosperms tested in the CBOL Plant Working Group in 2009 were reported successfully discriminated from one another by using a single primer pair to amplify and sequence the *mat*K gene (CBOL Plant Working Group, 2009; Stephens, 2013). Asahina et al. (2010) confirmed that using the *mat*K sequences as barcodes for the first identification process is very efficient. Generally, it is used to identify medicinal materials of different geographical origins for their high variability properties (Amin et al., 2020). Liu et al. (2019) reported *mat*K was accepted as a suitable plant barcode due to its high evolutionary rate, ideal length, obvious interspecific divergence, and low transition/transversion ratio. These characteristics of *mat*K gene are used to resolve family and species-level relationships.

2.2.2.6 Internal transcribed spacer (ITS)

The ITS has been developed as an effective universal region for molecular identification of medicinal plants (Samsuddin et al., 2012). Tippery and Les (2008) stated that nuclear ITS regions have been extensively sequenced because of their relatively high variability and amplification capacity. In addition, ITS region has proposed as a preference in barcoding gene selection for plant identification because of its higher species discrimination and sequence recovery

ability across different plant species based on previous barcoding research (Chen et al. 2010; Yao et al. 2010; Azizi, Lau and Abu-Bakar, 2021). The ITS region usually undergoes faster concerted evolution through unequal crossing over, high-frequency gene conversion, and large deletion (Liao, 1999; Ganley and Kobayashi, 2011; Xu et al., 2017a). Nevertheless, these imperfections did not lead to large problems, and ITS was re-proposed as a core barcode for seed plants (Hollingsworth, Graham and Little, 2011; China Plant BOL Group et al., 2011; Song et al., 2012).Up-to-date, Kang and scientists demonstrated that a success rate of species identification of ITS was highest when a single DNA fragment was used and proved that ITS is a plant core barcode that can effectively identify plant species (Kang et al., 2017).

2.3 Strategies for Detected Plant Metabolites

A good understanding of the chemical composition helps to better understand its possible medicinal value (Hussein and El-Anssary, 2019). It is believed that the plant kingdom produces approximately 600,000 metabolites to protect itself from microbial pathogens and herbivores (French, Harvey and McCullagh, 2018). In order to analyse plant metabolites, the analytical strategies are selected according to the research focus or research question (Weckwerth and Kahl, 2013). As mentioned by Satheeshkumar et al. (2012), the study of plant metabolites in herbal medicine research can be accomplished through two strategies: fingerprinting or profiling.

2.3.1 Metabolite Fingerprinting

The term “metabolite fingerprinting” proposed by Fiehn (2001) is referred to as strategies that determine metabolites in the test sample but does not include their identification (Jan and Ahmad, 2019). It is to provide global, high-throughput and fast analysis of sample classification. Besides, it is also used as a screening tool to distinguish samples from different biological sources (Ellis et al., 2007). Usually, no preliminary attempts are made to identify the metabolites present. In this strategy, all steps from sample preparation, separation, and detection should be fast and as simple as possible (Hall, 2006).

2.3.2 Metabolite Profiling

Metabolite profiling is not a new idea (van der Greef et al., 2013). It is designed to detect as many metabolites as possible in a predefined set of structurally related, such as organic acids, amino acids, and carbohydrates (Weckwerth and Kahl, 2013). Over 100,000 secondary metabolites with different structural, physical, and chemical characteristics have been discovered (Berkov, Mutafova and Christen, 2014), all of which require advanced analytical techniques to identify and quantify (Berkov et al., 2018). Metabolite profiling has been known for decades, but only recent technological advances have enabled metabolite profiling to be done on a large scale – in terms of both the number of metabolites measured and the number of trials performed (Fernie et al., 2004).

2.3.2.1 Targeted analysis Vs Untargeted analysis

A targeted analysis is used to accurately measure the concentration of a restricted number of known metabolites. To perform targeted analysis, it is necessary to understand the structure of the target metabolite and then establish an analytical method to quantify its concentration in the sample accurately. It is a true quantitative method that provides very low detection limits for known metabolites (Shulaev, 2006). On the contrary, untargeted analysis avoids the required for a prior specific hypothesis on a certain set of metabolites and the global metabolite profile is analysed (Alonso, Marsal and JuliÃ, 2015). Its purpose is to measure as many metabolites in the sample as possible (Nikolskiy et al., 2013; Wang et al., 2019a). Since untargeted screening can be performed without a priori, reference standards are not needed to identify unexpected compounds (Dom et al., 2018); in contrast, target analysis must use reference standards in the analysis process when looking for compounds of interest (Krauss, Singer and Hollender, 2010). It must be known that when using targeted analysis to identify unknown compounds, there is a bias, because it is looking for a specific set of compounds in an unknown sample such as lipids or alkaloids, and it has no chance to identify new compounds. In this case, it is feasible to use non-targeted analysis, which may lead to discovering new targets or new compounds from scratch (Pande and Chanda, 2020). In addition, another point to note when using untargeted analysis is that the compound is not initially identified, and further analysis of the characteristics of all potential compounds obtained will be considered (Kristensen, 2010).

Normally, metabolite profiling can be classified into targeted or untargeted (Wang et al., 2019b). The term "targeted metabolite profiling" refers to the process of profiling a group of specified metabolites, generally the most abundant ones. Meanwhile, if the goal is to disclose the holistic profile of the system under examination, “untargeted metabolite profiling” should be used, which involves dealing with many known and unknown metabolites while all the observed variables at the same time (Ibrahim and Fathy, 2018). Pande and Chanda's (2020) study reviews numerous researchers who successfully utilised a "profiling" strategy to analyse compounds from different medicinal plants and plant parts. For example, a report of Chiang et al. (2004) showed effective of using metabolite profiling to detect phenolic compounds in *Bidens pilosa* extract; detailed metabolite profiling of polyphenols in *Vaccinium* berry samples was carried out by Prencipe et al. (2014); many active compounds including flavonoids, phenolic acids and lignin were identified in *Cassia fistula* leaves (Martínez-Ávila, Castro-López and Rojas, 2018); and targeted and untargeted metabolite profiling of the ethnobotanical *Martynia Annua* L. identifies compounds with medicinal properties was attempted by Muazzam et al. (2018).

2.3.2.2 Analytical Techniques- Metabolite Profiling

Basically, there are two kinds of analytical techniques for metabolite profiling: Mass Spectrometry (MS) and Nuclear Magnetic Resonance (NMR) (Fernie et al., 2004). According to Piasecka, Kachlicki and Stobiecki (2019), mass spectrometry (MS) is the preferred method for metabolite profiling in biological

materials (Nakabayashi and Saito, 2013). This is because mass spectrometry (MS) has the characteristics of sensitivity and high specificity. It has always been desired to be used in combination with chromatographic techniques. Gas chromatography coupled with mass spectrometry (GC-MS) was realized in the 1950s with commercial instruments in the 1970s (Pitt, 2009). Subsequently, the emergence of liquid chromatography coupled with mass spectrometry (LC-MS) was first commercialized in the early 1990s (Looser, Krotzky and Trethewey, 2005).

In 2000, Roessner et al. first successfully applied metabolite profiling using GC-MS to plant biology. The use of GC-MS allows for the identification and quantification of hundreds of metabolites in a single plant extract, thereby providing comprehensive coverage of the central pathway of primary metabolism. The main advantage of this technique is that it has been used for metabolite profiling for a long time, so there is a stable machine setup and maintenance protocol, as well as chromatogram evaluation and interpretation (Lisec et al., 2006). However, it should be noted that the key requirement for GC is that the molecule should be sufficiently volatile to pass through the GC column when heated (Misra, Rai and Hossain, 2015). In short, it must be known that only volatile compounds can be analysed in GC (Jorge, Mata and António, 2016), and it tends to analyse primary metabolites (Panda, Parida and Rangani, 2018). Unlike GC-MS, LC-MS is a more versatile analytical technique in theory. It covers a wider range of masses and allows the targeting of many compound classes that GC-MS cannot detect. From the perspective of Panda and researchers: this may be due to LC does not require volatilization of the

compound, so it is suitable for analysis of metabolites with large molecular weight, temperature sensitivity, and chemically unstable functional groups. The most important advantage of using LC-MS is that it used a reversed-phase column to separate and analyze many secondary metabolites and complex lipids, which are resistant to gas chromatography volatilization (Matsuda et al., 2010; Okazaki et al., 2011). Today, modern LC-MS settings provide a superior choice for structural elucidation of unknown metabolites, namely accurate mass determination and elemental composition analysis (Xie et al., 2008). There is a design that combines LC-MS and metabolite profiling can detect secondary metabolites, including functional components in food and medicinal plants (Tamura et al., 2018). Recently, LC-MS has been proven to be a new powerful technique for identifying unknown components in plant extracts through the effective separation ability of high-performance liquid chromatography and the accurate structural characterization of mass spectrometry (Yang et al., 2009; Kumar, 2017). At the same time, tandem mass spectrometry (MS/MS) was introduced to increase the selectivity of detection and allow the identification of unknown metabolites (Karimpour, 2016). It can be said that the combination of liquid chromatography and tandem mass spectrometry (LC-MS/MS) has high sensitivity and selectivity and can detect metabolites in a wide range of samples. It enables us to characterize comprehensive metabolite accumulation patterns without relying on authentic standard compounds and isolating individual metabolites (Sawada and Hirai, 2013).

Nuclear magnetic resonance (NMR) spectroscopy has been established as a useful technique for determining the profile of plant metabolites in extracts

(Selegato, Pilon and Carnevale Neto, 2019). It is also widely accepted as ideally suited for structural confirmation and compound quantification in all areas of chemistry and pharmaceutical research (Thiele et al., 2011). However, Commisso et al. (2013) comment NMR is less sensitive than MS-based methods, and NMR data has been figuratively compared to the ‘tip of the iceberg,' with LC-MS is providing information on the much bigger, submerged section. Last but not least, NMR lacks the sensitivity needed for the simultaneous detection of thousands of metabolites seen in biological samples (Eisenreich and Bacher, 2007; Kim, Choi and Verpoorte, 2010; Blaženović et al., 2018).

2.3.3 Classification of Metabolites

Metabolites can be roughly divided into primary metabolites and secondary metabolites (Altaf-Ul-Amin, Kanaya and Mohamed-Hussein, 2018). Primary metabolites play a significant role in plant growth, development, maturation, senescence, and response to biotic or abiotic stressors. It is often referred to as a basal metabolite and is a key component of the physiological process that maintains normal energy and carbon supply (Wu et al., 2018). In fact, medicinal plants face many opponents in the natural system, so they have countless defensive abilities and have evolved a variety of resistance mechanisms through which they can respond to various biotic and abiotic stresses (Ballhorn et al., 2009). Here, secondary metabolites are some diverse chemical compounds produced by the plant to defend themselves against predators. Plant secondary metabolites are emphasized as compounds necessary for plant adaptation and

defence, but they do not play an important role in continuing of plant life processes. In addition, they are used by humans as medicines, flavoring agents, pharmaceuticals, agrochemicals, spices, pigments, biological pesticides, food additives and drugs (Jamwal, Bhattacharya and Puri, 2018). For different parts of the plant (leaf, root, bud, and bark), under varied environmental stresses (invasive microorganisms, herbivores), etc., the secondary metabolites are expressed in different combinations and combined into different classes in different ways (Delgoda and Murray, 2017). Although it is hard to draw general conclusions about plant secondary metabolite classification, Anulika et al. (2016) have been classified them into three chemically different groups, namely: Terpenes, Phenolics and Nitrogen-containing compounds.

2.3.3.1 Terpenes

Terpenes, also referred as terpenoids or isoprenoids are the most diverse chemically and structurally natural product family (more than 80000 members) (Christianson, 2017). According to reports, terpenes are divided into different groups, such as monoterpenes, sesquiterpenes, diterpenes, triterpenes, tetraterpenes, and polyterpenes (Verma and Shukla, 2015). It is the largest secondary metabolite in medicinal plants and has been extensively studied for its potential as an insecticide, antibacterial agent and weed control agent (Ninkuu et al., 2021). Recently, terpenes compounds reported its main role is to resist antibacterial and cytotoxic activity (Petrović, Stojković and Soković, 2019).

2.3.3.2 Phenolic compounds

Phenolic compounds are the second most abundant group of organic compounds in the plant kingdom and perform various functions in the plant, including structural support and protection against ultraviolet (UV) solar radiation, biotic or abiotic stress, pathogens, herbivores, and so on. All phenolic compounds have at least one aromatic ring with one hydroxyl group in their structure (de la Rosa et al., 2019). In addition, phenolic compounds are also considered one of the most common and widely distributed chemical classes in medicinal plants, with over 8000 different phenolic structures discovered (Tanase, Coșarcă and Muntean, 2019). Simple phenols, coumarins, lignins, lignans, condensed and hydrolysable tannins, phenolic acids, and flavonoids are examples (Khoddami, Wilkes and Roberts, 2013). These phytochemical compounds can be found in nutrients and herbal medicines; both flavonoids and many other phenolic components have been described as effective antioxidants, anticancer, antibacterial, cardioprotective agents, anti-inflammation, immune system boosting, skin protection from UV radiation, and attractive candidate for pharmaceutical and medical use (Chen, Dang and Facchini, 2015; Działo et al., 2016; Andreu et al., 2017; Meng et al., 2017; Tungmunnithum et al., 2018).

2.3.3.3 Nitrogen-containing compounds

In addition to terpenes and phenolics, nitrogen-containing compounds are also known as secondary metabolites that can protect medicinal plants from various insect herbivores. These metabolites, which impact herbivore feeding, growth, and survival, are generated either constitutively or in response to plant injury. Most nitrogen-containing secondary metabolites are biosynthesized from common amino acids, and they have attracted great interest due to their role in defense against herbivores and toxicity to humans (Taye and Borkataki, 2020; Jan et al., 2021). Nature is rich in nitrogen compounds, many of which are found in medicinal plants and are called alkaloids. It has been reported that Serotonin (Ferreira, Maia and Monteiro, 2002), Atropine (Almerico et al., 2010), Morphine (Schaefer et al., 2004), Coniine (Neamati et al., 1998), Caffeine (Deidda et al., 1998) and Nicotine (Kikuchi et al., 1999), etc., are the structural formulas of some representative alkaloids and other nitrogen-containing natural products (Shukla, Verma and Mishra, 2017). There are approximately 24,110 nitrogen-containing secondary metabolites recorded by the researchers (21,000 Alkaloids, 700 Non-protein amino acids, 60 Cyanogenic glycosides, 100 Glucosinolates, etc.), all of which are known secondary metabolites from higher medicinal plants (Wink, 2008). Recently, nitrogen-containing compounds have been discovered to have a wide range of biological activities, including antiproliferative (Çağlar Yavuz et al., 2020), antiviral (Zoidis et al., 2006), antimalarial (Kumar et al., 2015), anti-inflammatory (Khanum et al., 2009) and antimicrobial properties (Desai, Pandya and Vaja, 2017).

CHAPTER 3

MATERIALS AND METHODS

3.1 Selection and Collection of Medicinal Plant

Plant collection was carried out from August 2016 to April 2017. Prior to the field trip, a list of 153 local medicinal plants was given to the herbalist. The collection location was investigated by an herbalist. Then, a field trip with herbalist was conducted to collect specimens of each medicinal plant species. The purpose of the field trip was to collect a total of 35 species of medicinal plants from 153 species from the list (Table 3.1). The 35 local medicinal plants selected based on potential bioactivity, plant season and collection location. Table 3.1 showed the herbarium number, plant part collected for DNA barcoding analysis, plant part collected for LC-MS/MS analysis, and the specific location where plants were collected, corresponding to 35 medicinal plants. These medicinal plants were randomly collected from 8 a.m. to 12 noon. For general collection, commonly used equipment is listed in Table 3.2. For a quick overview of the experimental design in this study, the experimental layout of this study is shown in Figure 3.1.

Table 3.1: List of 35 local medicinal plants collected during field trips

No	Family Name	Scientific Plant Name	Herbarium Number	Plant Part (DNA barcoding analysis)	Plant Part (LC-MS/MS analysis)	GPS
1.	Acanthaceae	*Andrographis paniculata* (Burm.f.) Wall.ex Nees	LYMOOI 025	Young leaves	Leaves	N03° 01' 22.2" E101° 41' 33.6" 112m
2.	Acanthaceae	*Barleria lupulina* Lindl.	LYMOOI 036	Young leaves	Leaves	N02° 55' 38.9" E101° 55' 40.5" 97m
3.	Acanthaceae	*Clinacanthus nutans* (Burm.f) Lindau	LYMOOI 049	Young leaves	Leaves	N02° 55' 40.0" E101° 55' 40.0" 94m
4.	Acanthaceae	*Gendarussa ventricosa* (Wall.) Nees	LYMOOI 017	Young leaves	Leaves	N02° 46' 33.3" E101° 45' 11.3" 19m
5.	Acanthaceae	*Gendarussa vulgaris* Nees.	LYMOOI 041	Young leaves	Leaves	N02° 55' 39.8" E101° 55' 40.4" 106m
6.	Acanthaceae	*Rhinacanthus nasutus* (L) Kurz	LYMOOI 062	Young leaves	Leaves	N02° 55' 53.5" E101° 55' 31.7" 124m

Table 3.1 (Continued)

No	Family Name	Scientific Plant Name	Herbarium Number	Plant Part (DNA barcoding analysis)	Plant Part (LC-MS/MS analysis)	GPS
7.	Acanthaceae	*Ruellia simplex* C. Wright	LYMOOI 056	Young leaves	Leaves	N02° 55' 53.8" E101° 55' 29.3" 126m
8.	Acanthaceae	*Strobilanthes crispus* Blume	LYMOOI 033	Young leaves	Leaves	N03° 30' 54.4" E101° 05 '50.1" 9m
9.	Apocynaceae	*Catharanthus roseus* (L) G. Don	LYMOOI 057	Young leaves	Leaves	N02° 55' 53.8" E101° 55' 29.3" 126m
10.	Araceae	*Alocasia macrorrhizos* (L.) G.Don	LYMOOI 055	Young leaves	Root	N02° 55' 39.3" E101° 55' 39.6" 103m
11.	Araceae	*Rhaphidophora decursiva* (Roxb.) Schott	LYMOOI 064	Young leaves	Leaves	N02° 55' 54.3" E101° 55' 30.9" 127m
12.	Araceae	*Typhonium flagelliforme* (Lodd.) Blume	LYMOOI 060	Young leaves	Tuber	N02° 55' 53.8" E101° 55' 30.9" 127m
13.	Asclepiadaceae	*Calotropis gigantea* (L.) W.T.Aiton	LYMOOI 007	Young leaves	Leaves	N02° 47 '39.4" E101° 45 '50.3" 20m

Table 3.1 (Continued)

No	Family Name	Scientific Plant Name	Herbarium Number	Plant Part (DNA barcoding analysis)	Plant Part (LC-MS/MS analysis)	GPS
14.	Cucurbitaceae	*Gynostemma pentaphyllum* (Thunb.) Makino	LYMOOI 039	Young leaves	Leaves	N02° 55' 39.4" E101° 55' 40.5" 99m
15.	Cycadaceae	*Cycas revoluta*	LYMOOI 053	Young leaves	Leaves	N02° 55' 39.3" E101° 55 '39.6" 103m
16.	Cyperaceae	*Kyllinga brevifolia* Robbt	LYMOOI 005	Young leaves	Whole Plant	N02° 48 '01.1" E101° 46 '08.4" 27m
17.	Dioscoreaceae	*Dioscorea bulbifera* (L)	LYMOOI 018	Young leaves	Whole Plant	N02° 46' 33.2" E101° 45' 11.5" 16m
18.	Labiatae	*Ocimum basilicum* L.	LYMOOI 040	Young leaves	Whole Plant	N02° 55' 39.5" E101° 55' 40.4" 98m
19.	Labiatae	*Orthosiphon aristatus* (Blume) Miq.	LYMOOI 029	Young leaves	Leaves	N03° 30' 47.0" E101° 07' 50.1" 10m
20.	Lamiaceae	*Vitex trifolia* L.	LYMOOI 006	Young leaves	Whole Plant	N02° 47 '59.9" E101° 46 '06.3" 26m
21.	Lamiaceae	*Mentha spicata* L.	LYMOOI 004	Young leaves	Whole Plant	N03° 30' 21.0" E101° 06' 21.4" 15m

Table 3.1 (Continued)

No	Family Name	Scientific Plant Name	Herbarium Number	Plant Part (DNA barcoding analysis)	Plant Part (LC-MS/MS analysis)	GPS
22.	Lamiaceae	*Plectranthus amboinicus* (Lour.) Spreng.	LYMOOI 061	Young leaves	Leaves	N02° 55' 53.8" E101° 55' 31.2" 129m
23.	Lythraceae	*Punica granatum* L.	LYMOOI 070	Young leaves	Pericarp	N1° 58' 54.1" E102° 56' 21.8”
24.	Malvaceae	*Hibiscus mutabilis* L.	LYMOOI 045	Young leaves	Leaves	N02° 55' 39.6" E101° 55' 40.3" 97m
25.	Malvaceae	*Urena lobata* (L.)	LYMOOI 008	Young leaves	Root	N02° 47' 39.8" E101° 45' 52.0" 24m
26.	Melastomataceae	*Clidemia hirta* (L.) D. Don	LYMOOI 011	Young leaves	Leaves	N02° 47' 38.9" E101° 45' 51.9" 24m
27.	Melastomataceae	*Melastoma malabathricum* L.	LYMOOI 009	Young leaves	Root	N02° 47' 39.8" E101° 45' 52.0" 24m
28.	Plantaginaceae	*Plantago major* L.	LYMOOI 034	Young leaves	Leaves	N03° 31' 03.9" E101° 05' 51.5" 9m
29.	Rubiaceae	*Morinda citrifolia* L.	LYMOOI 031	Young leaves	Fruit	N03° 30' 59.5" E101° 08' 08.7" 9m

Table 3.1 (Continued)

No	Family Name	Scientific Plant Name	Herbarium Number	Plant Part (DNA barcoding analysis)	Plant Part (LC-MS/MS analysis)	GPS
30.	Rubiaceae	*Oldenlandia auricularia*	LYMOOI 015	Young leaves	Leaves	N02° 46' 33.3" E101° 45' 12.0" 19m
31.	Rubiaceae	*Oldenlandia corymbosa* (L)	LYMOOI 066	Young leaves	Whole Plant	N02° 55' 55.5" E101° 55' 28.1" 116m
32.	Rubiaceae	*Oldenlandia diffusa* (Willd.) Roxb	LYMOOI 073	Young leaves	Leaves	N1° 58' 54.1" E102° 56' 21.8"
33.	Verbenaceae	*Lantana camara* L.	LYMOOI 035	Young leaves	Leaves	N02° 55' 38.4" E101° 55' 40.1" 99m
34.	Verbenaceae	*Phyla nodiflora*	LYMOOI 001	Young leaves	Leaves	N02° 48' 01.6" E101° 46' 07.2" 30m
35.	Verbenaceae	*Stachytarpheta jamaicensis* (L) Vahl	LYMOOI 019	Young leaves	Whole Plant	N02° 46' 31.6" E101° 45' 13.2" 25m

Table 3.2: List of equipment for general collection

No	Item	Quantity	Aim
1.	Corrugated cardboard	Dozens	Inserted between the dry paper to balance the pressure and promote the ventilation of the pressing.
2.	Newspaper	1 bundle	To cover and separate specimens.
3.	Wooden board and straps	2 set	To press the plant sample.
4.	Secateurs	2	Cut and trim specimens.
5.	GPS	1	Recording an accurate longitude, latitude, and elevation of a field site.
6.	Field notebook	2	Record the field characteristics of the specimen.
7.	Pencil	1	Pencils for numbering collection and writing notes.
8.	Plastic bags	1 bundle	To hold specimens temporarily.
9.	Gloves	1 box	For handling prickly medicinal plant material or poisonous medicinal plants.
10.	Camera	1	To photograph the form or colour of the plant.
11.	Tape measures	1	To measure the plant samples.
12.	Specimen tags	1 box	Mark all specimens with field numbers.

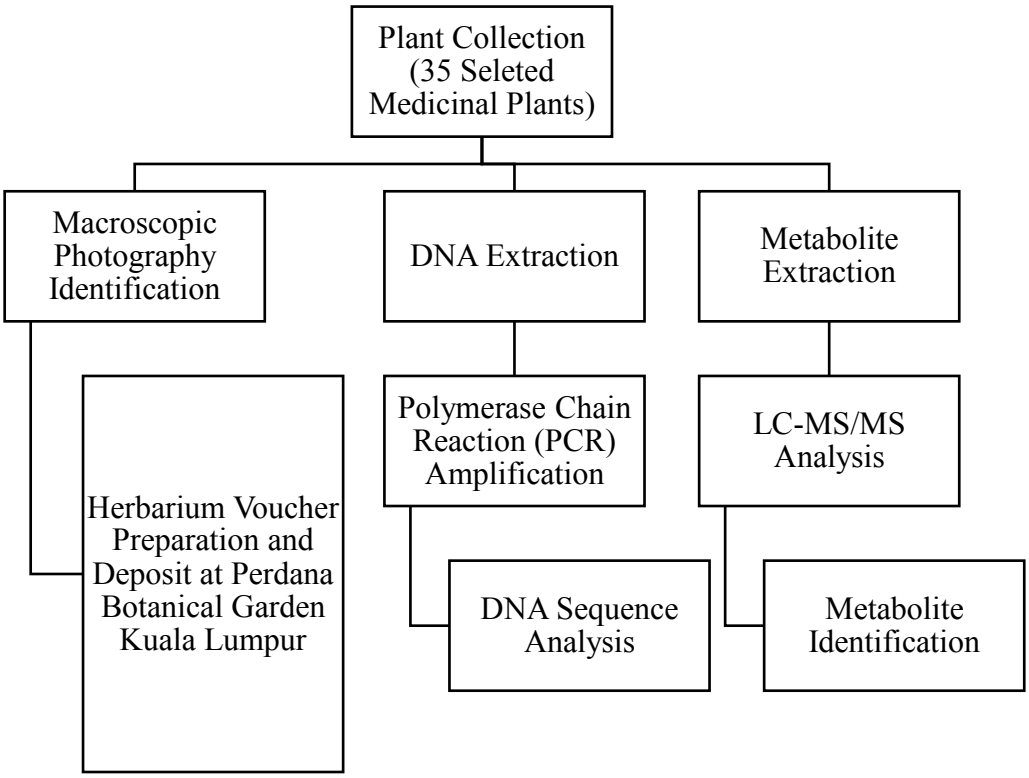

Figure 3.1: Experimental design layout in this study

3.2 Macroscopic Photography

Plant identification is to compare unknown medicinal plants with previously collected specimens to determine their identity, and the specimens collected during the identification process are associated with the plant name (Gawli and Gaikwad, 2020). In a traditional approach, one or more of the plant characteristics were used for plant identification. Paper of Prasad, Kudiri and Tripathi (2011) points out the characteristics as follows: the plant as a whole, flowers, stem, fruits, and leaves. The sampling and collection of medicinal plants was conducted with the help of local herbalist, Mr Haw Ming Hock. During plant collection, herbalist played roles of oral transmission of indigenous plant

knowledge and assisted in providing remedies (Dawn, 2003; Boudjelal et al., 2013). The camera was used to take the photo of desired medicinal plants external features such as leaves, stem, fruit or whole plant at the time of collection. Plant identification of 35 selected species was still in the preliminary stages of the plant collection process. Dr Richard Chung, the plant taxonomist responsible for description, identification, nomenclature, and classification (Simpson, 2019) from Forest Research Institute Malaysia was later consulted for the taxonomic identification of the medicinal plants. All the data collected was in accordance with the field note suggested by Forest Research Institute Malaysia.

3.3 Herbarium Voucher Preparation and Deposition

The herbarium voucher was prepared according to the methods acquired by Forest Research Institute Malaysia. All the plant specimens freshly collected were assigned with a specimen code and then were immediately processed for herbarium voucher. The medicinal plants sample were carefully cleaned, mounted with newspaper, pressed with wooden board, and placed inside the oven for drying. The dried plant specimens were sent to Perdana Botanical Garden Kuala Lumpur for mounting, verification, and storage. The herbarium specimen sheet was pasted at the right-side bottom corner. The taxonomy data collection was recorded in the database BRAHMS (Botanical Research and Herbarium Management System).

3.4 DNA Barcoding

Accurate identification of selected 35 plant samples were important for their safety, efficacy and herbal remedies. Hence, DNA extraction from 35 plant samples were performed followed by PCR amplification. The short sequence of three selected universal primers (*rbc*L, *mat*K, ITS markers) were used to identify the plant identities. Subsequently, all the successful sequence plant samples were blasting in the NCBI database.

3.4.1 DNA Extraction

A total of 35 medicinal plant species was sampled for DNA barcoding. Young leaves were chosen for the DNA extraction as chemical defenses accumulated in older leaves tend to reduce the quality of DNA extracted (Moreira and Oliveira, 2011). Prior to DNA extraction, all the leaves were first wiped with 75% ethanol to remove and adhering dirt and sand as well as kill any surface microbes. The leaves collected from individual plant samples were ground in liquid nitrogen and total DNA was extracted using the GeneJET Plant Genomic DNA Purification Kit (Thermo Scientific) using standard protocol. Lysis Buffer A, Lysis Buffer B and RNase A was added into grounded tissues. The extracted samples were incubated for 10 mins at 65°C. Then 130µl of Precipitation solution was added and mixed by inverting the tubes for few times before incubate on ice for 5 minutes. Then the tubes were kept in centrifuge for 5 minutes at 14,000 rpm. The aqueous later was transferred into a new tube and

400µl of Plant gDNA Binding Solution and 400µl 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 purified DNA was kept at -20°C for polymerase chain reaction (PCR) (Suriani et al., 2021).

3.4.2 Polymerase Chain Reaction (PCR) Amplification

Samples were amplified by PCR using the primer pairs listed in Table 3.3 for *rbc*L, *mat*K and ITS by Phire Plant Direct PCR Mastermix (Thermo Scientific). PCR was performed using Veriti 96 Well Thermal Cycle (Applied Biosystems). Repetitions of PCR were performed again under the same conditions for those samples of no band or weak bands. Successfully amplified DNA fragment was then visualized using 1.5% agarose gel electrophoresis. DNA ladder of DM2100 ExcelBand 100bp (SMOBIO) was used to estimate the size of amplification products (Appendix A) (Meanchaipiboon, Kobayashi and Nakatsuka, 2021). Band of the expected size was excised prior to being sent for DNA sequencing at the company Apical Scientific Malaysia (Seepiban et al., 2017).

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,	Fazekas et al., 2012
	rbcLajf634R	GAA ACG GTC TCT CCA ACG CAT	55°C for 30 s, 72°C for 1 min; final extension 72°C for 10 min.	
*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,	Fazekas et al., 2012
	matK-1326r	TCT AGC ACA CGA AAG TCG AAG T	48°C for 40 s, 72°C for 1 min, and a final extension at 72°C for 10 min	
ITS	ITS_5p	GGA AGG AGA AGT CGT AAC AAG G	94°C for 5 min, 35 cycles of 94°C for 30 s,	Möller and Cronk., 1997
	ITS_8P	CAC GCT TCT CCA GAC TAC A	55°C for 40 s, 72°C for 1 min, and a final extension at 72°C for 10 min	

3.4.3 DNA Sequence Analysis

Primers used for PCR amplification were also used in DNA sequencing reactions, Table 3.3. Bidirectional sequencing data was aligned using MEGA 7.0. Bioinformatics tool was then used to identify the identity of the species. Aligned and consensus sequences for each locus of each plant sample were searched in Genbank database through BLAST Procedure (Appendix B) (McGinnis and

Madden, 2004). Top matching hit of maximum identity (>95% in single species) of each sample was taken as the barcoding identification (de Groot et al., 2011). If the result indicated that the sample is different with the prior assigned taxon, it was flagged as a possible error and the sample was then compared with descriptions and herbariums specimens of the species involved, using morphological characteristics to confirm whether an error had been made.

3.5 LC-MS/MS

3.5.1 Metabolite Extraction

35 samples of local medicinal plants were dried in oven (Model UF450) with temperature of 40˚C for 5 days and grinded into powder by using mortar and pestle. 5 ±0.5 mg grinded samples were exhaustively extracted based on Folch extraction protocol (Folch, Lees and Stanley, 1957) with appropriate modifications (Ling et al., 2014; Lee et al., 2018; Puah et al., 2019). Briefly, powdered medicinal plants were extracted using solvent at a final ratio of 100% methanol: 100% chloroform: 0.05 M NaCl solution equal to 1:1:1 v/v/v.The samples were centrifuged at 500 g at 4°C for 30 minutes. Both upper (hydrophilic metabolites) and lower (hydrophobic metabolites) layers were transferred, vaporized, and stored at -80°C until analysis. Prior to the LC-MS/MS analysis, plant extracts were re-dissolved in 1.5 mL methanol.

3.5.2 LC-MS/MS Analysis

The LC-MS/MS system consists of Vanquish UHPLC system (Thermo Scientific, Waltham, MA, USA) coupled to ultra-high-resolution Q-Time-of-flight Impact II (Bruker, Billerica, MA, USA) was used for the metabolite profiling. In short, 10 µL and 30 µL extract was inserted to the system at positive and negative electrospray ionization modes, respectively. The chromatographic separation was done on a Pentafluorophenyl column, Kinetex F5 (2.1 mm x 100 mm x 2.6 µm; Phenomenex, Torrance, California, USA). The column temperature was kept at 35°C. The flow rate was set at 0.6 mL/min. For separation, mobile phases A (mixture of deionized water with 0.1 % formic acid and 1% ammonium acetate (NH_4AC)) and mobile phase B (mixture of acetonitrile and methanol [6:4 v/v] with 0.1 % formic acid and 1 % NH_4AC) were used. The gradient elution was set 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 carried on for 3 min. Then, the column was equilibrated with initial gradient for 1 minutes before the next sample injection. 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 calibration was enabled using Tune Mix (Sigma-Aldrich, St Louis, MO, USA) before each batch analysis. Mass calibrant, sodium formate was presented between 0.1-0.3 min during each acquisition. Post-acquisition obtained analytes m/z were calibrated against sodium formate. Various collision energies used during molecule fragmentation was carried out based on manufacturer's

guidelines where molecules < m/z 200, 201-500, 501-750, and > 751 was pre-established at 10, 20, 30, and 35 eV, respectively.

3.5.3 Metabolite Identification

Signal threshold was set above 1×10^3 intensity during compound matching. By using MS Finder (Lai et al., 2017) matched to database such as UNPD (nature product), Pubchem (biomolecule), KNApSAcK (nature product), NANPDB (nature product) and PlantCyc (plant) to identify extracted plant metabolite. Mass-to-charge ratio compliment with the fragmented spectral and acceptable mass tolerance (at 5 ppm) was strongly recommended to reveal the plant metabolome identity.

CHAPTER 4

RESULTS

4.1 Plant Sampling, Photography and Herbarium Voucher

A total of 35 species in 32 genera and 16 families were included in this study. There are 6 species in Selangor, 27 species in Negeri Sembilan, and 2 species in Johor. The collected local medicinal plants are processed for preparation of herbarium voucher, DNA barcoding and metabolite analysis study.

The capture of 35 photograph sets were recorded during field trips. Photograph images (including herbarium photo) documented as shown in Figures 4.1 to 4.35. Besides, Tables 4.1 to 4.35 show the voucher numbers, and the final label of the herbarium voucher of each sample respectively. In this study,the 35 herbarium voucher is sorted in Family + species in AZ order; each photography set is sorted if at all possible, habitat> stem> leaves > flower > fruit> tuber.

4.1.1 *Andrographis paniculata* (Burm.f.) Wall.ex Nees LYMOOI 025

Representative photographs dataset of morphology characteristic for *Andrographis paniculata* are shown in Figure 4.1a-b. Data obtained from the field notebook as shown in Table 4.1 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.1c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.1: Specimen LYMOOI 025 (A) Habitat. (B) Leaves and Flower. (C) Vouchered *Andrographis paniculata* (Burm.f.) Wall.ex Nees LYMOOI 025

Table 4.1: Information relating to vouchered specimen of *Andrographis paniculata* (Burm.f.) Wall.ex Nees LYMOOI 025

Voucher	LYMOOI 025
Family	Acanthaceae
Scientific Name	*Andrographis paniculata* (Burm.f.) Wall.ex Nees
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' 22.2" E101° 41' 33.6" 112m
Habitat	Residential area, loam soil moderate moisture and full sunlight.
Description	Annual herb with branched growth forms up to 0.5m tall. The slender stem is dark green, squared in cross-section with longitudinal furrows and wings along the angles. The lance-shaped leaves have hairless blades. Flowers are white in colour.
Medicinal Property	Not available

4.1.2 *Barleria lupulina* Lindl. LYMOOI 036

Representative photographs dataset of morphology characteristic for *Barleria lupulina* are shown in Figure 4.2a-b. Data obtained from the field notebook as shown in Table 4.2 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.2c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.2: Specimen LYMOOI 036 (A) Habitat. (B) Spine. (C) Vouchered *Barleria lupulina* Lindl. LYMOOI 036

Table 4.2: Information relating to vouchered specimen of *Barleria lupulina* Lindl. LYMOOI 036

Voucher	LYMOOI 036
Family	Acanthaceae
Scientific Name	*Barleria lupulina* Lindl.
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' 40.5" 97m
Habitat	Growing on slope of secondary forest.
Description	Perennial shrub grows to the height of 1.8m tall. Leaves size: 6.7-15.8cm and 0.8-1.3cm wide. Leaves are linear oblong and spine-tipped, the upper surface is dark green in colour with a distinct red midrib while the under surface is of a lighter shade of green. Stem is smooth, having red to brownish branches.
Medicinal Property	External used medication in Chinese orthopaedics, treat herpes zoster. Flower has anti-cancer property.

4.1.3 *Clinacanthus nutans* (Burm.f) Lindau LYMOOI 049

Representative photographs dataset of morphology characteristic for *Clinacanthus nutans* are shown in Figure 4.3a-b. Data obtained from the field notebook as shown in Table 4.3 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.3c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.3: Specimen LYMOOI 049 (A) Habitat. (B) Leaves. (C) Vouchered *Clinacanthus nutans* (Burm.f) Lindau LYMOOI 049

Table 4.3: Information relating to vouchered specimen of *Clinacanthus nutans* (Burm.f) Lindau LYMOOI 049

Voucher	LYMOOI 049
Family	Acanthaceae
Scientific Name	*Clinacanthus nutans* (Burm.f) Lindau
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' 40.0" 94m
Habitat	Growing on slope, secondary forest with moderate moist soil, partial to full sunlight.
Description	Perennial herbs grow up to 1.6m. Leaves size: 1.0-1.8m long and 3.2-9.0cm wide. Stems cylindrical, leaves are simple, opposite, narrowly elliptic-oblong.
Medicinal Property	Clear heat and cleansing toxin, anti-cancer.

4.1.4 *Gendarussa ventricosa* (Wall.) Nees LYMOOI 017

Representative photographs dataset of morphology characteristic for *Gendarussa ventricosa* are shown in Figure 4.4a-d. Data obtained from the field notebook as shown in Table 4.4 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.4e) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

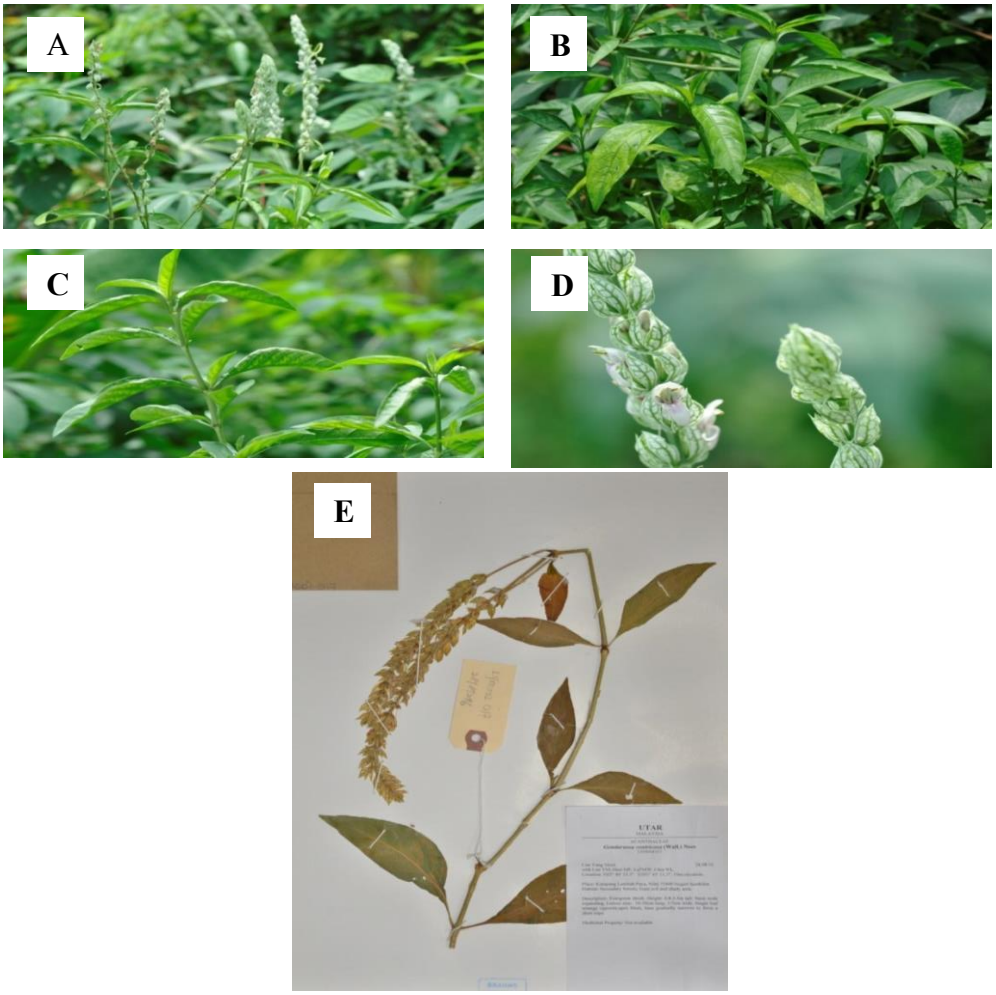

Figure 4.4: Specimen LYMOOI 017 (A) Habitat. (B) Leaves. (C) Lateral view. (D) Inflorescences on spikes. (E) Vouchered specimen *Gendarussa ventricosa* (Wall.) Nees LYMOOI017

Table 4.4: Information relating to vouchered specimen of *Gendarussa ventricosa* (Wall.) Nees LYMOOI 017

Voucher	LYMOOI 017
Family	Acanthaceae
Scientific Name	*Gendarussa ventricosa* (Wall.) Nees
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' 11.3" 19m
Habitat	Secondary forests, loam soil and shady area.
Description	Evergreen shrub. Height: 0.8-1.5m tall. Stem node expanding. Leaves size: 10-20cm long, 3-7cm wide. Single leaf arrange opposite, apex blunt, base gradually narrows to form a short stipe.
Medicinal Property	Not available

4.1.5 *Gendarussa vulgaris* Nees. LYMOOI 041

Representative photographs dataset of morphology characteristic for *Gendarussa vulgaris* are shown in Figure 4.5a-b. Data obtained from the field notebook as shown in Table 4.5 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.5c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.5: Specimen LYMOOI 041 (A) Habitat. (B) Leaves and. stem. (C) Vouchered *Gendarussa vulgaris* Nees.LYMOOI 041

Table 4.5: Information relating to vouchered specimen of *Gendarussa vulgaris* Nees. LYMOOI 041

Voucher	LYMOOI 041
Family	Acanthaceae
Scientific Name	*Gendarussa vulgaris* Nees.
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" 106m
Habitat	Growing on slope, sandy soil with semi-shade to full sunlight and well-drained soil with moderate moisture.
Description	Shrub that grows up to 1.5-2.3m tall. Leaves size: 5-9.2cm long and 0.7-2cm wide, arrange oppositely. Leaves simple, and apex acute-acuminate. Stems multi-branched.
Medicinal Property	Traditionally used in orthopaedics, either orally administered or apply externally as it has the property of activating blood and resolve stasis.

4.1.6 *Rhinacanthus nasutus* (L) Kurz LYMOOI 062

Representative photographs dataset of morphology characteristic for *Rhinacanthus nasutus* are shown in Figure 4.6a-b. Data obtained from the field notebook as shown in Table 4.6 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.6c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.6: Specimen LYMOOI 062 (A) Leaves. (B) Flower. (C) Vouchered *Rhinacanthus nasutus* (L) Kurz LYMOOI 062

Table 4.6: Information relating to vouchered specimen of *Rhinacanthus nasutus* (L) Kurz LYMOOI 062

Voucher	LYMOOI 062
Family	Acanthaceae
Scientific Name	*Rhinacanthus nasutus* (L) Kurz
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' 53.5" E101° 55' 31.7" 124m
Habitat	Growing on slope, moist loam with full sunlight.
Description	Small shrub can grow up to 1.1-1.6m. Leaves size: 3-6cm long and 1-2.5cm wide. Stems are erect and branched, leaves are simple and opposite, flower is white colour.
Medicinal Property	Treat tinea, cough, and Liver disease

4.1.7 *Ruellia simplex* C. Wright LYMOOI 056

Representative photographs dataset of morphology characteristic for *Ruellia simplex* are shown in Figure 4.7a-b. Data obtained from the field notebook as shown in Table 4.7 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.7c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.7: Specimen LYMOOI 056 (A) Habitat. (B) Flower. (C) Vouchered *Ruellia simplex* C. Wright LYMOOI 056

Table 4.7: Information relating to vouchered specimen of *Ruellia simplex* C. Wright LYMOOI 056

Voucher	LYMOOI 056
Family	Acanthaceae
Scientific Name	*Ruellia simplex* C. Wright
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' 29.3" 126m
Habitat	Growing on slope with well-drained soil, part shade to full sunlight.
Description	Evergreen shrub with height 60-95cm tall. Leaves size: 9-13cm long and 1.3-2cm wide. Semi-woody stalks, with dark green leaves oppositely at the nodes. The blue or purple colour flowers are fluted-funnel shaped and about 4-5cm in diameter.
Medicinal Property	Not available

4.1.8 *Strobilanthes crispus* Blume LYMOOI 033

Representative photographs dataset of morphology characteristic for *Strobilanthes crispus* are shown in Figure 4.8a-b. Data obtained from the field notebook as shown in Table 4.8 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.8c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.8: Specimen LYMOOI 033 (A) Habitat. (B) Top view of leaves. (C) Vouchered *Strobilanthes crispus* Blume LYMOOI 033

Table 4.8: Information relating to vouchered specimen of *Strobilanthes crispus* Blume LYMOOI 033

Voucher	LYMOOI 033
Family	Acanthaceae
Scientific Name	*Strobilanthes crispus* Blume
Date of Collection	11th November 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Jalan Aman Jaya 1, Taman Aman Jaya, 45400 Sekinchan, Selangor
Location	N03° 30' 54.4" E101° 05 '50.1" 9m
Habitat	Roadside of residential area. Full sunlight.
Description	Woody spreading shrub. Height: 1-1.6m tall. Leaves size: 5-8cm long and 2-6cm wide, elliptical in shape, cover with short hairs. Yellow flower with funnel-shaped.
Medicinal Property	In folk medicine, the leaves are used to treat cancer.

4.1.9 *Catharanthus roseus* (L) G. Don LYMOOI 057

Representative photographs dataset of morphology characteristic for *Catharanthus roseus* are shown in Figure 4.9a-b. Data obtained from the field notebook as shown in Table 4.9 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.9c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.9: Specimen LYMOOI 057 (A) Leaves and flower. (B) Bud. (C) Vouchered *Catharanthus roseus* (L) G. Don LYMOOI 057

Table 4.9: Information relating to vouchered specimen of *Catharanthus roseus* (L) G. Don LYMOOI 057

Voucher	LYMOOI 057
Family	Apocynaceae
Scientific Name	*Catharanthus roseus* (L) G. Don
Date of Collection	15th January 2017
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Broga Lenggeng, Negeri Sembilan
Location	Location: N02° 55' 53.8" E101° 55' 29.3" 126m
Habitat	Growing on slope with well-drained soil and full sunlight.
Description	Evergreen herbaceous plant growing 40-80 cm tall. Leaves size: 4-8cm long and 2-3cm wide. Shining dark green leaves arranged in opposite pairs. The dark pink flower has 5 petals with a basal tube.
Medicinal Property	Not available

4.1.10 *Alocasia macrorrhizos* (L.) G.Don LYMOOI 055

Representative photographs dataset of morphology characteristic for *Alocasia macrorrhizos* are shown in Figure 4.10a-b. Data obtained from the field notebook as shown in Table 4.10 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.10c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.10: Specimen LYMOOI 055 (A) Habitat. (B) Leaves. (C) Vouchered *Alocasia macrorrhizos* (L.) G.Don LYMOOI 055

Table 4.10: Information relating to vouchered specimen of *Alocasia macrorrhizos* (L.) G.Don LYMOOI 055

Voucher	LYMOOI 055
Family	Araceae
Scientific Name	*Alocasia macrorrhizos* (L.) G.Don
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	Secondary forests, loam soil and shady area.
Description	Herbaceous perennial. Height: 1.2-2.2m tall. Leaves size: 60-100cm long and 36-48cm wide. Plant is fleshy and non-woody. Leaves are giant heart-shaped or broadly ovate with slightly undulate margins.
Medicinal Property	Juice from macerated leaves can used to treat fever. As externally applied ointment used for wound of snake bite.

4.1.11 *Rhaphidophora decursiva* (Roxb.) Schott LYMOOI 064

Representative photographs dataset of morphology characteristic for *Rhaphidophora decursiva* are shown in Figure 4.11a-b. Data obtained from the field notebook as shown in Table 4.11 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.11c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.11: Specimen LYMOOI 064 (A) Habitat. (B) Leaves. (C) Vouchered *Rhaphidophora decursiva* (Roxb.) Schott LYMOOI 064

Table 4.11: Information relating to vouchered specimen of *Rhaphidophora decursiva* (Roxb.) Schott LYMOOI 064

Voucher	LYMOOI 064
Family	Araceae
Scientific Name	*Rhaphidophora decursiva* (Roxb.) Schott
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' 54.3" E101° 55' 30.9" 127m
Habitat	Grow in bark. Moist environment
Description	Vines and climber. Perennial, evergreen leaves. Leaves are large up to 80cm long, glossy, pinnately lobed.
Medicinal Property	Decoction used to treat gastric cancer.

4.1.12 *Typhonium flagelliforme* (Lodd.) Blume LYMOOI 060

Representative photographs dataset of morphology characteristic for *Typhonium flagelliforme* are shown in Figure 4.12a-d. Data obtained from the field notebook as shown in Table 4.12 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.12e) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

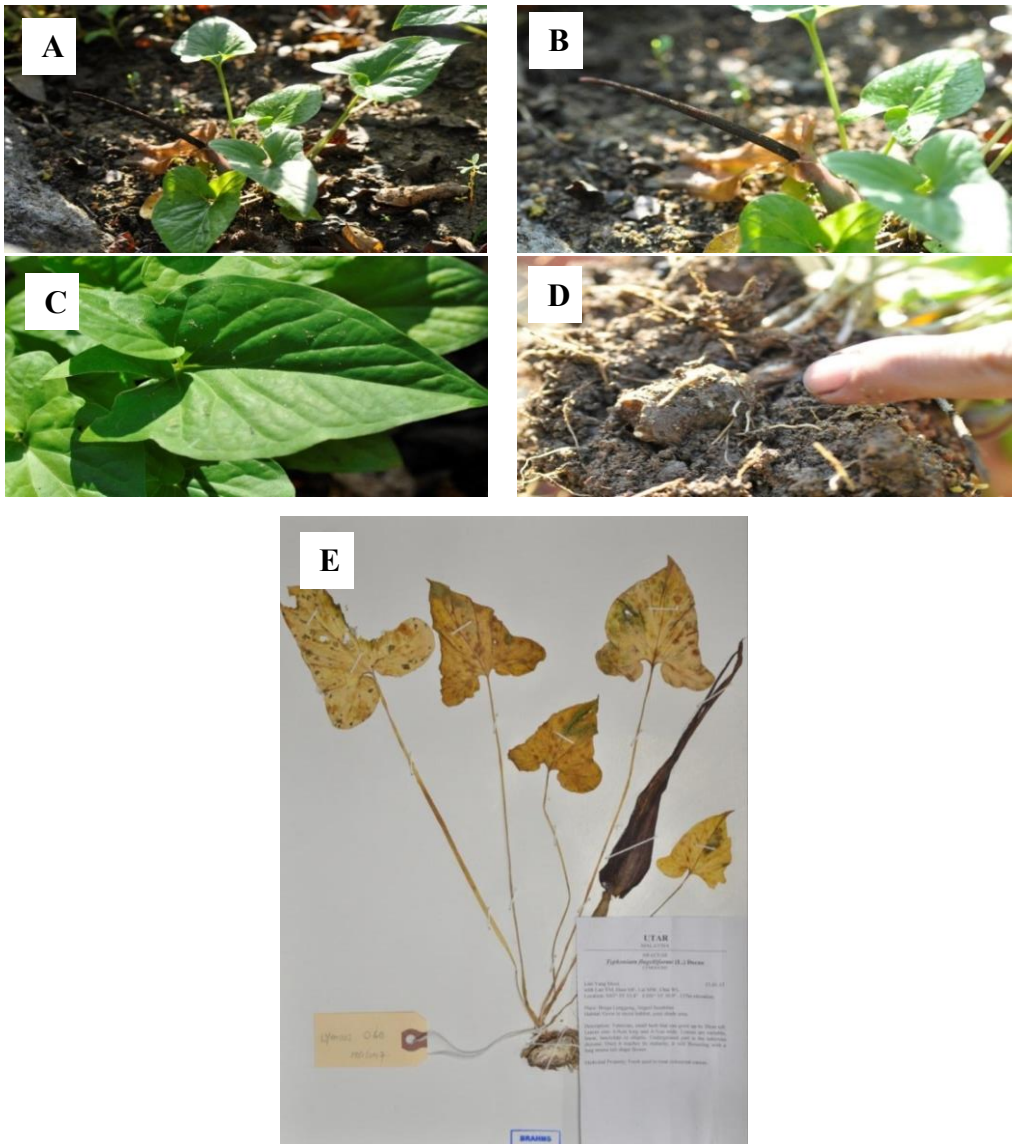

Figure 4.12: Specimen LYMOOI 060 (A) Habitat. (B) Spathe. (C) Top view of leaf. (D) tuber. (E) Vouchered *Typhonium flagelliforme* (Lodd.) Blume LYMOOI 060

Table 4.12: Information relating to vouchered specimen of *Typhonium flagelliforme* (Lodd.) Blume LYMOOI 060

Voucher	LYMOOI 060
Family	Araceae
Scientific Name	*Typhonium flagelliforme* (Lodd.) Blume
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' 30.9" 127m
Habitat	Grow in moist Habitat, semi shade area.
Description	Tuberous, small herb that can grow up to 30 cm tall. Leaves size: 6-9 cm long and 4-7 cm wide. Leaves are variable, linear, lanceolate or elliptic. Underground part is the tuberous rhizome. Once it reaches its maturity, it will be flowering with a long mouse tail shape flower.
Medicinal Property	Fresh used to treat colorectal cancer.

4.1.13 *Calotropis gigantea* (L.) W.T.Aiton LYMOOI 007

Representative photographs dataset of morphology characteristic for *Calotropis gigantea* are shown in Figure 4.13a-b. Data obtained from the field notebook as shown in Table 4.13 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.13c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.13: Specimen LYMOOI 007 (A) Habitat. (B) Flowers. (C) Vouchered specimen *Calotropis gigantea* (L.) W.T.Aiton LYMOOI 007

Table 4.13: Information relating to vouchered specimen of *Calotropis gigantea* (L.) W.T.Aiton LYMOOI 007

Voucher	LYMOOI 007
Family	Asclepiadaceae
Scientific Name	*Calotropis gigantea* (L.) W.T.Aiton
Date of Collection	28th August 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Jalan BBN 7c/2c, 71800 Nilai Negeri Sembilan
Location	N02° 47 '39.4" E101° 45 '50.3" 20m
Habitat	Sandy, well-drained soil with full sunlight.
Description	Shrub that can grow up to 2-3m tall. Leaves size: 8-10cm long, 6-8cm wide. The plant has oval, light green leaves and milky stem. Clusters of waxy flowers which are either white or lavender in colour, the diameter of flower is ranging from 3-5cm.
Medicinal Property	Not available

4.1.14 *Gynostemma pentaphyllum* (Thunb.) Makino LYMOOI 039

Representative photographs dataset of morphology characteristic for *Gynostemma pentaphyllum* are shown in Figure 4.14a-b. Data obtained from the field notebook as shown in Table 4.14 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.14c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.14: Specimen LYMOOI 039 (A) Habitat. (B) Top view of leaves. (C) Vouchered *Gynostemma pentaphyllum* (Thunb.) Makino LYMOOI 039

Table 4.14: Information relating to vouchered specimen of *Gynostemma pentaphyllum* (Thunb.) Makino LYMOOI 039

Voucher	LYMOOI 039
Family	Cucurbitaceae
Scientific Name	*Gynostemma pentaphyllum* (Thunb.) Makino
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' 39.4" E101° 55' 40.5" 99m
Habitat	Growing on slope, well-drained soil, and moisture-retentive soil with partial shade to full sunlight.
Description	Short lived perennial climbing vine attaching itself to support using tendrils. Leaves size: 0.5-5 cm long and 0.3-1.7 cm wide. The serrated leaflets commonly grow in groups of seven.
Medicinal Property	Lower blood pressure and glucose level

4.1.15 *Cycas revoluta* LYMOOI 053

Representative photographs dataset of morphology characteristic for *Cycas revoluta* are shown in Figure 4.15a-b. Data obtained from the field notebook as shown in Table 4.15 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.15c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.15: Specimen LYMOOI 053 (A) Stem. (B) Leaves. (C) Vouchered *Cycas revoluta* LYMOOI 053

Table 4.15: Information relating to vouchered specimen of *Cycas revoluta* LYMOOI 053

Voucher	LYMOOI 053
Family	Cycadaceae
Scientific Name	*Cycas revoluta*
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 full sunlight of secondary forest.
Description	Scrub with height 1-2m tall. Symmetrical plant supports a crown of shiny, needle-like dark green leaves on a thick shaggy trunk.
Medicinal Property	Decoction of leaves have anti-cancer property.

4.1.16 *Kyllinga brevifolia* Robbt LYMOOI 005

Representative photographs dataset of morphology characteristic for *Kyllinga brevifolia* are shown in Figure 4.16a-b. Data obtained from the field notebook as shown in Table 4.16 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.16c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.16: Specimen LYMOOI 005 (A) Habitat. (B) Top view. (C) Vouchered specimen *Kyllinga brevifolia* Robbt LYMOOI 005

Table 4.16: Information relating to vouchered specimen of *Kyllinga brevifolia* Robbt LYMOOI 005

Voucher	LYMOOI 005
Family	Cyperaceae
Scientific Name	*Kyllinga brevifolia* Robbt
Date of Collection	28th August 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Between Jalan BBN 6/2f and Jalan BBN 6/2g, 71800 Nilai Negeri Sembilan
Location	N02° 48 '01.1" E101° 46 '08.4" 27m
Habitat	Wet loam beside the drain, planted or wild.
Description	Plant height range from 5-35 cm. Leaves size: 2-10cm long and 0.1-0.3 cm wide. Leaves are ligule absent, the part of the leaf that occurs at the junction of the blade and sheath of the leaf. Stems are triangular and can produce terminal seedheads. The flower stalk is triangular in cross section. Directly below the flower is a group of three leaves that radiates out from the stalk
Medicinal Property	Whole plant juice is used as cooling agent to alleviate fever, traditionally used to treat damp-heat fever and heat cough, anti-mosquito application.

4.1.17 *Dioscorea bulbifera* (L) LYMOOI 018

Representative photographs dataset of morphology characteristic for *Dioscorea bulbifera* are shown in Figure 4.17a-d. Data obtained from the field notebook as shown in Table 4.17 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.17e) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

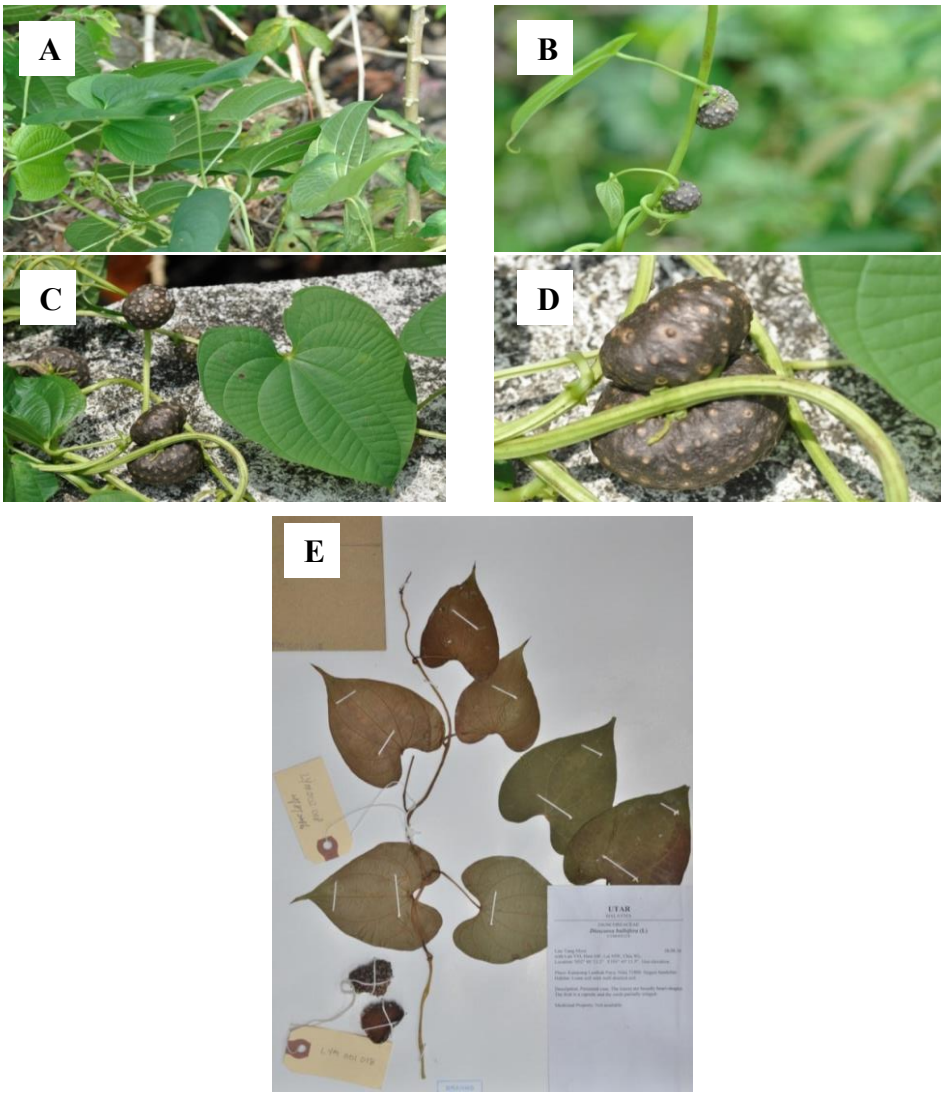

Figure 4.17: Specimen LYMOOI 018 (A) Habitat. (B) Lateral view of vein and aerial tubers (C) Top view of leaf. (D) Aerial tubers. (E) Vouchered specimen *Dioscorea bulbifera* (L) LYMOOI018

Table 4.17: Information relating to vouchered specimen of *Dioscorea bulbifera* (L) LYMOOI 018

Voucher	LYMOOI 018
Family	Dioscoreaceae
Scientific Name	*Dioscorea bulbifera* (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' 33.2" E101° 45' 11.5" 16m
Habitat	Loam soil with well-drained soil.
Description	Perennial vine. The leaves are broadly heart-shaped. The fruit is a capsule and the seeds partially winged.
Medicinal Property	Not available

4.1.18 *Ocimum basilicum* L. LYMOOI 040

Representative photographs dataset of morphology characteristic for *Ocimum basilicum* are shown in Figure 4.18a-b. Data obtained from the field notebook as shown in Table 4.18 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.18c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.18: Specimen LYMOOI 040 (A) Habitat. (B) Top view of leaves. (C) Vouchered specimen *Ocimum basilicum* L. LYMOOI 040

Table 4.18: Information relating to vouchered specimen of *Ocimum basilicum* L. LYMOOI 040

Voucher	LYMOOI 040
Family	Labiatae
Scientific Name	*Ocimum basilicum* 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' 39.5" E101° 55' 40.4" 98m
Habitat	Growing on slope, semi shade to full sunlight, well-drained loam soil with moderate moisture.
Description	0.4-0.8 m tall. Leaves size: 0.5-5.0 cm long and 0.5-2.5 cm wide. Large leaves which are ovate to elliptic. The leaf surface is very wrinkled and the leaf margin is lined with minute teeth that are widely spaced apart.
Medicinal Property	Regulating stomach qi, used to treat the symptoms of stomach distension and indigestion.

4.1.19 *Orthosiphon aristatus* (Blume) Miq. LYMOOI 029

Representative photographs dataset of morphology characteristic for *Orthosiphon aristatus* are shown in Figure 4.19a-b. Data obtained from the field notebook as shown in Table 4.19 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.19c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.19: Specimen LYMOOI 029 (A) Habitat. (B) Spike of flower. (C) Vouchered *Orthosiphon aristatus* (Blume) Miq. LYMOOI 029

Table 4.19: Information relating to vouchered specimen of *Orthosiphon aristatus* (Blume) Miq. LYMOOI 029

Voucher	LYMOOI 029
Family	Labiatae
Scientific Name	*Orthosiphon aristatus* (Blume) Miq.
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' 47.0" E101° 07' 50.1" 10m
Habitat	River side near paddy field, loam soil with full sunlight.
Description	Perennial, herbaceous plants. Height: 0.3 m to 1.8 m. Four strikingly long stamens, which stick out, as long as a pen, looking like a cat's whiskers sticking out from the white to pale purple flowers lip. The flowers are in spike-like flowery whorls.
Medicinal Property	Not available

4.1.20 *Vitex trifolia* L. LYMOOI 006

Representative photographs dataset of morphology characteristic for *Vitex trifolia* are shown in Figure 4.20a-b. Data obtained from the field notebook as shown in Table 4.20 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.20c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

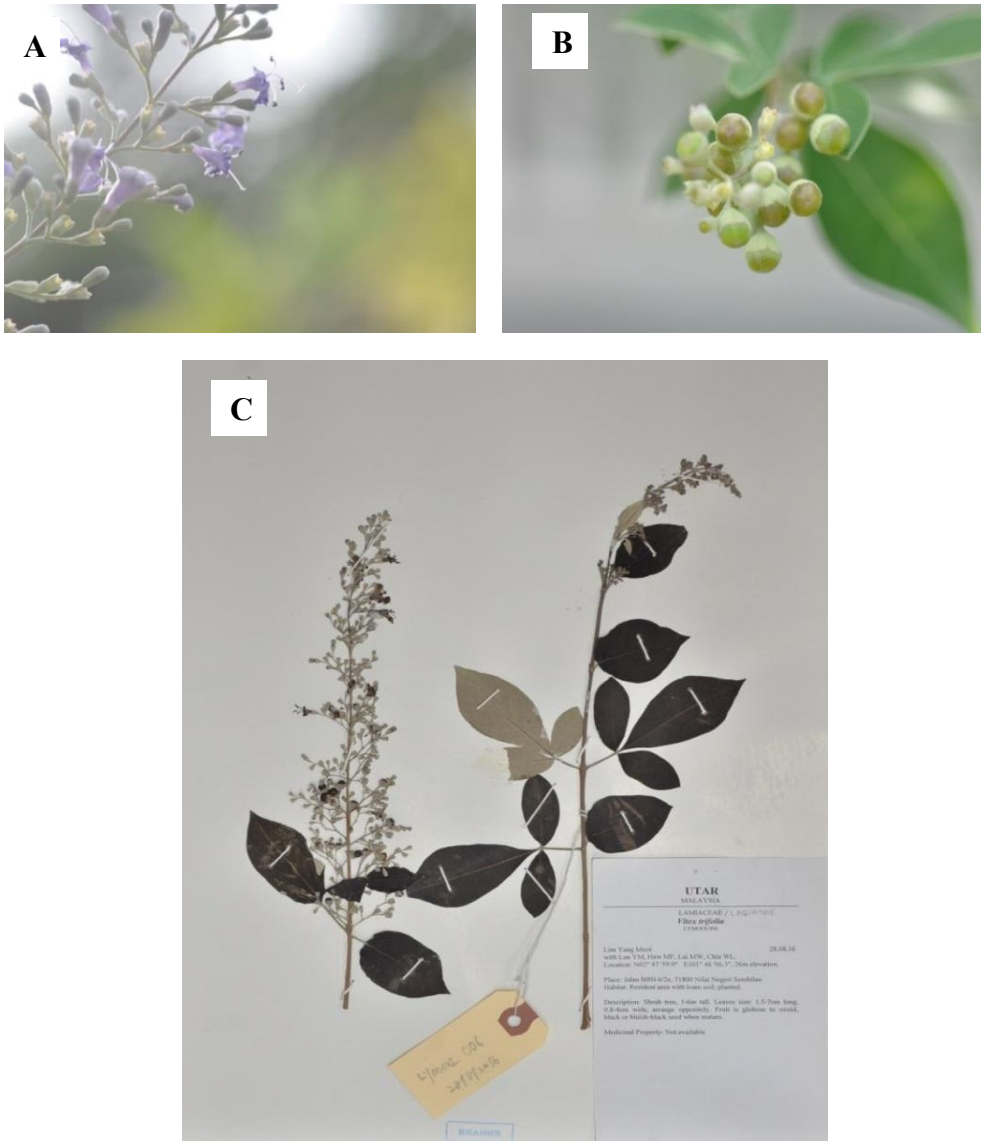

Figure 4.20: Specimen LYMOOI 006 (A) Flower. (B) Fruits. (C) Vouchered specimen *Vitex trifolia* L. LYMOOI 006

Table 4.20: Information relating to vouchered specimen of *Vitex trifolia* L. LYMOOI 006

Voucher	LYMOOI 006
Family	Lamiaceae
Scientific Name	*Vitex trifolia* L.
Date of Collection	28th August 2016
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Jalan BBN 6/2e, 71800 Nilai Negeri Sembilan
Location	N02° 47 '59.9" E101° 46 '06.3" 26m
Habitat	Resident area with loam soil; planted.
Description	Shrub tree, 1-6 m tall. Leaves size: 1.5-7 cm long, 0.8-4 cm wide, arrange oppositely. Fruit is globose to ovoid, black or bluish-black seed when mature.
Medicinal Property	Not available

4.1.21 *Mentha spicata* L. LYMOOI 004

Representative photographs dataset of morphology characteristic for *Mentha spicata* are shown in Figure 4.21a-b. Data obtained from the field notebook as shown in Table 4.21 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.21c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.21: Specimen LYMOOI 004 (A) Habitat. (B) Top view. (C) Vouchered specimen *Mentha spicata* L. LYMOOI 004

Table 4.21: Information relating to vouchered specimen of *Mentha spicata* L. LYMOOI 004

Voucher	LYMOOI 004
Family	Lamiaceae
Scientific Name	*Mentha spicata* L.
Date of Collection	17th February 2017
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	Jalan Malinja, 45400 Sekinchan, Selangor
Location	N03° 30' 21.0" E101° 06' 21.4" 15m
Habitat	Resident area with damp soil and shady area.
Description	Herbaceous perennial plant. Height: 10-35 cm tall. Hairy stems and leaves, and a wide-spreading rhizome. The leaves are 1-4 cm long, 0.6-2.5 cm wide. It has a very pleasant and refreshing taste of spearmint.
Medicinal Property	Not available

4.1.22 *Plectranthus amboinicus* (Lour.) Spreng. LYMOOI 061

Representative photographs dataset of morphology characteristic for *Plectranthus amboinicus* are shown in Figure 4.22a-b. Data obtained from the field notebook as shown in Table 4.22 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.22c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

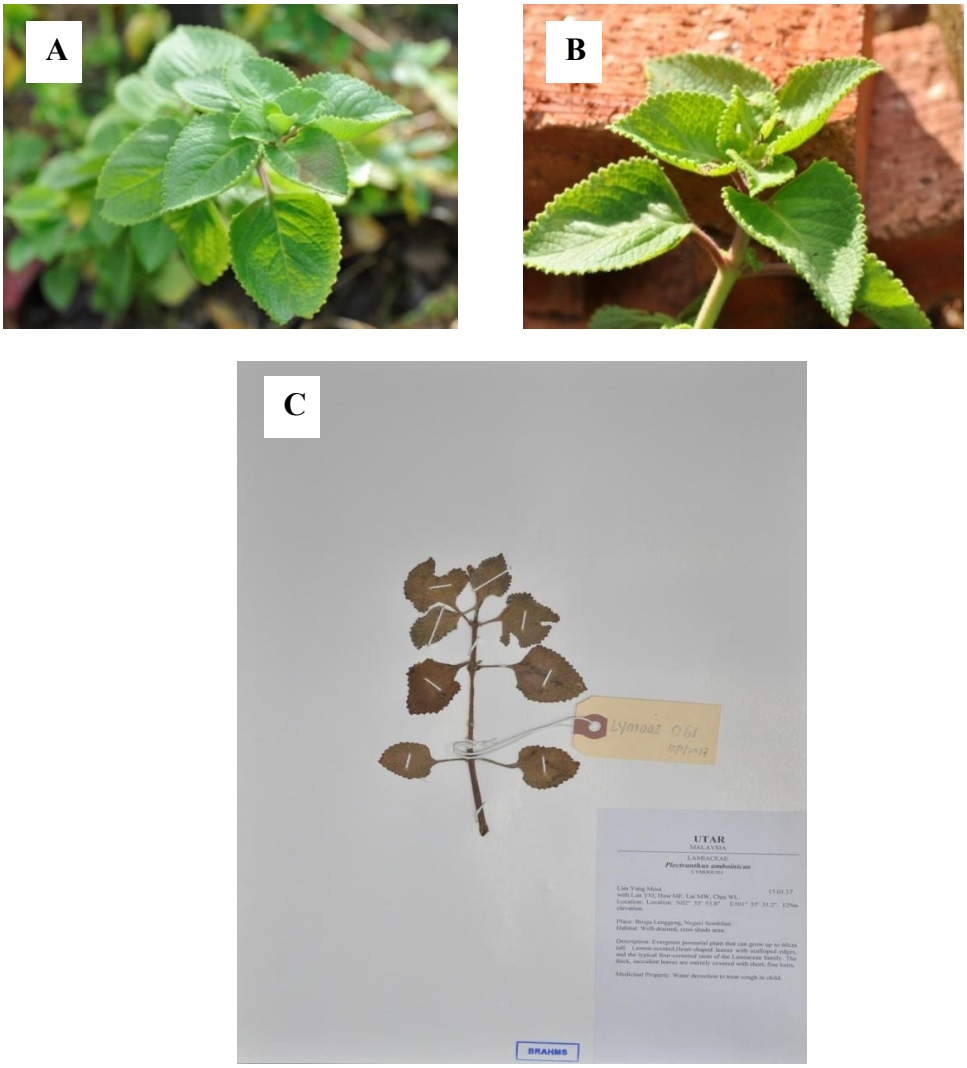

Figure 4.22: Specimen LYMOOI 061 (A) Top view of leaves. (B) Lateral view of leaves. (C) Vouchered *Plectranthus amboinicus* (Lour.) Spreng.LYMOOI 061

Table 4.22: Information relating to vouchered specimen of *Plectranthus amboinicus* (Lour.) Spreng. LYMOOI 061

Voucher	LYMOOI 061
Family	Lamiaceae
Scientific Name	*Plectranthus amboinicus* (Lour.) Spreng.
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' 31.2" 129m
Habitat	Well-drained, semi shade area.
Description	Evergreen perennial plant that can grow up to 60 cm tall. Heart-shaped, lemon-scented leaves with scalloped edges, and the typical four-cornered stem of the Lamiaceae family. The thick, succulent leaves are entirely covered with short, fine hairs.
Medicinal Property	Water decoction to treat cough in child.

4.1.23 *Punica granatum* L. LYMOOI 070

Representative photographs dataset of morphology characteristic for *Punica granatum* are shown in Figure 4.23a-b. Data obtained from the field notebook as shown in Table 4.23 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.23c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.23: Specimen LYMOOI 070 (A) Leaves. (B) Fruits. (C) Vouchered Punica granatum L. LYMOOI 070

Table 4.23: Information relating to vouchered specimen of *Punica granatum* L. LYMOOI 070

Voucher	LYMOOI 070
Family	Lythraceae
Scientific Name	*Punica granatum* L.
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	Cultivated at shop lot area, grown under full sunlight to semi-shade in well drained and fertile soil.
Description	Shrub or small tree growing up to 2 m high. Leaves size: 3-7 cm long and 2 cm wide, arrange opposite, narrow oblong. The flowers are red in colour. The fruits are red-brown in colour when ripe, and are spherical and leathery in shape. The fruit is divided into compartments, and the seeds are encased in a juicy, edible pulp.
Medicinal Property	The bark on the roots is used to treat tapeworms and other intestinal worms.

4.1.24 *Hibiscus mutabilis* L. LYMOOI 045

Representative photographs dataset of morphology characteristic for *Hibiscus mutabilis* are shown in Figure 4.24a-b. Data obtained from the field notebook as shown in Table 4.24 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.24c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.24: Specimen LYMOOI 045 (A) Habitat. (B)Bud. (C) Vouchered *Hibiscus mutabilis* L. LYMOOI 045

Table 4.24: Information relating to vouchered specimen of *Hibiscus mutabilis* L. LYMOOI 045

Voucher	LYMOOI 045
Family	Malvaceae
Scientific Name	*Hibiscus mutabilis* 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' 39.6" E101° 55' 40.3" 97m
Habitat	Full sunlight with moderate moist loam soil.
Description	Perennial shrub grows up to 3 m. Leaves size: 7-10.9 cm long and 5-11.8 cm wide. Large, green leaves hairy on the underside. Fluted-funnel shaped flowers are initially white, but darkens to pink and then red at maturity.
Medicinal Property	Flower: Soothing liver and relieve depression. Leaf: Clear heat and eliminate toxin.

4.1.25 *Urena lobata* (L.) LYMOOI 008

Representative photographs dataset of morphology characteristic for *Urena lobata* are shown in Figure 4.25a-d. Data obtained from the field notebook as shown in Table 4.25 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.25e) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

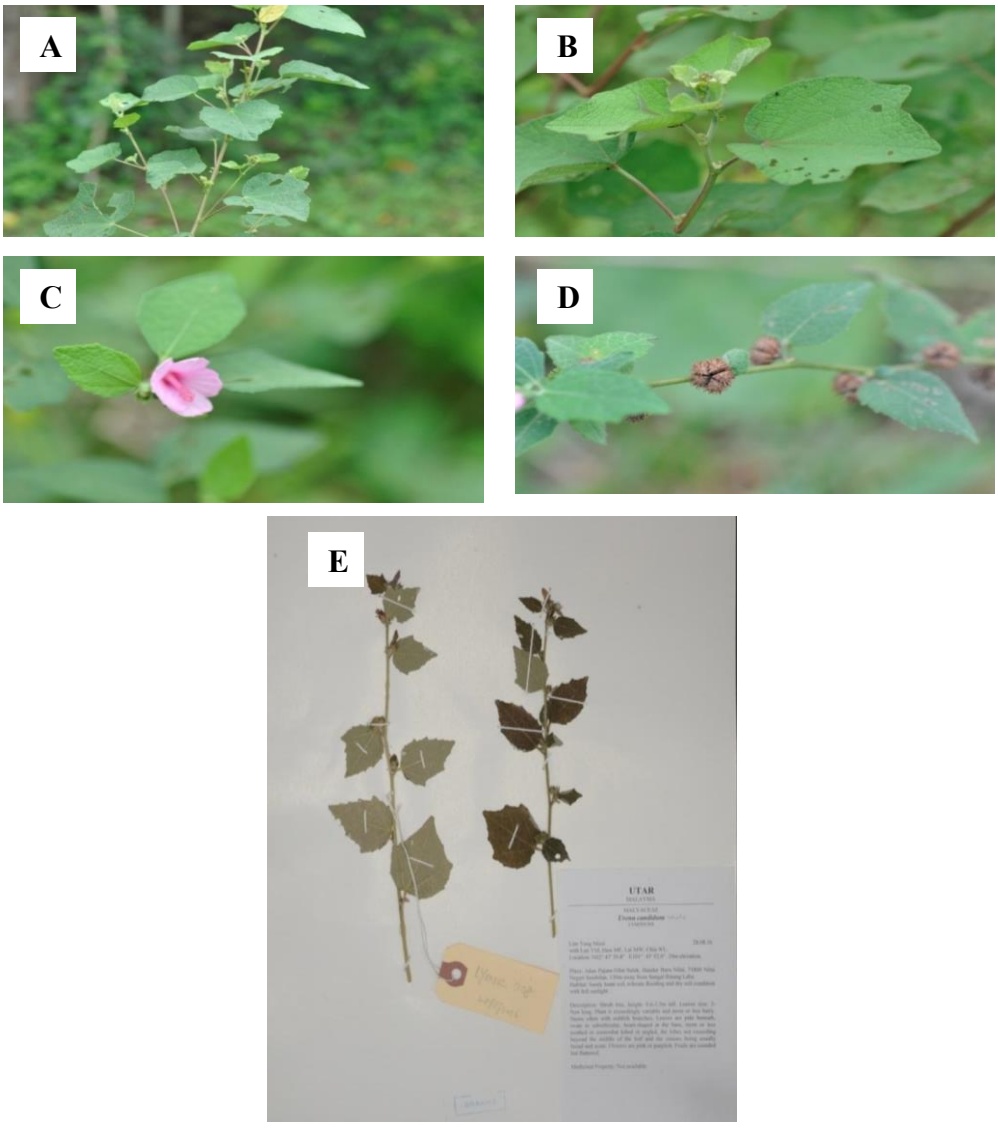

Figure 4.25: Specimen LYMOOI 008 (A) Habitat. (B) Leaves. (C) Flower. (D) Mature fruit. (E) Vouchered specimen *Urena lobata* (L.) LYMOOI 008

Table 4.25: Information relating to vouchered specimen of *Urena lobata (L.)* LYMOOI 008

Voucher	LYMOOI 008
Family	Malvaceae
Scientific Name	*Urena lobata* (L.)
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. 130m away from Sungai Batang Labu
Location	N02°47' 39.8" E101° 45' 52.0" 24m
Habitat	Sandy loam soil, tolerate flooding and dry soil condition with full sunlight.
Description	Shrub tree, height: 0.6-2.5 m tall. Leaves size: 3-9 cm long. Plant is exceedingly variable and more or less hairy. Stems often with reddish branches. Leaves are pale beneath, ovate to suborbicular, heart-shaped at the base, more or less toothed or somewhat lobed or angled, the lobes not exceeding beyond the middle of the leaf and the sinuses being usually broad and acute. Flowers are pink or purplish. Fruits are rounded but flattened.
Medicinal Property	Not available

4.1.26 *Clidemia hirta* (L.) D. Don LYMOOI 011

Representative photographs dataset of morphology characteristic for *Clidemia hirta* are shown in Figure 4.26a-d. Data obtained from the field notebook as shown in Table 4.26 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.26e) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

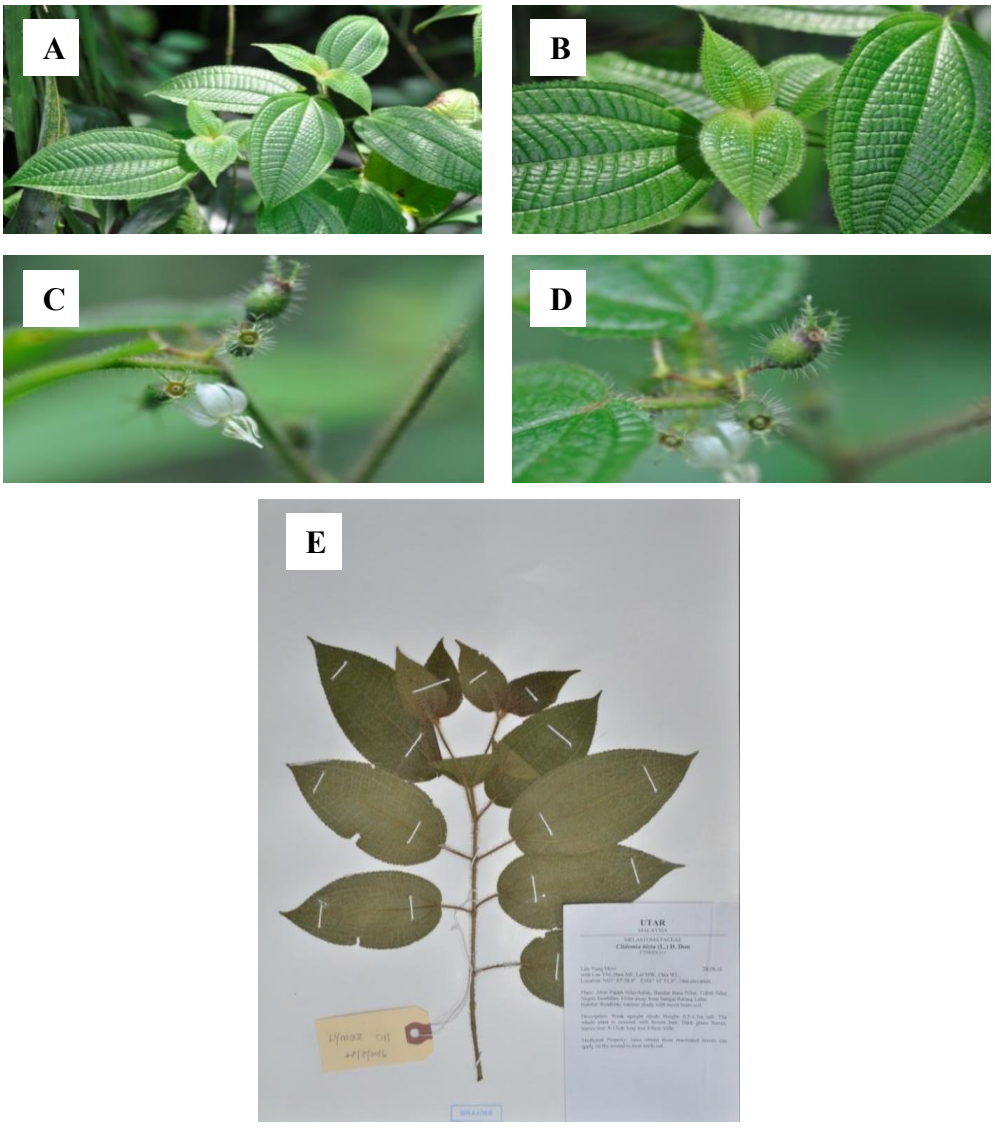

Figure 4.26: Specimen LYMOOI 011 (A) Habitat. (B) Leaves from top view. (C) Flower. (D) Fruit. (E) Vouchered specimen *Clidemia hirta* (L.) D. Don LYMOOI 011

Table 4.26: Information relating to vouchered specimen of *Clidemia hirta* (L.) D. Don LYMOOI 011

Voucher	LYMOOI 011
Family	Melastomataceae
Scientific Name	*Clidemia hirta* (L.) D. Don
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" 24m
Habitat	Roadside, various shady with moist loam soil.
Description	Weak upright shrub. Height: 0.5 - 1.3 m tall. The whole plant is covered with brown hair. Dark green leaves, leaves size: 8-13 cm long and 4-8 cm wide.
Medicinal Property	Juice obtained from macerated leaves can apply on the wound to treat knife cut.

4.1.27 *Melastoma malabathricum* L. LYMOOI 009

Representative photographs dataset of morphology characteristic for *Melastoma malabathricum* are shown in Figure 4.27a-d. Data obtained from the field notebook as shown in Table 4.27 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.27e) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

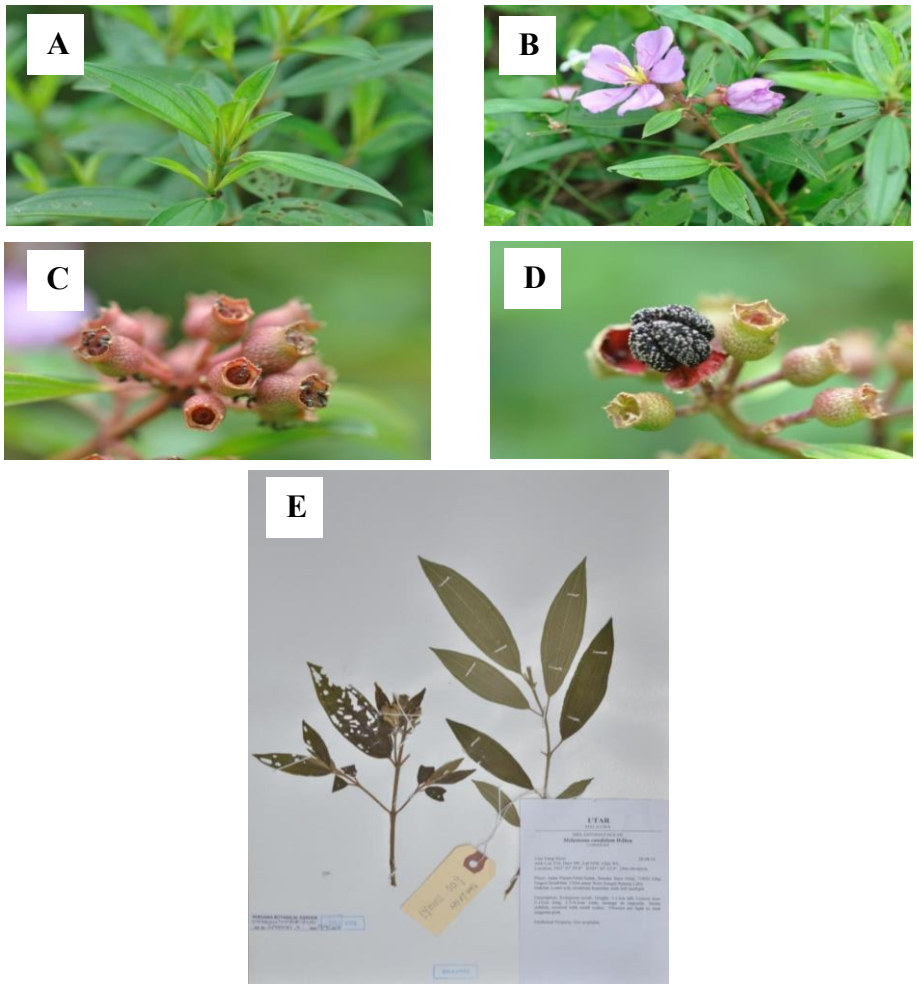

Figure 4.27: Specimen LYMOOI 009 (A) Leaves (B) Leaves and flower. (C) Unripe fruits. (D) Ripe fruit. (E) Vouchered specimen *Melastoma malabathricum* L. LYMOOI 009

Table 4.27: Information relating to vouchered specimen of *Melastoma malabathricum* L. LYMOOI 009

Voucher	LYMOOI 009
Family	Melastomataceae
Scientific Name	*Melastoma malabathricum* L.
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. 130 m away from Sungai Batang Labu
Location	N02° 47' 39.8" E101° 45' 52.0" 24m
Habitat	Loam soil, moderate humidity with full sunlight.
Description	Evergreen scrub. Height: 1-1.6 m tall. Leaves size: 5-12 cm long, 1.5-4.5 cm wide, arrange in opposite. Stems reddish, covered with small scales. Flowers are light to dark magenta-pink.
Medicinal Property	Not available

4.1.28 *Plantago major* L. LYMOOI 034

Representative photographs dataset of morphology characteristic for *Plantago major* are shown in Figure 4.28a-b. Data obtained from the field notebook as shown in Table 4.28 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.28c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.28: Specimen LYMOOI 034 (A) Habitat. (B) Spike of flower. (C) Vouchered *Plantago major* L. LYMOOI 034

Table 4.28: Information relating to vouchered specimen of *Plantago major* L. LYMOOI 034

Voucher	LYMOOI 034
Family	Plantaginaceae
Scientific Name	*Plantago major* L.
Date of Collection	11th November 2016
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" 9m
Habitat	Beside the drain of residential area. Moderate to high moisture and well-drained soil with various shade.
Description	Perennial herb that grows to the height of 15–60 cm tall. Leaves size: 10-12 cm long and 3.8-8 cm wide. Leaves gather on the ground, have oval blades, with obtuse apex and base, and 5 smooth main veins from the leaf base. The petioles are almost the same length as the blades.
Medicinal Property	Not available

4.1.29 *Morinda citrifolia* L. LYMOOI 031

Representative photographs dataset of morphology characteristic for *Morinda citrifolia* are shown in Figure 4.29a-c. Data obtained from the field notebook as shown in Table 4.29 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.29d) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

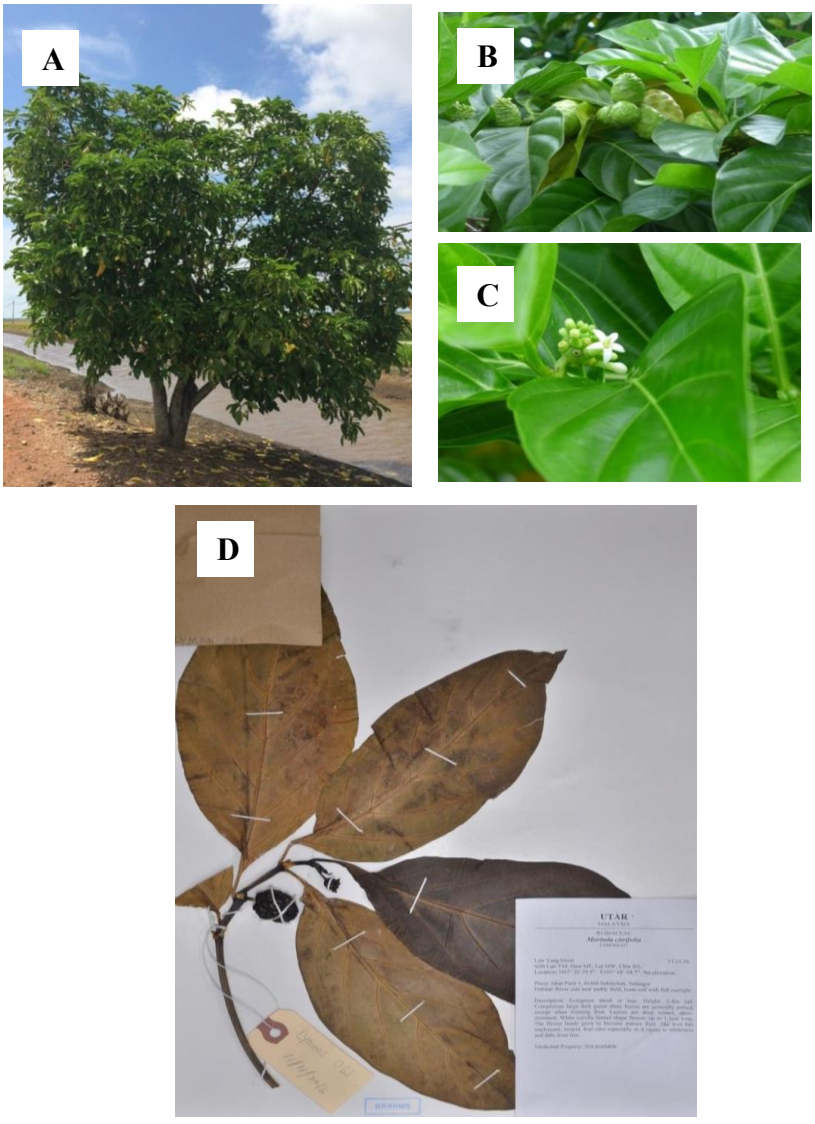

Figure 4.29: Specimen LYMOOI 031 (A) Habitat. (B) Fruit. (C) Flower. (D) Vouchered *Morinda citrifolia* L. LYMOOI 031

Table 4.29: Information relating to vouchered specimen of *Morinda citrifolia* L. LYMOOI 031

Voucher	LYMOOI 031
Family	Rubiaceae
Scientific Name	*Morinda citrifolia* L.
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" 9m
Habitat	River side near paddy field, loam soil with full sunlight.
Description	Evergreen shrub or tree. Height: 2-8 m tall. Conspicuous large dark green shiny leaves are generally paired, except when forming fruit. Leaves are deep veined, short-stemmed. White corolla funnel shape flower, up to 1.5 cm long. The flower heads grow to become mature fruit. The fruit has unpleasant, insipid, foul odour especially as it ripens to whiteness and falls from tree.
Medicinal Property	Not available

4.1.30 *Oldenlandia auricularia* LYMOOI 015

Representative photographs dataset of morphology characteristic for *Oldenlandia auricularia* are shown in Figure 4.30a-b. Data obtained from the field notebook as shown in Table 4.30 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.30c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

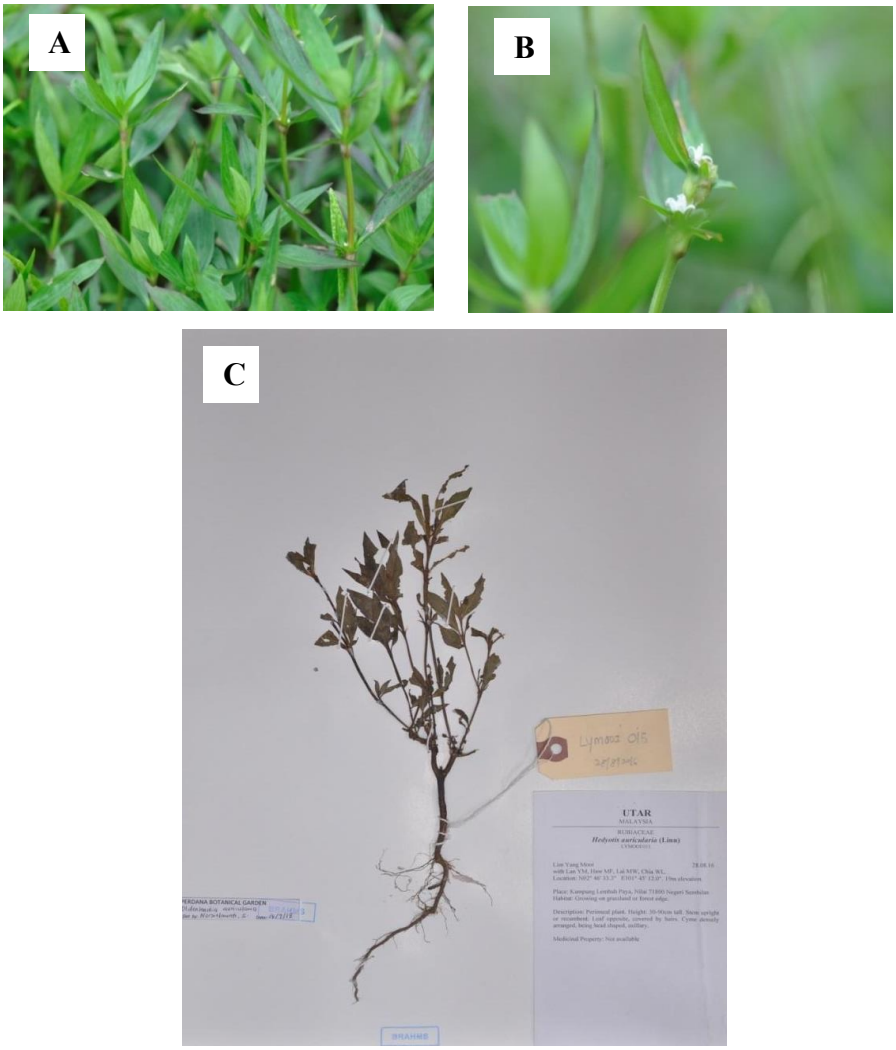

Figure 4.30: Specimen LYMOOI 015 (A) Habitat. (B) Leaves and flower. (C) Vouchered specimen *Oldenlandia auricularia* LYMOOI 015

Table 4.30: Information relating to vouchered specimen of *Oldenlandia auricularia* LYMOOI 015

Voucher	LYMOOI 015
Family	Rubiaceae
Scientific Name	*Oldenlandia auricularia*
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' 12.0" 19m
Habitat	Growing on grassland or forest edge.
Description	Perennial plant. Height: 30-90 cm tall. Stem grow upright or recumbent. Leaf opposite, covered by hairs. Cyme densely arranged, being head shaped, axillary.
Medicinal Property	Not available

4.1.31 *Oldenlandia corymbosa* (L) LYMOOI 066

Representative photographs dataset of morphology characteristic for *Oldenlandia corymbosa* are shown in Figure 4.31a-b. Data obtained from the field notebook as shown in Table 4.31 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.31c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.31: Specimen LYMOOI 066 (A) Habitat. (B) Leaves and flower position. (C) Vouchered *Oldenlandia corymbosa* (L) LYMOOI 066

Table 4.31: Information relating to vouchered specimen of *Oldenlandia corymbosa* (L) LYMOOI 066

Voucher	LYMOOI 066
Family	Rubiaceae
Scientific Name	*Oldenlandia corymbosa* (L)
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' 55.5" E101° 55' 28.1" 116m
Habitat	Moist soil at the side of the road, semi-shade to full sunlight.
Description	Perennial herb with erect growth Habitat. Height: 5-20 cm. Leaves size: 2-5 cm long and 1-1.5 cm width. Leaves arrange opposite, pointed leaves. Flower of 2-4 white in colour, comes out from the axillaries, shape like umbrella.
Medicinal Property	Not available

4.1.32 *Oldenlandia diffusa* (Willd.) Roxb LYMOOI 073

Representative photographs dataset of morphology characteristic for *Oldenlandia diffusa* are shown in Figure 4.32a-b. Data obtained from the field notebook as shown in Table 4.32 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.32c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.32: Specimen LYMOOI 073 (A) Habitat. (B) Leaves and flower position, scale. (C) Vouchered *Oldenlandia diffusa* (Willd.) Roxb LYMOOI 073

Table 4.32: Information relating to vouchered specimen of *Oldenlandia diffusa* (Willd.) Roxb LYMOOI 073

Voucher	LYMOOI 073
Family	Rubiaceae
Scientific Name	*Oldenlandia diffusa* (Willd.) Roxb
Date of Collection	24th April 2017
Collector	Lim Yang Mooi, Lan YM, Haw MF, Lai MW, Chia WL
Place	83500, Simpang Kiri, Batu Pahat, Johor
Location	N1° 58' 54.1" E102° 56' 21.8"
Habitat	Residential area, sandy and moist soil with partial sunlight.
Description	Slender annual plant with ascending and procumbent with branched stem. Leaves size: 1-3 cm long, 0.1-0.4 cm wide, arrange oppositely. White flower grows solitary in axillary with very short or no peduncle.
Medicinal Property	Whole plant is taken internally in the treatment of fevers and urinary tract infection.

4.1.33 *Lantana camara* L. LYMOOI 035

Representative photographs dataset of morphology characteristic for *Lantana camara* are shown in Figure 4.33a-d. Data obtained from the field notebook as shown in Table 4.33 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.33e) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

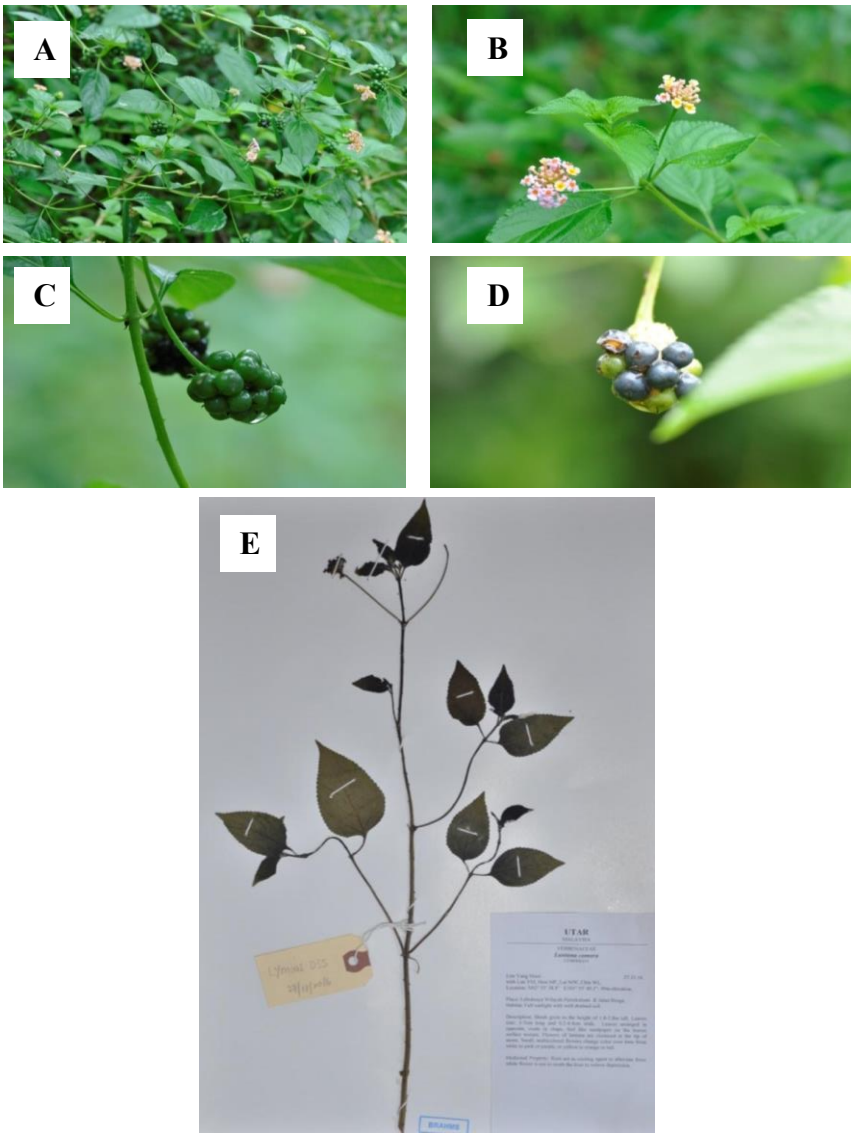

Figure 4.33: Specimen LYMOOI 035 (A) Habitat. (B) Leaves and flower. (C) Unripe fruits. (D) Ripe fruit. (E) Vouchered *Lantana camara* L. LYMOOI 035

Table 4.33: Information relating to vouchered specimen of *Lantana camara* L. LYMOOI 035

Voucher	LYMOOI 035
Family	Verbenaceae
Scientific Name	*Lantana camara* 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' 38.4" E101° 55' 40.1" 99m
Habitat	Full sunlight with well-drained soil.
Description	Shrub grows to the height of 1.8-2.8 m tall. Leaves size: 1-7 cm long and 0.2-4.4 cm wide. Leaves arranged in opposite, ovate in shape, feel like sandpaper on the leaves surface texture. Flowers of lantana are clustered at the tip of stems. Small, multi-coloured flowers change colour over time from white to pink or purple, or yellow to orange or red.
Medicinal Property	Root act as cooling agent to alleviate fever while flower is use to sooth the liver to relieve depression.

4.1.34 *Phyla nodiflora* LYMOOI 001

Representative photographs dataset of morphology characteristic for *Phyla nodiflora* are shown in Figure 4.34a-b. Data obtained from the field notebook as shown in Table 4.34 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.34c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

Figure 4.34: Specimen LYMOOI 001 (A) Habitat. (B) Leaves and flower position. (C) Vouchered specimen *Phyla nodiflora* LYMOOI 001

Table 4.34: Information relating to vouchered specimen of *Phyla nodiflora* LYMOOI 001

Voucher	LYMOOI 001
Family	Verbenaceae
Scientific Name	*Phyla nodiflora*
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' 01.6" E101° 46' 07.2" 30m
Habitat	Resident area with loam soil; planted.
Description	Height: 1-3 cm. Leaves size: wide 0.5-1.5 cm, long 1-3 cm. Leaf arrangement is opposite. Each leaf has one to seven teeth on each edge starting at the widest point and continuing to the tip. Young stem is green to purple colour and becomes grey and woody when mature. Seed not easily visible to naked eye. Flower usually white in colour, rarely pinkish to purple. Mature flowers are tubular at the base, ending in two lipped calyx. The lower lip has two lobes and upper lip has three lobes.
Medicinal Property	Traditionally used to clear heat and inducing diuresis to eliminate dampness, cooling agent to alleviate fever, antihypertensive, taken as decoction for diabetic wound.

4.1.35 *Stachytarpheta jamaicensis* (L) Vahl LYMOOI 019

Representative photographs dataset of morphology characteristic for *Stachytarpheta jamaicensis* are shown in Figure 4.35a-b. Data obtained from the field notebook as shown in Table 4.35 were used to prepare labels for the voucher specimens. The mounted voucher herbarium specimen (Figure 4.35c) with a label detail at the lower right corner was deposited at Perdana Botanical Garden Kuala Lumpur.

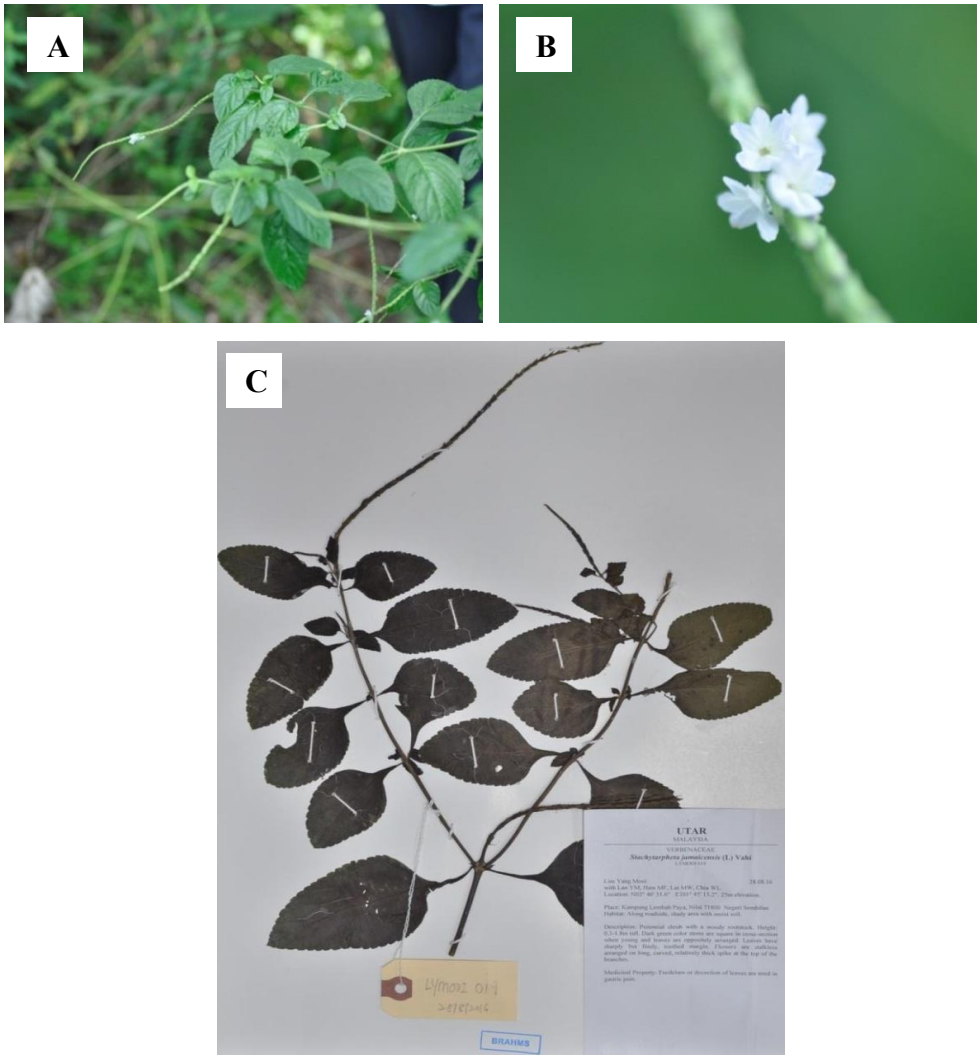

Figure 4.35: Specimen LYMOOI 019 (A) Habitat. (B) Flower. (C) Vouchered specimen *Stachytarpheta jamaicensis* (L) Vahl LYMOOI 019

Table 4.35: Information relating to vouchered specimen of *Stachytarpheta jamaicensis* (L) Vahl LYMOOI 019

Voucher	LYMOOI 019
Family	Verbenaceae
Scientific Name	*Stachytarpheta jamaicensis* (L) Vahl
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' 31.6" E101° 45' 13.2" 25m
Habitat	Along roadside, shady area with moist soil.
Description	Perennial shrub with a woody rootstock. Height: 0.3-1.8 m tall. Dark green colour stems are square in cross-section when young and leaves are oppositely arranged. Leaves have sharply but finely, toothed margin. Flowers are stalkless arranged on long, curved, relatively thick spike at the top of the branches.
Medicinal Property	Fresh/raw or decoction of leaves are used in gastric pain.

4.2 DNA Barcoding Analysis

4.2.1 Universality of Primer Sequences

Samples of a total of 35 plant were collected, and 70 sequences were available for the three DNA fragments. Among these fragments, *rbc*L had the highest success rate of PCR amplification (100%), followed by ITS (94.3%) and the success rate of PCR amplification for *mat*K was the lowest (71.4%). Regarding DNA sequencing, *rbc*L showed the highest success rate (100%), followed by *mat*K (84%) and ITS (42.4%).

Table 4.36: Amplification and sequencing success rate of the three candidate loci for 35 local medicinal plants

Locus	**No. of samples used for PCR Amplification**	**No. of amplicons obtained**	**Amplification success (%)**	**No. of finished sequences generated**	**Sequencing success (%)**
*rbc*L	35	35	100	35	100
*mat*K	35	25	71.4	21	84
ITS	35	33	94.3	14	42.4

4.2.2 DNA Barcoding: Identification Efficiency

In order to select the most suitable barcode, the identification efficiency of these three regions is investigated as shown in Table 4.37. In term of genus-level

identification, ITS shown the highest correct identification rate at 100%, followed by *mat*K (90.5%), and then *rbc*L (71.4%). In term of species-level identification, *mat*K shown the highest correct identification rate at 52.4%, which is higher than ITS (35.8%) and *rbc*L (34.3%). Table 4.38 indicates the BLAST result of 35 plant samples.

Table 4.37: Identification efficiency for three loci of 35 local medicinal plants

Locus	**Identification Method**	**Plant Taxa Level**	**Sample Size**	**Correct Identification**	**Ambiguous Identification**	**No Match/ Incorrect Identification**
*rbc*L	BLAST	Genus	35	71.4%	17.1%	11.5%
		Species	35	34.3%	54.2%	
*mat*K	BLAST	Genus	21	90.5%	9.5%	0%
		Species	21	52.4%	47.6%	
ITS	BLAST	Genus	14	100%	0%	0%
		Species	14	35.8%	64.3%	

Table 4.38: Sequence data from GenBank for 35 species of local medicinal plants

Scientific Name	***rbc*L**		***mat*K**		**ITS**	
	BLAST	**ID**	**BLAST**	**ID**	**BLAST**	**ID**
Acanthaceae						
Andrographis paniculata	*Andrographis paniculata*	100%	*Andrographis paniculata*	99%	-	
Barleria lupulina	*Barleria prionitis*	99%	-		-	
Clinacanthus nutans	*Ruttya sp.*	99%	*Carlowrightia arizonica*	97%	-	
	Clinacanthus nutans	100%	*Clinacanthus nutans*	99%		
Gendarussa ventricosa	*Justicia adhatoda*	99%	*Justicia adhatoda*	97%	-	
Gendarussa vulgaris	*Justicia ventricosa*	98%	-			
Rhinacanthus nasutus	*Rhinacanthus nasutus*	100%	-		-	
Ruellia simplex	*Ruellia sp*	100%	*Ruellia tweediana*	100%	*Ruellia runyonii*	99%
Strobilanthes Crispus	*Strobilanthes cusia*	99%	-		*Strobilanthes namkadingensis*	97.52%
Apocynaceae						
Catharanthus roseus	*Catharanthus roseus*	100%	*Catharanthus sp.*	100%	*Catharanthus roseus*	97.5%
			Catharanthus roseus	100%		

Table 4.38 (Continued)

Scientific Name	*rbc*L		*mat*K		ITS	
	BLAST	**ID**	**BLAST**	**ID**	**BLAST**	**ID**
Araceae						
Alocasia macrorrhizos	*Alocasia macrorrhizos*	100%	*Alocasia cucullata*	99%	-	
			Alocasia sp.	99%		
Rhaphidophora decursiva	*Zantedeschia aethiopica*	100%	-		-	
Typhonium flagelliforme	*Colocasia esculenta*	99%	*Typhonium roxburghii*	100%		
	Typhonium flagelliforme	99%				
Asclepiadaceae						
Calotropis gigantea	*Calotropis procera*	100%	-			
Cucurbitaceae						
Gynostemma pentaphyllum	*Gynostemma compressum*	99%	-		*Gynostemma compressum*	100%
Cycadaceae						
Cycas revoluta	*Cycas debaoensis*	99%	-		-	
Cyperaceae						
Kyllinga brevifolia	*Pycreus sp*	100%	-		-	
	Kyllinga brevifolia	100%	-		-	

Table 4.38 (Continued)

Scientific Name	*rbc*L		*mat*K		ITS	
	BLAST	**ID**	**BLAST**	**ID**	**BLAST**	**ID**
Dioscoreaceae						
Dioscorea bulbifera	*Dioscorea alata*	99%	*Dioscorea alata*	100%	-	
Labiatae						
Ocimum basilicum	*Ocimum basilicum*	100%	*Ocimum basilicum*	99%	-	
Orthosiphon aristatus	*Plectranthus barbatus*	99%	*Ocimum gratissimum*	99%	*Orthosiphon aristatus*	99%
	Clerodendranthus spicatus	100%	*Orthosiphon stamineus*	99%		
Vitex trifolia	*Vitex negundo*	99%	*Vitex trifolia*	99%	-	
	Vitex trifolia	100%				
Lamiaceae						
Mentha spicata	*Mentha spicata*	100%	*Mentha spicata*	100%	-	
Plectranthus amboinicus	*Perilla setoyensis*	99%	*Plectranthus amboinicus*	100%	-	
	Perilla frutescens	99%				
Lythraceae						
Punica granatum	*Punica granatum*	100%	*Punica granatum*	100%	-	

Table 4.38 (Continued)

Scientific Name	*rbc*L		*mat*K		ITS	
	BLAST	**ID**	**BLAST**	**ID**	**BLAST**	**ID**
Malvaceae						
Hibiscus mutabilis	*Pavonia sp.*	99%	-		*Hibiscus mutabilis*	99%
Urena lobata	*Gossypium nelsonii*	99%	-			
	Taliparititi hamabo	99%				
	Urena lobata	100%				
Melastomataceae						
Clidemia hirta	*Melastomataceae*	99%	-		*Clidemia octona*	99%
	Miconia dodecandra	99%			*Clidemia laevifolia*	99%
					Clidemia hirta	99%
Melastoma malabathricum	*Melastoma candidum*	100%	-		*Melastoma malabathricum*	99%
					Melastoma denticulatum	99%
					Melastoma candidum	99%
Plantaginaceae						
Plantago major	*Plantago major*	99%	*Plantago rugelii*	99%	*Plantago asiatica*	99%
	Plantago asiatica	100%	*Plantago media*	99%		
			Plantago asiatica	100%		

Table 4.38 (Continued)

Scientific Name	*rbc*L		*mat*K		ITS	
	BLAST	**ID**	**BLAST**	**ID**	**BLAST**	**ID**
Rubiaceae						
Morinda citrifolia L.	*Morinda citrifolia*	100%	*Morinda citrifolia*	100%	-	
Oldenlandia auricularia	*Spermacoce tenuior*	99%	*Spermacoce hispida*	98%	*Spermacoce ocymifolia*	96%
					Hedyotis coronaria	100%
Oldenlandia corymbosa	*Oldenlandia corymbosa*	100%	*Oldenlandia corymbosa*	100%	*Oldenlandia corymbosa*	100%
Oldenlandia diffusa	*Oldenlandia corymbosa*	100%	*Oldenlandia diffusa*	99.64%	*Oldenlandia corymbosa*	98.7%
Verbenaceae						
Lantana camara	*Lantana camara*	99%	-		*Lantana sp.*	99%
					Lantana camara	99%
Phyla nodiflora	*Lantana sp*	99%	*Phyla nodiflora*	100%	*Phyla nodiflora*	100%
	Phyla nodiflora	100%				
Stachytarpheta jamaicensis	*Stachytarpheta jamaicensis*	99%	*Stachytarpheta dichotoma*	100%	-	
			Stachytarpheta cayennensis	100%		

4.3 Untargeted Metabolite Profiling

As a result of untargeted metabolite profiling, list of putative compounds identification in positive mode was recorded. Result of negative mode was excluded because of no result. The putative compounds were classified into primary and secondary according to classification of databases. These findings are recorded in Table 4.39- 4.73.

In this study, secondary putative compounds were the focus of the report. They were classified into four main group that is N-containing compounds, phenolics, terpenes and others. In order to find potential secondary compounds, the same secondary putative compound is counted as one. After counted, there are 44 unique putative N-containing compounds, 142 unique putative phenolic compounds, 87 unique putative terpenes, and 59 unique other putative compounds.

4.3.1 *Andrographis paniculata* (Burm.f.) Wall.ex Nees LYMOOI 025

LC-MS/MS analysis of extract from *Andrographis paniculata* enabled the identification of 29 putative compounds (Table 4.39) belonging to different chemical families. It contains 2 putative primary metabolites and 27 putative secondary metabolites.

Table 4.39: List of putative compounds in LYMOOI 025, *Andrographis paniculata*, Precursor type: $(M+H)^+$, Plant Part: Leaves

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 025	Primary	Nucleic acids	131.1293	0.79	Agmatine	Guanidines
			268.1041	1.25	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
	Secondary	N-containing compounds	118.0863	0.80	3-(dimethylamino)propanoic acid	Trialkylamines
			188.0706	1.96	3-(1H-indol-3-yl)prop-2-enoic acid	Indoles

Table 4.39 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 025	Secondary	N-containing compounds	205.0973	1.96	L-tryptophan	L-tryptophan
			217.0970	2.42	3-(1-phenylethyl)imidazole-4-carboxylic acid	Carbonylimidazoles
			124.0860	13.95	Benzene-1,2,4-triamine	Aniline and substituted anilines
		Phenolics	183.0652	1.03	3,4-dimethoxybenzoic acid	P-methoxybenzoic acids and derivatives
			163.0383	1.40	3-hydroxycoumarin	Hydroxycoumarins
			151.0750	2.35	3-[(1e)-3-hydroxyprop-1-en-1-yl]phenol	Cinnamyl alcohols
			329.1234	2.5	3-(2-{[3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxy}phenyl)propanoic acid	Phenolic glycosides
			355.1024	2.69	1-[3-(3,4-dihydroxyphenyl)prop-2-enoyloxy]-3,4,5-trihydroxycyclohexane-1-carboxylic acid	Quinic acids and derivatives

Table 4.39 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 025	Secondary	Phenolics	595.1662	2.99	Kaempferol 3-rhamnoside-7-glucoside	Flavonoid-7-o-glycosides
			297.1844	3.03	3-methoxy-2-(3-methylbut-2-enyl)-5-(2-phenylethyl) phenol	Stilbenes
			447.0924	3.72	Apigenin-7-O-glucuronide	Flavonoid-7-o-glucuronides
			271.1692	4.13	4-[2-ethyl-1-(4-hydroxyphenyl)butyl]phenol	Diphenylmethanes
		Terpenes	315.1951	2.92	6,7-dehydroroyleanone	Diterpenoids
			373.2000	3.85	14-hydroxy-14-(2-hydroxyacetyl)-2,13,15-trimethyl-18-oxapentacyclo[8.8.0.0^{1,17}.0^{2,7}.0^{11,15}]octadeca-3,6-dien-5-one	Iridoids and derivatives
			315.1956	4.13	Kahweol	Naphthofurans

Table 4.39 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 025	Secondary	Terpenes	319.2270	4.86	(1s,2s,4ar,4bs,7r,10ar)-7-ethenyl-2-hydroxy-1,4a,7-trimethyl-3,4,4b,5,6,9,10,10a-octahydro-2h-phenanthrene-1-carboxylic acid	Hydroxysteroids
			301.2164	4.87	6,7-dehydrosandaracopimaric acid	Diterpenoids
			329.2112	5.08	(8~{s},10~{s},13~{s},14~{s},17~{r})-17-acetyl-17-hydroxy-10,13-dimethyl-2,6,7,8,12,14,15,16-octahydro-1~{h}-cyclopenta[a]phenanthren-3-one	20-oxosteroids
			409.2742	7.12	(3s,5r,6s)-5,6-epoxy-5,6-dihydro-3-hydroxy-10'-apo-beta,psi-carotenal	Sesterterpenoids

Table 4.39 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 025	Secondary	Others	156.0419	0.65	2-(methylamino)ethyl dihydrogen phosphate	Phosphoethanolamines
			175.1480	4.13	4,4,7-trimethyl-2,3-dihydro-1~{h}-naphthalene	Tetralins
			187.1480	4.13	7-ethyl-1,4-dimethyl-4,5-dihydroazulene	Branched unsaturated hydrocarbons
			205.1586	4.13	2-benzylidene-1-heptanol	Cinnamyl alcohols
			257.1536	4.13	(2e,4e,6e,8e,10e,12e)-2,6,11-trimethyltetradeca-2,4,6,8,10,12-hexaenedial	Fatty aldehydes
			319.2277	5.54	9-hydroxy-2z,5e,7z,11z,14z-eicosapentaenoic acid	Hydroxyeicosapentaenoic acids

4.3.2 *Barleria lupulina* Lindl. LYMOOI 036

LC-MS/MS analysis of extract from *Barleria lupulina* enabled the identification of 26 putative compounds (Table 4.40) belonging to different chemical families. It contains 1 putative primary metabolites and 25 putative secondary metabolites.

Table 4.40: List of putative compounds in LYMOOI 036, *Barleria lupulina*, Precursor type: $(M+H)^+$, Plant Part: Leaves

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 036	Primary	Nucleic acids	268.1039	1.60	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
	Secondary	N-containing compounds	118.0862	0.71	3-(dimethylamino)propanoic acid	Trialkylamines
			138.0549	0.81	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids
			205.0975	1.96	L-tryptophan	L-tryptophan
			124.0877	14.05	Benzene-1,2,4-triamine	Aniline and substituted anilines

Table 4.40 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 036	Secondary	Phenolics	191.0698	0.82	7-methoxy-4-methyl-1-benzopyran-2-one	Coumarins and derivatives
			209.0801	1.44	1-hydroxy-4-(4-hydroxy-3-methoxyphenyl)but-3-en-2-one	Hydroxycinnamic acids and derivatives
			227.0906	1.70	Dihydrosinapic acid	Phenylpropanoic acids
			191.0700	1.83	7-methoxy-6-methyl-2h-1-benzopyran-2-one	Coumarins and derivatives
			209.0810	2.36	3,4-dimethoxy-trans-cinnamic acid	Coumaric acids and derivatives
			357.1189	2.73	Trans-p-feruloyl-beta-d-glucopyranoside	Phenolic glycosides
			371.1346	3.43	(~{e})-3-[3,5-dimethoxy-4-[(2~{s},3~{r},4~{s},5~{s},6~{r})-3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxyphenyl]prop-2-enal	Phenolic glycosides
			353.1237	3.69	Methyl 4-o-coumaroylquinate	Quinic acids and derivatives

Table 4.40 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 036	Secondary	Phenolics	329.1240	3.70	3-(2-{[3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxy}phenyl)propanoic acid	Phenolic glycosides
			121.0649	3.70	4-vinylphenol	Styrenes
			209.0812	3.70	Methyl 3-(4-hydroxy-3-methoxyphenyl)prop-2-enoate	Coumaric acids and derivatives
			177.0549	3.70	7-hydroxy-6-methyl-2h-chromen-2-one	7-hydroxycoumarins
			237.0761	3.70	5-(4-hydroxy-3-methoxyphenyl)-3-oxopent-4-enoic acid	Hydroxycinnamic acids and derivatives
			147.0442	4.49	3-phenylprop-2-ynoic acid	Benzene and substituted derivatives
			433.1503	4.49	3-(4-methoxyphenyl)-7-[3,4,5-trihydroxy-6-(hydroxylmethyl)oxan-2-yl]oxy-2,3-dihydrochromen-4-one	Isoflavonoid o-glycosides
			161.0601	4.56	6-methylcoumarin	Coumarins and derivatives

Table 4.40 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 036	Secondary	Phenolics	387.1447	5.22	(−)-5'-desmethylyatein	Dibenzylbutyrolactone lignans
		Terpenes	387.1293	2.74	Hedyotoside	Terpene glycosides
		Others	174.1493	1.11	9-aminononanoic acid	Medium-chain fatty acids
			177.0543	1.75	3-(1,3-benzodioxol-5-yl)prop-2-enal	Benzodioxoles
			159.0442	3.70	Dec-2-en-4,6,8-triynoic acid	Medium-chain fatty acids

4.3.3 *Clinacanthus nutans* (Burm.f) Lindau LYMOOI 049

LC-MS/MS analysis of extract from *Clinacanthus nutans* enabled the identification of 17 putative compounds (Table 4.41) belonging to different chemical families. It contains 2 putative primary metabolites and 15 putative secondary metabolites.

Table 4.41: List of putative compounds in LYMOOI 049, *Clinacanthus nutans*, Precursor type: $(M+H)^+$, Plant Part: Leaves

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 049	Primary	Proteins	250.1445	3.12	Tyrosine and derivatives	Tyrosine and derivatives
		Pigments	607.2922	9.35	Methyl pheophorbide a	Chlorins
	Secondary	N-containing compounds	104.1068	0.79	3-(dimethylamino)propan-1-ol	1,3-aminoalcohols
			118.0862	0.81	3-(dimethylamino)propanoic acid	Trialkylamines
			144.1019	0.84	1-aminocyclohexane-1-carboxylic acid	L-alpha-amino acids

Table 4.41 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 049	Secondary	N-containing compounds	158.1175	0.90	8-methyl-8-azabicyclo[3.2.1]octane-3,6-diol	Tropane alkaloids
			118.0861	1.08	N,N-dimethyl-L-alanine	Alanine and derivatives
			188.0697	1.34	3-(1H-indol-3-yl)prop-2-enoic acid	Indoles
			205.0972	1.96	L-tryptophan	L-tryptophan
		Phenolics	469.1335	2.88	2'-Hydroxy-dihydrochalcones	2'-Hydroxy-dihydrochalcones
		Terpenes	439.2320	3.62	3-[1,3,5,11,14-pentahydroxy-10-(hydroxymethyl)-13-methyl-2,3,4,6,7,8,9,11,12,15,16,17-dodecahydro-1H-cyclopenta[a]phenanthren-17-yl]-2H-furan-5-one	Cardenolides and derivatives
			445.3682	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

Table 4.41 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 049	Secondary	Others	229.1551	1.11	Fatty acid methyl esters	Fatty acid methyl esters
			165.0540	2.31	Enol-phenylpyruvate	Phenylpyruvic acid derivatives
			613.4835	8.89	(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
			549.4882	9.64	3-[(17Z)-13,14-dihydroxytriacont-17-en-1-yl]-5-methyl-2,5-dihydrofuran-2-one	Annonaceous acetogenins

4.3.4 *Gendarussa ventricosa* (Wall.) Nees LYMOOI 017

LC-MS/MS analysis of extract from *Gendarussa ventricosa* enabled the identification of 24 putative compounds (Table 4.42) belonging to different chemical families. It contains 3 putative primary metabolites and 21 putative secondary metabolites.

Table 4.42: List of putative compounds in LYMOOI 017, *Gendarussa ventricosa*, Precursor type: $(M+H)^+$, Plant Part: Leaves

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 017	Primary	Nucleic acids	268.1046	1.63	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
		Proteins	166.0866	1.10	3-amino-3-phenylpropanoic acid	Beta amino acids and derivatives

Table 4.42 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 017	Primary	Pigments	569.4362	8.98	4,4,7~{a}-trimethyl-2-[6,11,15-trimethyl-17-(2,6,6-trimethylcyclohexen-1-yl)heptadeca-2,4,6,8,10,12,14,16-octaen-2-yl]-2,5,6,7-tetrahydro-1-benzofuran-6-ol	Xanthophylls
	Secondary	N-containing compounds	104.1069	0.78	3-(dimethylamino)propan-1-ol	1,3-aminoalcohols
			138.0549	0.79	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids
			118.0863	0.80	3-(dimethylamino)propanoic acid	Trialkylamines
			188.0700	1.04	3-(1H-indol-3-yl)prop-2-enoic acid	Indoles
			120.0808	1.11	2,3-dihydro-1~{H}-indole	Indolines
			205.0972	1.16	L-tryptophan	L-tryptophan

Table 4.42 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 017	Secondary	Phenolics	287.0554	3.32	3,7,8-trihydroxy-2-(4-hydroxyphenyl)chromen-4-one	Flavonols
			207.0656	4.42	4-(2-methoxyphenyl)-2-oxobut-3-enoic acid	Cinnamic acids and derivatives
		Terpenes	227.1639	2.86	4,5-Dihydrovomifoliol	Sesquiterpenoids
			227.1650	2.90	4-hydroxy-4-(3-hydroxybutyl)-3,5,5-trimethylcyclohex-2-en-1-one	Sesquiterpenoids
			209.1530	3.02	4-(4-hydroxy-2,6,6-trimethylcyclohex-2-en-1-yl)but-3-en-2-one	Sesquiterpenoids

Table 4.42 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 017	Secondary	Terpenes	781.4726	4.96	(4aS,6aR,6aS,6bR,8aR,10S,12aR,14bS)-10-[(2R,3R,4S,5R,6R)-3,5-dihydroxy-6-(hydroxymethyl)-4-[(2S,3R,4S,5R,6R)-3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxyoxan-2-yl]oxy-2,2,6a,6b,9,9,12a-heptamethyl-1,3,4,5,6,6a,7,8,8a,10,11,12,13,14b-tetradecahydropicene-4a-carboxylic acid	Triterpene saponins
			409.3831	11.45	Ferna-7,9(11)-diene	Triterpenoids
		Others	227.1283	2.68	Tuberonic acid	Jasmonic acids
			351.2158	4.52	7-[2-(3-hydroxyoct-1-enyl)-3,5-dioxocyclopentyl]hept-5-enoic acid	Prostaglandins and related compounds

Table 4.42 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 017	Secondary	Others	181.1226	4.50	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols
			256.2642	7.27	Hexadecanamide	Fatty amides
			613.4830	8.94	(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
			429.3737	9.28	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols
			758.5701	11.20	[(2R)-2,3-bis(octadec-9-enoyloxy)propoxy][2-(methylamino)ethoxy]phosphinic acid	Monomethylphosphatidylethanolamines

Table Table 4.42 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 017	Secondary	Others	760.5853	11.62	[2-(methylamino)ethoxy] ({2-[(9Z)-octadec-9-enoy loxy]-3-(octadecanoyloxy)propoxy})phosphinic acid	Monomethylphosphatidyletha nolamines

4.3.5 *Gendarussa vulgaris* Nees. LYMOOI 041

LC-MS/MS analysis of extract from *Gendarussa vulgaris* enabled the identification of 9 putative compounds (Table 4.43) belonging to different chemical families. It contains 9 putative secondary metabolites.

Table 4.43: List of putative compounds in LYMOOI 041, *Gendarussa vulgaris*, Precursor type: $(M+H)^+$, Plant Part: Leaves

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 041	Secondary	N-containing compounds	138.0548	0.66	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids
			118.0863	0.67	3-(dimethylamino) propanoic acid	Trialkylamines
		Phenolics	177.0545	2.48	7-hydroxy-6-methyl-2H-chromen-2-one	7-hydroxycoumarins
			493.1349	4.06	Rhamnazin 3-galactoside	Flavonoid-3-O-glycosides

Table 4.43 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 041	Secondary	Terpenes	445.3685	9.66	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
			431.3889	9.69	17-(5-ethyl-6-methylheptan-2-yl)-10,13-dimethyl-2,3,4,7,8,9,11,12,14,15,16,17-dodecahydro-1~{H}-cyclopenta[a]phenanthrene-3,7-diol	Stigmastanes and derivatives
		Others	156.0421	0.65	2-(methylamino)ethyl dihydrogen phosphate	Phosphoethanolamines
			256.2641	7.08	Hexadecanamide	Fatty amides
			429.3736	9.28	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols

4.3.6 *Rhinacanthus nasutus* (L) Kurz LYMOOI 062

LC-MS/MS analysis of extract from *Rhinacanthus nasutus* enabled the identification of 11 putative compounds (Table 4.44) belonging to different chemical families. It contains 1putative primary metabolites and 10 putative secondary metabolites.

Table 4.44: List of putative compounds in LYMOOI 062, *Rhinacanthus nasutus*, Precursor type: $(M+H)^+$, Plant Part: Leaves

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 062	Primary	Pigments	551.4256	8.98	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 4.44 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 062	Secondary	N-containing compounds	118.0862	0.67	3-(dimethylamino)propanoic acid	Trialkylamines
			206.1399	13.97	N-(3-methylbut-2-enyl)-1,4,5,7-tetrahydropurin-6-imine	Imidazopyrimidines
		Phenolics	183.0655	2.14	methyl 2,4-dihydroxy-6-methylbenzoate	p-Hydroxybenzoic acid alkyl esters
			463.0867	2.64	Kaempferol 3-glucuronide	Flavonoid-3-O-glucuronides
		Terpenes	445.3679	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
		Others	138.0549	0.83	Phenylcarbamic acid	Phenylcarbamic acids
			181.1221	4.53	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols

Table 4.44 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 062	Secondary	Others	277.2164	5.98	9,12,15,17-octadecatetraenoic acid	Lineolic acids and derivatives
			279.2319	6.22	Octadeca-9,12,15-trienoic acid	Lineolic acids and derivatives
			429.3734	9.29	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols

4.3.7 *Ruellia simplex* C. Wright LYMOOI 056

LC-MS/MS analysis of extract from *Ruellia simplex* enabled the identification of 28 putative compounds (Table 4.45) belonging to different chemical families. It contains 2 putative primary metabolites and 26 putative secondary metabolites.

Table 4.45: List of putative compounds in LYMOOI 056, *Ruellia simplex*, Precursor type: $(M+H)^+$, Plant Part: Leaves

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 056	Primary	Nucleic acids	136.0614	0.96	7H-purin-6-amine	Adenine
		Proteins	207.1251	13.39	2-amino-5-(diaminomethylideneamino)-2-(fluoromethyl)pentanoic acid	Alpha amino acids
	Secondary	N-containing compounds	104.1068	0.80	3-(dimethylamino)propan-1-ol	1,3-aminoalcohols

Table 4.45 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 056	Secondary	N-containing compounds	118.0862	0.82	3-(dimethylamino)propanoic acid	Trialkylamines
			188.0700	1.96	3-(1H-indol-3-yl)prop-2-enoic acid	Indoles
			205.0966	1.98	L-tryptophan	L-tryptophan
		Phenolics	579.1701	2.95	Swertisin 2''-O-arabinoside	Flavonoid C-glycosides
			609.1821	3.06	Isoscoparin 2''-O-rhamnoside	Flavonoid C-glycosides
			625.1762	3.10	Isorhamnetin 3-rhamnoside-7-glucoside	Flavonoid-7-O-glycosides
			595.1658	3.29	Kaempferol 3-galactoside-7-rhamnoside	Flavonoid-7-O-glycosides
			595.1662	3.37	Kaempferol 3-rhamnoside-7-glucoside	Flavonoid-7-O-glycosides
			477.1030	3.54	Kaempferide 3-glucuronide	Flavonoid-3-O-glucuronides

Table 4.45 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 056	Secondary	Phenolics	507.1138	3.62	[6-[2-(3,4-dihydroxyphenyl)-5,7-dihydroxy-4-oxochromen-3-yl]oxy-3,4,5-trihydroxyoxan-2-yl]methyl acetate	Flavonoid-3-O-glycosides
			607.1659	3.92	6''-Acetylapiin	Flavonoid-7-O-glycosides
			491.1185	4.13	Luteolin 7-(6''-acetylglucoside)	Flavonoid-7-O-glycosides
		Terpenes	209.1169	2.57	(4-hydroxy-5-methyl-2-propan-2-ylphenyl) acetate	Aromatic monoterpenoids
			191.1063	2.80	2,6-dimethyldeca-2,4,6,8-tetraenedial	Acyclic monoterpenoids
			351.2163	4.74	(ent-6alpha,7alpha,12alpha)-6,7,12-Trihydroxy-16-kauren-19-oic acid	Kaurane diterpenoids

Table 4.45 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 056	Secondary	Terpenes	275.2010	6.17	(3E,5E,7E)-8-[(4R)-4-hydroxy-2,6,6-trimethylcyclohex-1-en-1-yl]-6-methylocta-3,5,7-trien-2-one	Sesquiterpenoids
			409.2747	7.05	(3S,5R,6S)-5,6-Epoxy-5,6-dihydro-3-hydroxy-10'-apo-beta,psi-carotenal	Sesterterpenoids
		Others	229.1544	1.06	Fatty acid methyl esters	Fatty acid methyl esters
			227.1276	2.70	2-[(1R,2R)-2-[(Z,4S)-4-hydroxypent-2-enyl]-3-oxocyclopentyl]acetic acid	Jasmonic acids
			211.1686	3.20	1-cyclohexylcyclohexane-1-carboxylic acid	Carboxylic acids
			179.1066	3.30	(4S)-4-hydroxy-3-methyl-2-[(2Z)-penta-2,4-dienyl]cyclopent-2-en-1-one	Secondary alcohols

Table 4.45 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 056	Secondary	Others	181.1226	4.51	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclo pent-2-en-1-one	Secondary alcohols
			277.2162	5.84	9,12,15,17-octadecatetra enoic acid	Lineolic acids and derivatives
			221.1176	6.16	Alkyl-phenylketones	Alkyl-phenylketones
			429.3735	9.27	2,5,7,8-tetramethyl-2-(4 ,8,12-trimethyltridecyl)c hromen-6-ol	Tocopherols

4.3.8 *Strobilanthes crispus* Blume LYMOOI 033

LC-MS/MS analysis of extract from *Strobilanthes crispus* enabled the identification of 20 putative compounds (Table 4.46) belonging to different chemical families. It contains 1 putative primary metabolites and 19 putative secondary metabolites.

Table 4.46: List of putative compounds in LYMOOI 033, *Strobilanthes crispus*, Precursor type: $(M+H)^+$, Plant Part: Leaves

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 033	Primary	Nucleic acids	268.1043	1.37	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
	Secondary	N-containing compounds	104.1071	0.81	1-(dimethylamino)propan-2-ol	1,2-aminoalcohols
			118.0862	0.82	3-(dimethylamino)propanoic acid	Trialkylamines
			158.1172	0.97	8-methyl-8-azabicyclo[3.2.1]octane-3,6-diol	Tropane alkaloids

Table 4.46 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 033	Secondary	N-containing compounds	124.0875	13.92	Benzene-1,2,4-triamine	Aniline and substituted anilines
		Phenolics	463.0875	2.79	Luteolin 4'-glucuronide	Flavonoid O-glucuronides
			147.0436	3.03	3-phenylprop-2-ynoic acid	Benzene and substituted derivatives
			243.0863	3.05	2,3-Dihydroxy-1-(4-hydroxy-3,5-dimethoxyphenyl)-1-propanone	Alkyl-phenylketones
			463.0876	3.13	Kaempferol 3-glucuronide	Flavonoid-3-O-glucuronides
			325.0917	3.46	Hydroxycinnamic acids	Hydroxycinnamic acids
			163.0383	3.58	8-hydroxy-2H-chromen-2-one	Hydroxycoumarins
		Terpenes	209.1533	3.49	(6R,9R)-9-Hydroxy-4-megastigmen-3-one	Sesquiterpenoids
			353.2681	7.42	Tomentol	Sesquiterpenoids

Table 4.46 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 033	Secondary	Others	229.1553	1.14	Fatty acid methyl esters	Fatty acid methyl esters
			209.1170	2.59	(Z)-3-Oxo-2-(2-pentenyl) -1-cyclopenteneacetic aci d	Cyclic ketones
			227.1280	2.68	2-[(1R,2R)-2-[(Z,4S)-4-h ydroxypent-2-enyl]-3-oxo cyclopentyl]acetic acid	Jasmonic acids
			325.0916	3.57	Benzofurans	Benzofurans
			277.2165	5.99	9,12,15,17-octadecatetraen oic acid	Lineolic acids and derivatives
			256.2636	7.30	Hexadecanamide	Fatty amides
			429.3734	9.30	2,5,7,8-tetramethyl-2-(4,8 ,12-trimethyltridecyl)chro men-6-ol	Tocopherols

4.3.9 *Catharanthus roseus* (L) G. Don LYMOOI 057

LC-MS/MS analysis of extract from *Catharanthus roseus* enabled the identification of 35 putative compounds (Table 4.47) belonging to different chemical families. It contains 3 putative primary metabolites and 32 putative secondary metabolites.

Table 4.47: List of putative compounds in LYMOOI 057, *Catharanthus roseus*, Precursor type: $(M+H)^+$, Plant Part: Leaves

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 057	Primary	Nucleic acids	268.1044	1.18	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
			339.0692	1.45	[5-(5-amino-4-carbamoylimidazol-1-yl)-3,4-dihydroxyoxolan-2-yl]methyl dihydrogenphosphate	1-ribosyl-imidazolecarboxamides
		Proteins	166.0861	1.11	3-amino-3-phenylpropanoic acid	Beta amino acids and derivatives

Table 4.47 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 057	Secondary	N-containing compounds	205.0972	1.45	L-tryptophan	L-tryptophan
			188.0700	1.56	3-(1H-indol-3-yl)prop-2-enoic acid	Indoles
			383.1606	2.54	Apodinine	Aspidospermatan-type alkaloids
			369.1810	2.81	14alpha-Hydroxy-3-isorauniticine	Yohimbine alkaloids
			339.1705	2.96	vinervine	Strychnos alkaloids
			355.2016	3.06	3-Epivobasinol	Vobasan alkaloids
			369.1814	3.17	11-Hydroxy-14,15-epoxytabersonine	Aspidospermatan-type alkaloids
			371.1963	3.17	14,15-Dihydroxyvincadifformine	Aspidospermatan-type alkaloids
			371.1966	3.44	18-Hydroxyepialloyohimbine	Yohimbine alkaloids
			339.1707	3.48	Perivine	Vobasan alkaloids
			353.1867	3.55	19,20-Dihydrovomilenine	Ajmaline-sarpagine alkaloids
			337.1914	3.60	(+)-17-O-Acetylnortetraphyllicine	Ajmaline-sarpagine alkaloids

Table 4.47 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 057	Secondary	N-containing compounds	323.1753	4.29	Methyl (1S,14S,15E)-15 -ethylidene-3,17-diazape ntacyclo[12.3.1.02,10.04 ,9.012,17]octadeca-2(10) ,4,6,8-tetraene-13-carbox ylate	Macroline alkaloids
			383.1971	4.62	19R-Hydroxy-11-metho xy-tabersonine	Plumeran-type alkaloids
			124.0871	13.94	Benzene-1,2,4-triamine	Aniline and substituted anilines
		Phenolics	197.0800	1.54	2-methyl-1-(2,4,6-trihyd roxyphenyl)propan-1-on e	Phlorisobutanophenone
			179.0701	2.23	3-(2-methoxyphenyl)-2-propenoic acid	Coumaric acids
			355.1023	2.66	4-[3-(3,4-dihydroxypheny l)prop-2-enoyloxy]-1,3,5-trihydroxycyclohexane-1-carboxylic acid	Quinic acids and derivatives

Table 4.47 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 057	Secondary	Phenolics	303.0495	3.28	2-(3,4-dihydroxyphenyl)-3,7,8-trihydroxychromen-4-one	Flavonols
			179.1068	3.30	2-methoxy-3-methyl-4-prop-1-enylphenol	Methoxyphenols
			287.0555	3.41	3,7,8-trihydroxy-2-(4-hydroxyphenyl)chromen-4-one	Flavonols
			347.0766	3.88	5-hydroxy-11-methoxy-6,8,16,20-tetraoxapentacyclo[10.8.0.0^{2},^{9}.0^{3},^{7}.0^{13},^{18}]icosa-1(12),2(9),10,13(18)-tetraene-17,19-dione	Difurocoumarolactones
		Terpenes	229.1072	2.86	methyl (1R,4aS,6S,7R,7aS)-1,6-dihydroxy-7-methyl-1,4a,5,6,7,7a-hexahydrocyclopenta[c]pyran-4-carboxylate	Iridoids and derivatives
			517.2190	3.52	Strictosidinic acid	Terpene glycosides

Table 4.47 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 057	Secondary	Terpenes	411.3626	7.10	14-[(3Z)-5-ethyl-6-methylhept-3-en-2-yl]-2,15-dimethyltetracyclo[8.7.0.0^{2},^{7}.0^{11},^{15}]heptadeca-7,9-dien-5-ol	Stigmastanes and derivatives
			457.3683	7.10	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
			249.1852	7.31	Artemisinic acid methyl ester	Sesquiterpenoids
			445.3676	9.05	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
			409.383	11.7	Ferna-7,9(11)-diene	Triterpenoids

Table 4.47 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 057	Secondary	Others	256.2643	7.27	Hexadecanamide	Fatty amides
			613.4824	8.97	(2S)-1-hydroxy-3-[(9Z,12 Z)-octadeca-9,12-dienoyl oxy]propan-2-yl (6Z,9Z,1 2Z,15Z)-octadeca-6,9,12, 15-tetraenoate	Lineolic acids and derivatives
			429.3735	9.28	2,5,7,8-tetramethyl-2-(4, 8,12-trimethyltridecyl)ch romen-6-ol	Tocopherols

4.3.10 *Alocasia macrorrhizos* (L.) G.Don LYMOOI 055

LC-MS/MS analysis of extract from *Alocasia macrorrhizos* enabled the identification of 7 putative compounds (Table 4.48) belonging to different chemical families. It contains 7 putative secondary metabolites.

Table 4.48: List of putative compounds in LYMOOI 055, *Alocasia macrorrhizos*, Precursor type: $(M+H)^+$, Plant Part: Root

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 055	Secondary	N-containing compounds	144.1019	0.83	1-aminocyclohexane-1-carboxylic acid	L-alpha-amino acids
			118.0859	0.84	3-(dimethylamino)propanoic acid	Trialkylamines
			314.1388	4.19	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

Table 4.48 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 055	Secondary	N-containing compounds	124.0864	13.97	Benzene-1,2,4-triamine	Aniline and substituted anilines
			206.1398	13.97	N-(3-methylbut-2-enyl) -1,4,5,7-tetrahydropurin -6-imine	Imidazopyrimidines
		Others	279.2322	6.08	Octadeca-9,12,15-trienoic acid	Lineolic acids and derivatives
			256.2642	7.31	Hexadecanamide	Fatty amides

4.3.11 *Rhaphidophora decursiva* (Roxb.) Schott LYMOOI 064

LC-MS/MS analysis of extract from *Rhaphidophora decursiva* enabled the identification of 14 putative compounds (Table 4.49) belonging to different chemical families. It contains 2 putative primary metabolites and 12 putative secondary metabolites.

Table 4.49: List of putative compounds in LYMOOI 064, *Rhaphidophora decursiva*, Precursor type: $(M+H)^+$, Plant Part: Leaves

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 064	Primary	Nucleic acids	268.1038	1.12	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
			136.0612	1.65	7H-purin-6-amine	Adenine
	Secondary	N-containing compounds	104.1069	0.65	1-(dimethylamino)propan-2-ol	1,2-aminoalcohols
			138.0547	0.83	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids
		Phenolics	579.1714	2.85	Swertisin 2''-O-arabinoside	Flavonoid C-glycosides

Table 4.49 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 064	Secondary	Phenolics	433.1139	3.10	1-hydroxy-3-(hydroxymethyl)-8-{[3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxy}-9,10-dihydroanthracene-9,10-dione	Anthraquinones
		Terpenes	209.1538	2.77	3,5,5-trimethyl-4-(3-oxobutyl)cyclohex-2-en-1-one	Sesquiterpenoids
			291.1949	5.05	(8R,9S,10R,13S,14S,17S)-4,17-dihydroxy-13-methyl-2,6,7,8,9,10,11,12,14,15,16,17-dodecahydro-1H-cyclopenta[a]phenanthren-3-one	Estrogens and derivatives

Table 4.49 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 064	Secondary	Terpenes	277.2169	5.97	17-hydroxy-13-methyl-2, 4,5,6,7,8,9,10,11,12,14,1 5,16,17-tetradecahydro-1 H-cyclopenta[a]phenanth ren-3-one	Estrogens and derivatives
		Others	229.1547	1.09	Fatty acid methyl esters	Fatty acid methyl esters
			209.1541	2.81	4-(2,2,6-trimethyl-7-ox abicyclo[4.1.0]heptan-1 -yl)but-3-en-2-one	Oxepanes
			181.1224	4.43	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyc lopent-2-en-1-one	Secondary alcohols
			277.2167	5.85	9,12,15,17-octadecatetrae noic acid	Lineolic acids and derivatives
			221.1168	6.13	2-(1-hydroxycyclopentyl) -2-phenylacetic acid	Benzene and substituted derivatives

4.3.12 *Typhonium flagelliforme* (Lodd.) Blume LYMOOI 060

LC-MS/MS analysis of extract from *Typhonium flagelliforme* enabled the identification of 5 putative compounds (Table 4.50) belonging to different chemical families. It contains 2 putative primary metabolites and 3 putative secondary metabolites.

Table 4.50: List of putative compounds in LYMOOI 060, *Typhonium flagelliforme*, Precursor type: $(M+H)^+$, Plant Part: Tuber

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 060	Primary	Nucleic acids	136.0615	0.98	7H-purin-6-amine	Adenine
			268.1039	1.12	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
	Secondary	N-containing compounds	120.0806	1.12	2,3-dihydro-1~{H}-indole	Indolines
			188.0702	1.98	3-(1H-indol-3-yl)prop-2-enoic acid	Indoles

Table 4.50 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 060	Secondary	Terpenes	498.2606	3.72	(2Z)-3-(4-hydroxy-3-methoxyphenyl)-N-[3-({4-[(2E)-3-(4-hydroxy-3-methoxyphenyl)prop-2-enamido]butyl}amino)propyl]prop-2-enamide	Hydroxycinnamic acids and derivatives

4.3.13 *Calotropis gigantea* (L.) W.T.Aiton LYMOOI 007

LC-MS/MS analysis of extract from *Calotropis gigantean* enabled the identification of 26 putative compounds (Table 4.51) belonging to different chemical families. It contains 5 putative primary metabolites and 21 putative secondary metabolites.

Table 4.51: List of putative compounds in LYMOOI 007, *Calotropis gigantean*, Precursor type: $(M+H)^+$, Plant Part: Leaves

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 007	Primary	Nucleic acids	136.0613	0.96	7H-purin-6-amine	Adenine
			268.1041	1.08	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
		Proteins	175.1188	0.60	(3~{S})-3-azaniumyl-5-(diaminomethylideneazaniumyl)pentanoate	Beta amino acids and derivatives
			166.0861	1.09	3-amino-3-phenylpropanoic acid	Beta amino acids and derivatives

Table 4.51 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 007	Primary	Pigments	565.4047	7.95	2,3-Didehydro-3-hydroxy-beta,beta-caroten-4-one	Xanthophylls
	Secondary	N-containing compounds	104.1068	0.65	3-(dimethylamino)propan-1-ol	1,3-aminoalcohols
			120.0807	1.09	2,3-dihydro-1~{H}-indole	Indolines
			205.0972	1.96	L-tryptophan	L-tryptophan
			188.0705	1.97	3-(1H-indol-3-yl)prop-2-enoic acid	Indoles
			217.0975	2.42	3-(1-phenylethyl)imidazole-4-carboxylic acid	Carbonylimidazoles
		Phenolics	479.1189	3.55	5,7-dihydroxy-2-(4-hydroxy-3-methoxyphenyl)-3-[3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxychromen-4-one	Flavonoid-3-O-glycosides

Table 4.51 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 007	Secondary	Phenolics	625.1766	3.58	3,5-dihydroxy-2-(3-hydroxy-4-methoxyphenyl)-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
			317.0658	3.90	2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxy-6-methylchromen-4-one	Flavonols
			195.1378	4.53	Phenylpropanes	Phenylpropanes
		Terpenes	213.1485	4.38	(3-hydroxy-1,7,7-trimethyl-2-bicyclo[2.2.1]heptanyl) acetate	Bicyclic monoterpenoids
			275.2011	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

Table 4.51 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 007	Secondary	Terpenes	291.1955	4.97	(8R,9S,10R,13S,14S,17 S)-4,17-dihydroxy-13-m ethyl-2,6,7,8,9,10,11,12, 14,15,16,17-dodecahydr o-1H-cyclopenta[a]phen anthren-3-one	Estrogens and derivatives
			277.2162	5.84	17-hydroxy-13-methyl-2 ,4,5,6,7,8,9,10,11,12,14, 15,16,17-tetradecahydro- 1H-cyclopenta[a]phenant hren-3-one	Estrogens and derivatives
			335.2578	6.89	1-(3,16-dihydroxy-10,13 -dimethyl-2,3,4,5,6,7,8,9 ,11,12,14,15,16,17-tetrad ecahydro-1H-cyclopenta[a]phenanthren-17-yl)etha none	Gluco/mineralocorticoids, progestogins and derivatives

Table 4.51 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 007	Secondary	Terpenes	583.4153	7.91	(3S,3'R,4R)-7',8'-Dideh ydro-beta,beta-carotene -3,3',4-triol	Triterpenoids
			409.3838	10.08	Ferna-7,9(11)-diene	Triterpenoids
		Others	177.0537	2.63	3-(1,3-benzodioxol-5 -yl)prop-2-enal	Benzodioxoles
			235.0971	3.63	2-hydroxy-1-[6-hydroxy -2-(prop-1-en-2-yl)-2,3- dihydro-1-benzofuran-5 -yl]ethan-1-one	Coumarans
			293.2113	4.35	10-methoxyheptadec-1- en-4,6-diyne-3,9-diol	Long-chain fatty alcohols
			291.1960	5.18	Deoxy phytoprostane J1	Prostaglandins and related compounds
			351.2536	5.76	Other hydroperoxyeicos apolyenoic acids	Other hydroperoxyeicosap olyenoic acids

4.3.14 *Gynostemma pentaphyllum* (Thunb.) Makino LYMOOI 039

LC-MS/MS analysis of extract from *Gynostemma pentaphyllum* enabled the identification of 18 putative compounds (Table 4.52) belonging to different chemical families. It contains 2 putative primary metabolites and 16 putative secondary metabolites.

Table 4.52: List of putative compounds in LYMOOI 039, *Gynostemma pentaphyllum*, Precursor type: $(M+H)^+$, Plant Part: Leaves

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 039	Primary	Nucleic acids	136.0615	0.97	7H-purin-6-amine	Adenine
			268.1042	1.62	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
	Secondary	N-containing compounds	217.0975	2.41	3-(1-phenylethyl)imidazole-4-carboxylic acid	Carbonylimidazoles
			124.0869	14.02	Benzene-1,2,4-triamine	Aniline and substituted anilines

Table 4.52 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 039	Secondary	Phenolics	147.0437	2.84	3-phenylprop-2-ynoic acid	Benzene and substituted derivatives
			195.1011	3.66	2,5-Dimethoxy-4-(2-propenyl)phenol	Methoxyphenols
		Terpenes	207.1377	2.84	3,5,5-trimethyl-4-(3-oxobut-1-enyl)cyclohex-2-en-1-one	Sesquiterpenoids
			209.1536	3.48	(6R,9R)-9-Hydroxy-4-megastigmen-3-one	Sesquiterpenoids
			137.1322	4.11	p-Mentha-1(7),3-diene beta-Terpinen	Menthane monoterpenoids
			619.4211	4.32	Oleanolic acid 28-O-beta-D-glucopyranoside	Triterpene saponins
			457.3685	4.67	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
			455.3515	5.38	Melilotigenin B	Triterpenoids

Table 4.52 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 039	Secondary	Terpenes	411.3625	9.55	(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
		Others	251.0910	4.14	3-(1,3-benzodioxol-5-yl)-1,3,3a,4,6,6a-hexahydrofuro[3,4-c]furan-6-ol	Benzodioxoles
			277.2166	5.85	9,12,15,17-octadecatetraenoic acid	Lineolic acids and derivatives
			279.2313	6.08	9,12,14-octadecatrienoic acid	Lineolic acids and derivatives

Table 4.52 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 039	Secondary	Others	237.1482	6.59	[3R-(3alpha,4beta,4abeta,6alpha)]-4,4a,5,6,7,8-Hexahydro-3,4a-dihydroxy-4-methyl-6-(1-methylethenyl)-2(3H)-naphthalenone	Cyclohexenones
			256.2637	7.09	Hexadecanamide	Fatty amides

4.3.15 *Cycas revoluta* LYMOOI 053

LC-MS/MS analysis of extract from *Cycas revolute* enabled the identification of 15 putative compounds (Table 4.53) belonging to different chemical families. It contains 1 putative primary metabolites and 14 putative secondary metabolites.

Table 4.53: List of putative compounds in LYMOOI 053, *Cycas revolute*, Precursor type: $(M+H)^+$, Plant Part: Leaves

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 053	Primary	Pigments	607.2919	9.35	Methyl pheophorbide a	Chlorins
	Secondary	N containing compounds	224.1282	1.05	6,7-dimethoxy-2-methyl-3,4-dihydro-1H-isoquinolin-8-ol	Tetrahydroisoquinolines
			238.1439	2.48	6,7-dimethoxy-1,2-dimethyl-3,4-dihydro-1H-isoquinolin-4-ol	Tetrahydroisoquinolines
			206.1397	13.97	N-(3-methylbut-2-enyl)-1,4,5,7-tetrahydropurin-6-imine	Imidazopyrimidines

Table 4.53 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 053	Secondary	N containing compounds	124.0865	13.98	Benzene-1,2,4-triamine	Aniline and substituted anilines
		Phenolics	313.1434	3.74	Kachirachirol B	2-arylbenzofuran flavonoids
			327.1595	3.81	Pyranoisoflavonoids	Pyranoisoflavonoids
			541.1131	5.30	8-[5-(5,7-dihydroxy-4-oxo-2,3-dihydrochromen-2-yl)-2-hydroxyphenyl]-5,7-dihydroxy-2-(4-hydroxyphenyl)chromen-4-one	Biflavonoids and polyflavonoids
		Terpenes	269.211	4.97	11-methoxy-3,7,11-trimethyldodeca-2,4-dienoic acid	Sesquiterpenoids
		Others	229.1548	1.11	Fatty acid methyl esters	Fatty acid methyl esters
			174.1488	1.22	9-aminononanoic acid	Medium-chain fatty acids
			329.269	5.84	1,3-dihydroxypropan-2-yl hexadec-9-enoate	2-monoacylglycerols
			277.2166	6.00	9,12,15,17-octadecatetraenoic acid	Lineolic acids and derivatives

Table 4.53 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 053	Secondary	Others	237.1487	6.57	[3R-(3alpha,4beta,4abeta ,6alpha)]-4,4a,5,6,7,8-He xahydro-3,4a-dihydroxy- 4-methyl-6-(1-methylethe nyl)-2(3H)-naphthalenone	Cyclohexenones
			429.3734	9.27	2,5,7,8-tetramethyl-2-(4, 8,12-trimethyltridecyl)ch romen-6-ol	Tocopherols

4.3.16 *Kyllinga brevifolia* Robbt LYMOOI 005

LC-MS/MS analysis of extract from *Kyllinga brevifolia* enabled the identification of 6 putative compounds (Table 4.54) belonging to different chemical families. It contains 2 putative primary metabolites and 4 putative secondary metabolites.

Table 4.54: List of putative compounds in LYMOOI 005, *Kyllinga brevifolia*, Precursor type: $(M+H)^+$, Plant Part: Whole plants

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 005	Primary	Nucleic acids	268.1041	1.61	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
		Carbohydrates	423.0904	3.25	Lactose 6-phosphate	Disaccharide phosphates
	Secondary	N-containing compounds	138.0551	0.79	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids
		Phenolics	147.0437	1.58	3-phenylprop-2-ynoic acid	Benzene and substituted derivatives

Table 4.54 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 005	Secondary	Phenolics	433.1131	2.61	1-hydroxy-3-(hydroxymethyl)-8-{[3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxy}-9,10-dihydroanthracene-9,10-dione	Anthraquinones
			433.1126	2.63	3,5-dihydroxy-2-phenyl-7-[(2S,4S,5S)-3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxychromen-4-one	Flavonoid-7-O-glycosides

4.3.17 *Dioscorea bulbifera* (L) LYMOOI 018

LC-MS/MS analysis of extract from *Dioscorea bulbifera* enabled the identification of 31 putative compounds (Table 4.55) belonging to different chemical families. It contains 3 putative primary metabolites and 28 putative secondary metabolites.

Table 4.55: List of putative compounds in LYMOOI 018, *Dioscorea bulbifera*, Precursor type: $(M+H)^+$, Plant Part: Whole plants

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 018	Primary	Nucleic acids	268.1046	1.29	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
		Proteins	166.0866	1.12	3-amino-3-phenylpropanoic acid	Beta amino acids and derivatives
		Vitamins	415.3210	6.05	Vitamin D and derivatives	Vitamin D and derivatives

Table 4.55 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 018	Secondary	N-containing compounds	138.0549	0.69	5-methylpyridine-3-carboxylic acid	Pyridinecarboxylic acids
			118.0861	0.83	3-(dimethylamino)propanoic acid	Trialkylamines
			120.0807	1.11	2,3-dihydro-1~{H}-indole	Indolines
			188.0707	1.34	3-(1H-indol-3-yl)prop-2-enoic acid	Indoles
			205.0975	1.97	L-tryptophan	L-tryptophan
			316.2852	6.03	1,2-aminoalcohols	1,2-aminoalcohols
			206.1408	9.23	N-(3-methylbut-2-enyl)-1,4,5,7-tetrahydropurin-6-imine	Imidazopyrimidines

Table 4.55 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 018	Secondary	Phenolics	303.0509	2.72	2-(3,4-dihydroxyphenyl)-3,7,8-trihydroxychromen-4-one	Flavonols
			498.2602	4.01	(2Z)-3-(4-hydroxy-3-methoxyphenyl)-N-[3-({4-[(2E)-3-(4-hydroxy-3-methoxyphenyl)prop-2-enamido]butyl}amino)propyl]prop-2-enamide	Hydroxycinnamic acids and derivatives
			331.0819	4.03	Aromadendrin 3-acetate	Flavanonols
			345.1337	4.19	Pd-C-I	Linear pyranocoumarins

Table 4.55 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 018	Secondary	Phenolics	315.0873	4.35	7-hydroxy-3-(3-hydroxy -4-methoxyphenyl)-6-me thoxychromen-4-one	3'-hydroxy,4'-methoxyisoflavonoids
			331.1541	4.44	Psoralens	Psoralens
			565.1184	4.50	3-[(6-{[5,7-dihydroxy-2-(4-hydroxy-3-methoxyph enyl)-4-oxo-4H-chromen -3-yl]oxy}-3,4,5-trihydro xyoxan-2-yl)methoxy]-3-oxopropanoic acid	Flavonoid-3-O-glycosides
		Terpenes	277.2164	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

Table 4.55 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 018	Secondary	Terpenes	413.3787	9.67	17-(5-ethyl-6-methylheptan-2-yl)-10,13-dimethyl-2,3,4,9,11,12,14,15,16,17-decahydro-1H-cyclopenta[a]phenanthren-3-ol	Stigmastanes and derivatives
			445.3682	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	229.1552	1.08	Fatty acid methyl esters	Fatty acid methyl esters
			179.1070	3.28	(4S)-4-hydroxy-3-methyl-2-[(2Z)-penta-2,4-dienyl]cyclopent-2-en-1-one	Secondary alcohols
			363.1444	3.42	11,13-Dihydrovernodalin	Tricarboxylic acids and derivatives
			277.1068	4.19	Linderadin	1,4-dioxanes

Table 4.55 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 018	Secondary	Others	739.4262	4.48	2-[4,5-dihydroxy-6-(hydroxymethyl)-2-(5',7,9,13-tetramethylspiro[5-oxapentacyclo[10.8.0.0^{2,9}.0^{4,8}.0^{13,18}]icos-18-ene-6,2'-oxane]-16-yl)oxyoxan-3-yl]oxy-6-(hydroxymethyl)oxane-3,4,5-triol	Steroidal saponins
			181.1223	4.52	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols
			291.1960	5.23	Deoxy phytoprostane J1	Prostaglandins and related compounds
			293.1174	5.30	(1E,6E)-1-(4-hydroxyphenyl)-7-phenylhepta-1,6-diene-3,5-dione	(1E,6E)-1-(4-hydroxyphenyl)-7-phenylhepta-1,6-diene-3,5-dione

Table 4.55 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 018	Secondary	Others	295.2259	6.25	8-(3-octa-2,5-dienyloxiran-2-yl)octanoic acid	Medium-chain fatty acids
			237.1487	6.59	[3R-(3alpha,4beta,4abeta,6alpha)]-4,4a,5,6,7,8-Hexahydro-3,4a-dihydroxy-4-methyl-6-(1-methylethenyl)-2(3H)-naphthalenone	Cyclohexenones
			429.3734	9.28	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols

4.3.18 *Ocimum basilicum* L. LYMOOI 040

LC-MS/MS analysis of extract from *Ocimum basilicum* enabled the identification of 34 putative compounds (Table 4.56) belonging to different chemical families. It contains 3 putative primary metabolites and 31 putative secondary metabolites.

Table 4.56: List of putative compounds in LYMOOI 040, *Ocimum basilicum*, Precursor type: $(M+H)^+$, Plant Part: Whole plants

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 040	Primary	Nucleic acids	136.0615	0.97	7H-purin-6-amine	Adenine
			268.1043	1.19	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
		Pigments	593.2759	11.08	Chlorins	Chlorins
	Secondary	N-containing compounds	188.0704	1.98	3-(1H-indol-3-yl)prop-2-enoic acid	Indoles
			205.0976	1.99	L-tryptophan	L-tryptophan

Table 4.56 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 040	Secondary	Phenolics	531.1855	3.85	3,5-dihydroxy-2-(4-methoxyphenyl)-8-(3-methylbut-2-en-1-yl)-7-{[3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxy}-4H-chromen-4-one	Flavonoid-7-O-glycosides
			287.0913	4.09	9-[(3,3-dimethyloxiran-2-yl)methoxy]furo[3,2-g]chromen-7-one	Psoralens
			493.1335	4.20	Rhamnazin 3-galactoside	Flavonoid-3-O-glycosides
			271.0597	4.91	5,7-dihydroxy-2-(2-hydroxyphenyl)chromen-4-one	Flavones
			317.1020	4.99	Pterocarpans	Pterocarpans
			315.0870	5.29	7-hydroxy-3-(2-hydroxy-4,5-dimethoxyphenyl)chromen-4-one	4'-O-methylisoflavones
			245.0812	5.91	Seselinol	Angular pyranocoumarins

Table 4.56 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 040	Secondary	Phenolics	329.1027	5.97	8-Hydroxy-5,6,7-trim ethoxyflavone	7-O-methylated flavonoids
			315.0857	6.04	7-hydroxy-2-(4-hydroxy-3-methoxyphenyl)-5-met hoxychromen-4-one	5-O-methylated flavonoids
			359.1132	6.16	2,5,7-Trihydroxy-6,8-di methyl-3-(3',4'-methylen edioxybenzyl)-chroman-4-one	Homoisoflavanones
			329.1024	6.56	3,5-Dihydroxy-7-methox yflavanone 3-acetate	7-O-methylated flavonoids
			195.0656	6.74	Methyl 3-(3,4-dihydroxyp henyl)prop-2-enoate	Coumaric acids and deriva tives
			353.2689	6.83	1-(4-hydroxy-3-methoxyp henyl)tetradecane-3,5-diol	Gingerdiols
		Terpenes	689.3887	4.02	Methylcimicifugoside	Cycloartanols and derivatives
			489.3583	5.70	Spathodic acid	Triterpenoids
			455.3523	6.37	Eucalyptanoic acid	Triterpenoids

Table 4.56 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 040	Secondary	Terpenes	353.2686	6.80	Tomentol	Sesquiterpenoids
			191.1795	7.29	Acyclic monoterpenoids	Acyclic monoterpenoids
			411.3631	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
			413.3784	9.66	17-(5-ethyl-6-methylheptan-2-yl)-10,13-dimethyl-2,3,4,9,11,12,14,15,16,17-decahydro-1H-cyclopenta[a]phenanthren-3-ol	Stigmastanes and derivatives
			409.3828	11.91	Ferna-7,9(11)-diene	Triterpenoids
		Others	229.1553	1.13	Fatty acid methyl esters	Fatty acid methyl esters

Table 4.56 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 040	Secondary	Others	209.1175	2.34	(Z)-3-Oxo-2-(2-pentenyl)-1-cyclopenteneacetic acid	Cyclic ketones
			227.1285	2.70	2-[(1R,2R)-2-[(Z,4S)-4-hydroxypent-2-enyl]-3-oxocyclopentyl]acetic acid	Jasmonic acids
			295.1022	3.83	6-tuliposide B	Saccharolipids
			181.1224	4.53	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols
			256.2640	7.10	Hexadecanamide	Fatty amides
			429.3737	9.26	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols

Table 4.56 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 040	Secondary	Others	760.5855	11.62	[2-(methylamino)ethoxy]({2-[(9Z)-octadec-9-enoyloxy]-3-(octadecanoyloxy)propoxy})phosphinic acid	Monomethylphosphatidylethanolamines

4.3.19 *Orthosiphon aristatus* (Blume) Miq. LYMOOI 029

LC-MS/MS analysis of extract from *Orthosiphon aristatus* enabled the identification of 30 putative compounds (Table 4.57) belonging to different chemical families. It contains 3 putative primary metabolites and 27 putative secondary metabolites.

Table 4.57: List of putative compounds in LYMOOI 029, *Orthosiphon aristatus*, Precursor type: $(M+H)^+$, Plant Part: Leaves

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 029	Primary	Nucleic acids	136.0618	0.98	7H-purin-6-amine	Adenine
			268.1042	1.29	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
		Proteins	207.1255	8.59	2-amino-5-(diaminomethylideneamino)-2-(fluoromethyl)pentanoic acid	Alpha amino acids

Table 4.57 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 029	Secondary	N-containing compounds	118.0860	0.65	3-(dimethylamino)propanoic acid	Trialkylamines
			120.0808	1.09	2,3-dihydro-1~{H}-indole	Indolines
			188.0705	1.73	3-(1H-indol-3-yl)prop-2-enoic acid	Indoles
			205.0974	1.96	L-tryptophan	L-tryptophan
			190.0497	2.19	8-hydroxy-2-quinoline carboxylic acid	Quinoline carboxylic acids
		Phenolics	213.0755	1.77	5-(3,3-Dihydroxypropeny)-3-Methoxy-Benzene-1,2-Diol	Methoxyphenols
			359.1132	4.95	5-Hydroxy-2-(4-hydroxy-3-methoxyphenyl)-3,7-dimethoxy-6-methyl-4H-1-benzopyran-4-one	7-O-methylated flavonoids
			329.1029	5.98	8-Hydroxy-5,6,7-trimethoxyflavone	7-O-methylated flavonoids

Table 4.57 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 029	Secondary	Phenolics	329.1027	6.97	7-Hydroxy-5,6,4'-trim ethoxyisoflavone	4'-O-methylisoflavones
		Terpenes	207.1381	2.73	3,5,5-trimethyl-4-(3-o xobut-1-enyl)cyclohex -2-en-1-one	Sesquiterpenoids
			209.1534	2.90	4-(4-hydroxy-2,6,6-tri methylcyclohexen-1-y l)but-3-en-2-one	Sesquiterpenoids
			209.1545	3.07	(6R,9R)-9-Hydroxy-4-megastigmen-3-one	Sesquiterpenoids
			209.1536	3.25	4-(4-hydroxy-2,6,6-trim ethylcyclohex-2-en-1-yl)but-3-en-2-one	Sesquiterpenoids
			347.1855	4.87	Methyl (1~{R},2~{R},5 ~{R},8~{R},9~{S},10~ {R},11~{R},12~{S})-12 -hydroxy-11-methyl-6-m ethylidene-16-oxo-15-ox apentacyclo[9.3.2.1^{5,8 }.0^{1,10}.0^{2,8}]hepta decane-9-carboxylate	Diterpene lactones

Table 4.57 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 029	Secondary	Terpenes	353.2688	6.86	Tomentol	Sesquiterpenoids
			411.3630	7.11	(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
			457.3682	7.12	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
			191.1798	7.31	Acyclic monoterpenoids	Acyclic monoterpenoids

Table 4.57 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 029	Secondary	Terpenes	445.3682	7.34	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
			537.4458	10.65	1,3,3-trimethyl-2-[3,7,12,16-tetramethyl-18-(2,6,6-trimethylcyclohex-2-en-1-yl)octadeca-1,3,5,7,9,11,13,15,17-nonaenyl]cyclohexene	Alpha-carotene
			409.3838	11.39	Ferna-7,9(11)-diene	Triterpenoids
			205.1945	11.95	5,5-dimethyl-1-(4-methylcyclohex-3-en-1-yl)cyclohexene	(S)-beta-macrocarpene
			205.1951	12.12	1-methyl-4-(6-methylhept-5-en-2-yl)cyclohexa-1,4-diene	Sesquiterpenoids

Table 4.57 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 029	Secondary	Terpenes	205.1952	12.14	3,8-dimethyl-5-propan -2-yl-1,2,6,7,8,8a-hexa hydroazulene	Guaianes
		Others	229.1549	1.07	Fatty acid methyl esters	Fatty acid methyl esters
			371.2062	3.07	Fatty acyl glycosides of mono- and disaccharide s	Fatty acyl glycosides of mono- and disaccharides
			181.1223	4.35	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyc lopent-2-en-1-one	Secondary alcohols

4.3.20 *Vitex trifolia* L. LYMOOI 006

LC-MS/MS analysis of extract from *Vitex trifolia* enabled the identification of 42 putative compounds (Table 4.58) belonging to different chemical families. It contains 4 putative primary metabolites and 38 putative secondary metabolites.

Table 4.58: List of putative compounds in LYMOOI 006, *Vitex trifolia*, Precursor type: $(M+H)^+$, Plant Part: Whole plants

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 006	Primary	Nucleic acids	136.0614	0.97	7H-purin-6-amine	Adenine
			268.1033	1.59	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
		Carbohydrates	162.1128	0.83	4-amino-4,6-dimethyloxane-2,5-diol	Hexoses

Table 4.58 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 006	Primary	Vitamins	457.1127	4.13	[5-(7,8-dimethyl-2,4-dioxobenzo[g]pteridin-10-yl)-2,3,4-trihydroxypentyl] dihydrogen phosphate	Catechin gallates
	Secondary	N-containing compounds	217.0968	2.42	3-(1-phenylethyl)imidazole-4-carboxylic acid	Carbonylimidazoles
			330.1343	2.91	9-methoxy-4-methyl-11,16,18-trioxa-4-azapentacyclo[11.7.0.02,10.03,7.015,19]icosa-1(20),7,13,15(19)-tetraen-12-one	Homolycorine-type amaryllidaceae alkaloids
			372.1440	3.10	Tetrahydroisoquinolines	Tetrahydroisoquinolines
			356.1129	3.33	7,8-dihydro-[1,3]dioxolo[4,5-g]isoquinolin-5-yl-(2-hydroxy-3,4-dimethoxyphenyl)methanone	Benzylisoquinolines

Table 4.58 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 006	Secondary	N-containing compounds	370.1291	3.52	24-methoxy-5,7,19,21,25-pentaoxa-13-azahexacyclo[12.11.0.02,10.04,8.015,23.018,22]pentacosa-2,4(8),9,15(23),16,18(22)-hexaene	Rhoeadine alkaloids
		Phenolics	163.0382	2.03	3-Hydroxycoumarin	Hydroxycoumarins
			269.0804	2.20	5,7-dihydroxy-6-methyl-2-phenylchromen-4-one	Flavones
			581.1498	2.21	Isoorientin 2"-O-xyloside	Flavonoid C-glycosides
			449.1079	2.41	Flavonoid 8-C-glycosides	Flavonoid 8-C-glycosides
			163.0383	1.78	4-hydroxychromen-2-one	4-hydroxycoumarins
			139.0383	1.85	2-(hydroxymethyl)cyclohexa-2,5-diene-1,4-dione	P-benzoquinones
			287.0916	2.26	Neosakuranetin	2'-Hydroxychalcones
			287.0915	3.22	3-O-methylbutein	2'-Hydroxychalcones

Table 4.58 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 006	Secondary	Phenolics	433.1133	3.24	3,5-dihydroxy-2-phenyl -7-[(2S,4S,5S)-3,4,5-trih ydroxy-6-(hydroxymethy l)oxan-2-yl]oxychromen- 4-one	Flavonoid-7-O-glycosides
			415.1031	3.54	6,7,9,11-tetrahydroxy-9-(2-hydroxyacetyl)-4-metho xy-8,10-dihydro-7H-tetrac ene-5,12-dione	Tetracenequinones
			463.0879	3.66	Luteolin 4'-glucuronide	Flavonoid O-glucuronides
			163.0380	3.99	8-hydroxy-2H-chrome n-2-one	Hydroxycoumarins
			449.1074	4.91	Flavonoid-7-O-glycosi des	Flavonoid-7-O-glycosides
			375.1070	5.47	2-(3,4-dihydroxyphenyl) -5-hydroxy-3,6,7-trimeth oxy-8-methylchromen-4- one	7-O-methylated flavonoids

Table 4.58 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 006	Secondary	Phenolics	584.2759	4.62	3-(4-hydroxyphenyl) -N-{3-[3-(4-hydroxy phenyl)-N-{4-[3-(4-h ydroxyphenyl)prop-2 -enamido]butyl}prop- 2-enamido]propyl}pro p-2-enamide	Tricoumaroyl spermidine
			361.0923	5.16	3,5,7,4'-Tetrahydroxy-3 '-methoxyflavanone 3-a cetate	3'-O-methylated flavonoids
			345.0970	5.44	2-(3,4-dihydroxyphenyl)-5 -hydroxy-3,7-dimethoxy-6 -methylchromen-4-one	7-O-methylated flavonoids
		Terpenes	301.2172	4.30	(+)-Sugikurojin A	Diterpenoids
			259.2056	6.94	(3~{E},5~{E},7~{E})-6- methyl-8-(2,6,6-trimethyl cyclohexen-1-yl)octa-3,5, 7-trien-2-one	Sesquiterpenoids

Table 4.58 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 006	Secondary	Terpenes	409.3830	11.17	Ferna-7,9(11)-diene	Triterpenoids
			301.2161	4.26	6,7-Dehydrosandaracopimaric acid (+)-6,7-Dehydrosandaracopimaric acid	Diterpenoids
			335.2216	5.01	Cyathin A4	Diterpenoids
			319.2270	5.44	(1S,2S,4aR,4bS,7R,10aR)-7-ethenyl-2-hydroxy-1,4a,7-trimethyl-3,4,4b,5,6,9,10,10a-octahydro-2H-phenanthrene-1-carboxylic acid	Hydroxysteroids
			271.2422	6.04	1,1,4a-trimethyl-7-propan-2-yl-2,3,4,9,10,10a-hexahydrophenanthrene	Diterpenoids

Table 4.58 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 006	Secondary	Terpenes	287.2372	6.20	(1,4a-dimethyl-7-propan-2-yl-2,3,4,9,10,10a-hexahydrophenanthren-1-yl)methanol	Diterpenoids
			303.2317	6.36	1,4a-dimethyl-7-propan-2-yl-2,3,4,4b,5,9,10,10a-octahydrophenanthrene-1-carboxylic acid	Diterpenoids
			285.2212	6.94	4b,8,8-trimethyl-2-propan-2-yl-5,6,7,8a-tetrahydrophenanthren-3-ol	Diterpenoids
			303.2313	7.36	(4aS)-1,1,4a-trimethyl-7-(propan-2-yl)-1,2,3,4,4a,9,10,10a-octahydrophenanthrene-3,6-diol	Diterpenoids

Table 4.58 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 006	Secondary	Terpenes	305.2477	7.52	(2R,4aR,4bS,7S,9S,10aS)-7-ethenyl-1,1,4a,7-tetramethyl-1,2,3,4,4a,4b,5,6,7,9,10,10a-dodecahydrophenanthrene-2,9-diol	Diterpenoids
			413.3783	9.68	(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	229.1548	1.16	Fatty acid methyl esters	Fatty acid methyl esters
			329.2477	7.10	Docosa-4,7,10,13,16,19-hexaenoic acid	Very long-chain fatty acids

Table 4.58 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 006	Secondary	Others	429.3730	9.26	2,5,7,8-tetramethyl-2-(4 ,8,12-trimethyltridecyl)c hromen-6-ol	Tocopherols

4.3.21 *Mentha spicata* L. LYMOOI 004

LC-MS/MS analysis of extract from *Mentha spicata* enabled the identification of 21 putative compounds (Table 4.59) belonging to different chemical families. It contains 1 putative primary metabolites and 20 putative secondary metabolites.

Table 4.59: List of putative compounds in LYMOOI 004, *Mentha spicata*, Precursor type: $(M+H)^+$, Plant Part: Whole plants

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 004	Primary	Nucleic acids	268.1043	1.51	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
	Secondary	N-containing compounds	104.1067	0.62	3-(dimethylamino)propan-1-ol	1,3-aminoalcohols
			118.0861	0.65	3-(dimethylamino)propanoic acid	Trialkylamines
			144.1019	0.79	1-aminocyclohexane-1-carboxylic acid	L-alpha-amino acids

Table 4.59 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 004	Secondary	Phenolics	463.1244	3.64	5,7-dihydroxy-2-(3-hydroxy-4-methoxyphenyl)-3-[(2S,3S,5R)-3,4,5-trihydroxy-6-methyloxan-2-yl]oxychromen-4-one	Flavonoid-3-O-glycosides
			463.1236	4.05	5,7-dihydroxy-2-(3-hydroxy-4-methoxyphenyl)-6-[3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]chromen-4-one	Flavonoid C-glycosides
			593.1874	4.12	7-[4,5-dihydroxy-6-(hydroxymethyl)-3-(3,4,5-trihydroxy-6-methyloxan-2-yl)oxyoxan-2-yl]oxy-5-hydroxy-2-(4-methoxyphenyl)chromen-4-one	Flavonoid-7-O-glycosides

Table 4.59 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 004	Secondary	Phenolics	609.1822	4.51	Isoscoparin 2"-O-rhamnoside	Flavonoid C-glycosides
			285.0757	5.67	5,7-dihydroxy-2-(4-hydroxyphenyl)-6-methylchromen-4-one	Flavones
		Terpenes	209.1170	2.54	(4-hydroxy-5-methyl-2-propan-2-ylphenyl) acetate	Aromatic monoterpenoids
			291.1960	5.19	(8R,9S,10R,13S,14S,17S)-4,17-dihydroxy-13-methyl-2,6,7,8,9,10,11,12,14,15,16,17-dodecahydro-1H-cyclopenta[a]phenanthren-3-one	Estrogens and derivatives
			409.3834	11.38	Ferna-7,9(11)-diene	Triterpenoids
		Others	156.0421	0.73	2-(methylamino)ethyl dihydrogen phosphate	Phosphoethanolamines

Table 4.59 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 004	Secondary	Others	227.1277	2.29	2-[(1R,2R)-2-[(Z,4S)-4-hydroxypent-2-enyl]-3-oxocyclopentyl]acetic acid	Jasmonic acids
			209.1173	2.71	(Z)-3-Oxo-2-(2-pentenyl)-1-cyclopenteneacetic acid	Cyclic ketones
			191.1067	2.85	Benzyl 2-methylbut-2-enoate	Benzyloxycarbonyls
			179.1062	3.29	(4S)-4-hydroxy-3-methyl-2-[(2Z)-penta-2,4-dienyl]cyclopent-2-en-1-one	Secondary alcohols
			293.2104	4.36	10-methoxyheptadec-1-en-4,6-diyne-3,9-diol	Long-chain fatty alcohols
			181.1218	4.50	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols
			291.1957	5.02	Deoxy phytoprostane J1	Prostaglandins and related compounds
			256.2643	7.29	Hexadecanamide	Fatty amides

4.3.22 *Plectranthus amboinicus* (Lour.) Spreng. LYMOOI 061

LC-MS/MS analysis of extract from *Plectranthus amboinicus* enabled the identification of 32 putative compounds (Table 4.60) belonging to different chemical families. It contains 3 putative primary metabolites and 29 putative secondary metabolites.

Table 4.60: List of putative compounds in LYMOOI 061, *Plectranthus amboinicus*, Precursor type: $(M+H)^+$, Plant Part: Leaves

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 061	Primary	Nucleic acids	136.0614	0.97	7H-purin-6-amine	Adenine
		Proteins	166.0862	1.09	3-amino-3-phenylpropanoic acid	Beta amino acids and derivatives
		Pigments	607.2918	9.41	Methyl pheophorbide a	Chlorins
	Secondary	N-containing compounds	104.1069	0.65	3-(dimethylamino)propan-1-ol	1,3-aminoalcohols
			120.0805	1.14	2,3-dihydro-1~{H}-indole	Indolines

Table 4.60 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 061	Secondary	N-containing compounds	205.0977	1.98	L-tryptophan	L-tryptophan
			165.0656	2.36	4-methoxy-1-methyl-2-oxopyridine-3-carbonitrile	Ricinine
			217.0970	2.42	3-(1-phenylethyl)imidazole-4-carboxylic acid	Carbonylimidazoles
			312.123	3.27	Velucryptine	Benzylisoquinolines
			124.0870	13.96	Benzene-1,2,4-triamine	Aniline and substituted anilines
		Phenolics	463.0880	2.79	Kaempferol 3-glucuronide	Flavonoid-3-O-glucuronides
			433.1131	3.44	3,5-dihydroxy-2-phenyl-7-[(2S,4S,5S)-3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxychromen-4-one	Flavonoid-7-O-glycosides
			463.0879	3.94	Luteolin 4'-glucuronide	Flavonoid O-glucuronides
			493.1338	4.33	Rhamnazin 3-galactoside	Flavonoid-3-O-glycosides

Table 4.60 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 061	Secondary	Phenolics	271.0600	4.88	5,7-dihydroxy-2-(3-hydroxyphenyl)-4H-chromen-4-one	Flavones
			301.0703	4.97	6,7-dihydroxy-2-(4-hydroxy-3-methoxyphenyl) chromen-4-one	3'-O-methylated flavonoids
			331.0815	5.04	2-(3,4-dihydroxyphenyl) -5,7-dihydroxy-3-methoxy-6-methylchromen-4-one	3-O-methylated flavonoids
			315.0867	5.29	7-hydroxy-3-(2-hydroxy-4,5-dimethoxyphenyl)chromen-4-one	4'-O-methylisoflavones
			329.1024	5.98	3,5-Dihydroxy-7-methoxyflavanone 3-acetate	7-O-methylated flavonoids
		Terpenes	191.1063	2.74	2,6-dimethyldeca-2,4,6, 8-tetraenedial	Acyclic monoterpenoids

Table 4.60 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 061	Secondary	Terpenes	471.3473	5.54	10-hydroxy-2,4a,6a,6b, 9,9,12a-heptamethyl-13 -oxo-3,4,5,6,6a,7,8,8a,1 0,11,12,14b-dodecahyd ro-1H-picene-2-carboxy lic acid	Triterpenoids
			489.3584	5.66	10,11-dihydroxy-9-(hyd roxymethyl)-2,2,6a,6b,9 ,12a-hexamethyl-1,3,4,5 ,6,6a,7,8,8a,10,11,12,13, 14b-tetradecahydropicen e-4a-carboxylic acid	Triterpenoids
			455.3521	6.51	Eucalyptanoic acid	Triterpenoids

Table 4.60 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 061	Secondary	Terpenes	473.3633	6.55	(1S,2R,4aS,6aR,6bR,7R, 10S,12aS,14bS)-7,10-dih ydroxy-1,2,6a,6b,9,9,12a -heptamethyl-1,2,3,4,4a,5 ,6,6a,6b,7,8,8a,9,10,11,12 ,12a,12b,13,14b-icosahyd ropicene-4a-carboxylic ac id	Triterpenoids
			473.3623	6.73	Pomolic acid	Triterpenoids
			277.2159	7.25	17-hydroxy-13-methyl-2, 4,5,6,7,8,9,10,11,12,14,1 5,16,17-tetradecahydro-1 H-cyclopenta[a]phenanth ren-3-one	Estrogens and derivatives
			409.3835	10.95	Ferna-7,9(11)-diene	Triterpenoids
		Others	229.1550	1.15	Fatty acid methyl esters	Fatty acid methyl esters
			209.1174	2.42	(Z)-3-Oxo-2-(2-pentenyl) -1-cyclopenteneacetic acid	Cyclic ketones

Table 4.60 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 061	Secondary	Others	227.1281	2.69	2-[(1R,2R)-2-[(Z,4S)-4-hydroxypent-2-enyl]-3-oxocyclopentyl]acetic acid	Jasmonic acids
			181.1221	4.5	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols
			221.117	6.15	Alkyl-phenylketones	Alkyl-phenylketones

4.3.23 *Punica granatum* L. LYMOOI 070

LC-MS/MS analysis of extract from *Punica granatum* enabled the identification of 14 putative compounds (Table 4.61) belonging to different chemical families. It contains 14 putative secondary metabolites.

Table 4.61: List of putative compounds in LYMOOI 070, *Punica granatum*, Precursor type: $(M+H)^+$, Plant Part: Pericarp

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 070	Secondary	N-containing compounds	124.1119	1.03	6-prop-1-enyl-2,3,4,5-tetrahydropyridine	Tetrahydropyridines
			144.1380	1.46	(+)-Allosedridine	Piperidines
			156.1380	1.55	Piperidines	Piperidines
			205.0972	1.95	L-tryptophan	L-tryptophan
			186.1484	2.44	4beta-Hydroxyepilupinine	Lupinine-type alkaloids
			126.1274	2.44	1-prop-2-enylpiperidine	Piperidines
			353.1866	4.68	19,20-Dihydrovomilenine	Ajmaline-sarpagine alkaloids

Table 4.61 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 070	Secondary	Phenolics	319.0818	1.91	3-(4-hydroxy-3-methoxy phenyl)-1-(2,3,4,6-tetrah ydroxyphenyl)prop-2-en-1-one	2'-Hydroxychalcones
			287.055	3.48	3,5,7-trihydroxy-2-(3-hyd roxyphenyl)-4H-chromen-4-one	Flavonols
			433.1128	3.99	Kaempferol-3-O-rhamnos ide	Flavonoid-3-O-glycosides
		Terpenes	469.3669	8.77	Dehydroeburiconic acid	Triterpenoids
		Others	229.1549	1.08	Fatty acid methyl esters	Fatty acid methyl esters
			359.1491	4.30	1-methyl-7-propan-2-yl-3 ,6,10,16-tetraoxaheptacyc lo[11.7.0.02,4.02,9.05,7.0 9,11.014,18]icos-14(18)-e ne-8,17-dione	Oxepanes

Table 4.61 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 070	Secondary	Others	429.3735	9.29	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols

4.3.24 *Hibiscus mutabilis* L. LYMOOI 045

LC-MS/MS analysis of extract from *Hibiscus mutabilis* enabled the identification of 27 putative compounds (Table 4.62 belonging to different chemical families. It contains 4 putative primary metabolites and 23 putative secondary metabolites.

Table 4.62: List of putative compounds in LYMOOI 045, *Hibiscus mutabilis*, Precursor type: $(M+H)^+$, Plant Part: Leaves

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 045	Primary	Nucleic acids	268.1042	1.29	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
		Proteins	160.1334	0.96	3-aminooctanoic acid	Beta amino acids and derivatives
			166.0861	1.12	3-amino-3-phenylpropanoic acid	Beta amino acids and derivatives
		Pigments	607.2921	9.36	Methyl pheophorbide a	Chlorins
	Secondary	N-containing compounds	104.1067	0.80	3-(dimethylamino)propan-1-ol	1,3-aminoalcohols

Table 4.62 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 045	Secondary	N-containing compounds	118.0862	0.82	3-(dimethylamino)propanoic acid	Trialkylamines
			188.0700	1.24	3-(1H-indol-3-yl)prop-2-enoic acid	Indoles
			205.0972	1.98	L-tryptophan	L-tryptophan
			144.0802	2.44	3-methylquinoline	Quinolines and derivatives
			217.0969	2.45	3-(1-phenylethyl)imidazole-4-carboxylic acid	Carbonylimidazoles
			334.2012	3.28	(2R)-2-[[4-[(2R)-1-hydroxypropan-2-yl]cyclohexanecarbonyl]amino]-3-phenylpropanoic acid	Phenylalanine and derivatives
			314.1391	3.94	(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 4.62 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 045	Secondary	Phenolics	303.0500	3.07	2-(2,5-dihydroxyphenyl) -3,5,7-trihydroxychrome n-4-one	Flavonols
			303.0503	3.09	2-(3,4-dihydroxyphenyl) -3,6,7-trihydroxychrome n-4-one	Flavonols
			197.1170	3.32	4-(3-hydroxybutyl)-2-m ethoxyphenol	Methoxyphenols
			287.0550	3.53	3,5,7-trihydroxy-2-(3-hyd roxyphenyl)-4H-chromen -4-one	Flavonols
			595.1653	3.55	5,7-dihydroxy-2-(4-hydro xyphenyl)-3-[(3,4,5-trihyd roxy-6-{[(3,4,5-trihydroxy -6-methyloxan-2-yl)oxy]m ethyl}oxan-2-yl)oxy]-4H-c hromen-4-one	Flavonoid-3-O-glycosides

Table 4.62 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 045	Secondary	Phenolics	465.1033	3.60	2-(3,4-dihydroxyphenyl) -6-beta-D-Glucopyranos yl-3,5,7-trihydroxy-4H-1 -benzopyran-4-one	Flavonoid C-glycosides
			309.0963	4.29	4-methylumbelliferyl α -L-arabinoside	Coumarin glycosides
			595.1454	4.56	Gallocatechin-(4alpha ->6)-catechin	Biflavonoids and polyflavonoids
			345.0974	5.91	2-(3,4-dihydroxyphenyl)- 5-hydroxy-3,7-dimethoxy -6-methylchromen-4-one	7-O-methylated flavonoids
		Terpenes	277.2164	5.98	17-hydroxy-13-methyl-2, 4,5,6,7,8,9,10,11,12,14,1 5,16,17-tetradecahydro-1 H-cyclopenta[a]phenanth ren-3-one	Estrogens and derivatives

Table 4.62 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 045	Secondary	Others	229.1545	1.15	Fatty acid methyl esters	Fatty acid methyl esters
			174.1488	1.25	9-aminononanoic acid	Medium-chain fatty acids
			277.2165	5.85	9,12,15,17-octadecatetraenoic acid	Lineolic acids and derivatives
			279.2321	6.22	Octadeca-9,12,15-trienoic acid	Lineolic acids and derivatives
			429.3733	9.27	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols

4.3.25 *Urena lobata* (L.) LYMOOI 008

LC-MS/MS analysis of extract from *Urena lobata* enabled the identification of 10 putative compounds (Table 4.63) belonging to different chemical families. It contains 10 putative secondary metabolites.

Table 4.63: List of putative compounds in LYMOOI 008, *Urena lobata*, Precursor type: $(M+H)^+$, Plant Part: Root

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 008	Secondary	N-containing compounds	118.0862	0.65	3-(dimethylamino)propanoic acid	Trialkylamines
			314.1395	3.89	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
		Phenolics	209.0451	2.76	5,6-dihydroxy-7-methoxychromen-2-one	Hydroxycoumarins

Table 4.63 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 008	Secondary	Phenolics	417.1183	4.39	Sophoraflavone B	Flavonoid O-glycosides
			245.0810	5.37	5-hydroxy-8,8-dimethylpyrano[2,3-f]chromen-2-one	Angular pyranocoumarins
		Others	229.1545	0.99	Fatty acid methyl esters	Fatty acid methyl esters
			263.0912	4.96	Benzodioxoles	Benzodioxoles
			231.0650	5.19	4-(3-hydroxy-1H-inden-2-yl)-2-oxobut-3-enoic acid	Indenes and isoindenes
			149.0232	6.43	4-formylcyclohexa-1,3-dien-5-yne-1-carboxylic acid	Carboxylic acids
			311.2582	6.90	2-hydroxy-8-(2-octylcycloprop-1-en-1-yl)octanoic acid	Fatty alcohols

4.3.26 *Clidemia hirta* (L.) D. Don LYMOOI 011

LC-MS/MS analysis of extract from *Clidemia hirta* enabled the identification of 16 putative compounds (Table 4.64) belonging to different chemical families. It contains 1 putative primary metabolites and 15 putative secondary metabolites.

Table 4.64: List of putative compounds in LYMOOI 011, *Clidemia hirta*, Precursor type: $(M+H)^+$, Plant Part: Leaves

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 011	Primary	Nucleic acids	268.1037	1.60	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
	Secondary	N-containing compounds	124.0863	13.96	Benzene-1,2,4-triamine	Aniline and substituted anilines
		Phenolics	303.0495	3.16	2-(3,4-dihydroxyphenyl)-3,6,7-trihydroxychromen-4-one	Flavonols

Table 4.64 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 011	Secondary	Phenolics	611.1600	3.17	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
			303.0496	3.18	2-(3,4-dihydroxyphenyl)-3,7,8-trihydroxychromen-4-one	Flavonols
			465.1024	3.57	2-(3,4-dihydroxyphenyl)-6-beta-D-Glucopyranosyl-3,5,7-trihydroxy-4H-1-benzopyran-4-one	Flavonoid C-glycosides

Table 4.64 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 011	Secondary	Phenolics	595.1661	3.78	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
			303.0491	4.25	2-(2,5-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one	Flavonols
			313.1075	5.70	3-(3,4-dimethoxyphenyl)-7-methoxychromen-4-one	7-O-methylisoflavones

Table 4.64 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 011	Secondary	Terpenes	473.3618	6.36	10-hydroxy-9-(hydroxyl methyl)-2,4a,6a,6b,9,12 a-hexamethyl-1,3,4,5,6, 6a,7,8,8a,10,11,12,13,1 4b-tetradecahydropicen e-2-carboxylic acid	Triterpenoids
			445.3681	9.03	5-hydroxy-2,6,15-trime thyl-14-(6-methylhepta n-2-yl)tetracyclo[8.7.0. $0^{2,7}.0^{11,15}$]heptadec-1(10)-ene-6-carboxylate	Triterpenoids
			409.3835	11.83	Ferna-7,9(11)-diene	Triterpenoids
		Others	179.1062	3.31	(4S)-4-hydroxy-3-meth yl-2-[(2Z)-penta-2,4-di enyl]cyclopent-2-en-1- one	Secondary alcohols
			181.1219	4.55	4-hydroxy-3-methyl-2- [(2E)-pent-2-en-1-yl]cy clopent-2-en-1-one	Secondary alcohols

Table 4.64 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 011	Secondary	Others	613.4833	8.91	(2S)-1-hydroxy-3-[(9Z, 12Z)-octadeca-9,12-die noyloxy]propan-2-yl (6 Z,9Z,12Z,15Z)-octadec a-6,9,12,15-tetraenoate	Lineolic acids and derivatives
			429.3737	9.29	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridec yl)chromen-6-ol	Tocopherols

4.3.27 *Melastoma malabathricum* L. LYMOOI 009

LC-MS/MS analysis of extract from *Melastoma malabathricum* enabled the identification of 9 putative compounds (Table 4.65) belonging to different chemical families. It contains 2 putative primary metabolites and 7 putative secondary metabolites.

Table 4.65: List of putative compounds in LYMOOI 009, *Melastoma malabathricum*, Precursor type: $(M+H)^+$, Plant Part: Root

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 009	Primary	Nucleic acids	268.1042	1.60	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
		Proteins	166.0862	1.12	3-amino-3-phenylpropanoic acid	Beta amino acids and derivatives
	Secondary	N-containing compounds	118.0859	0.80	3-(dimethylamino)propanoic acid	Trialkylamines

Table 4.65 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 009	Secondary	Phenolics	303.0502	3.67	2-(2,5-dihydroxyphenyl) -3,5,7-trihydroxychrome n-4-one	Flavonols
			303.0504	3.75	2-(3,4-dihydroxyphenyl) -3,7,8-trihydroxychrome n-4-one	Flavonols
			303.0504	3.89	2-(3,4-dihydroxyphenyl) -3,6,7-trihydroxychrome n-4-one	Flavonols
		Terpenes	471.3473	5.67	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 ac id	Triterpenoids

Table 4.65 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 009	Secondary	Terpenes	413.3787	9.68	17-(5-ethyl-6-methylheptan-2-yl)-10,13-dimethyl-2,3,4,9,11,12,14,15,16,17-decahydro-1H-cyclopenta[a]phenanthren-3-ol	Stigmastanes and derivatives
		Others	429.3737	9.29	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols

4.3.28 *Plantago major* L. LYMOOI 034

LC-MS/MS analysis of extract from *Plantago major* enabled the identification of 20 putative compounds (Table 4.66) belonging to different chemical families. It contains 2 putative primary metabolites and 18 putative secondary metabolites.

Table 4.66: List of putative compounds in LYMOOI 034, *Plantago major*, Precursor type: $(M+H)^+$, Plant Part: Leaves

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 034	Primary	Nucleic acids	268.1042	1.61	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
		Proteins	160.1330	0.92	3-aminooctanoic acid	Beta amino acids and derivatives
	Secondary	N-containing compounds	118.0861	0.65	3-(dimethylamino)propanoic acid	Trialkylamines
			188.0701	1.96	3-(1H-indol-3-yl)prop-2-enoic acid	Indoles

Table 4.66 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 034	Secondary	Phenolics	249.0754	3.14	4,9-dimethoxy-2,3-dihydrofuro[3,2-g]chromen-7-one	Psoralens
			449.1080	3.50	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
			163.0382	3.60	8-hydroxy-2H-chromen-2-one	Hydroxycoumarins
			449.1088	3.69	6-beta-D-Glucopyranosyl-3,5,7-trihydroxy-2-(4-hydroxyphenyl)-4H-1-benzopyran-4-one	Flavonoid C-glycosides
			301.0704	4.66	5,7,8-Trihydroxy-2-(4-methoxyphenyl)-4H-1-benzopyran-4-one	4'-O-methylated flavonoids
		Terpenes	213.0757	1.40	Iridoids and derivatives	Iridoids and derivatives

Table 4.66 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 034	Secondary	Terpenes	457.3680	7.09	3,9-dihydroxy-4,6~{a}, 6~{b},8~{a},11,11,14~ {b}-heptamethyl-1,2,3, 4~{a},5,6,7,8,9,10,12,1 2~{a},14,14~{a}-tetrad ecahydropicene-4-carba ldehyde	Triterpenoids
			191.1793	7.30	Acyclic monoterpenoids	Acyclic monoterpenoids
			457.3682	7.30	Melilotigenin C	Triterpenoids
			411.3626	9.57	(3S,10R,13R)-10,13-dim ethyl-17-[(Z,2R)-5-propa n-2-ylhept-5-en-2-yl]-2,3 ,4,9,11,12,14,15,16,17-de cahydro-1H-cyclopenta[a]phenanthren-3-ol	Stigmastanes and derivatives
		Others	229.1547	1.08	Fatty acid methyl esters	Fatty acid methyl esters

Table 4.66 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 034	Secondary	Others	179.1066	3.30	(4S)-4-hydroxy-3-methyl-2-[(2Z)-penta-2,4-dienyl]cyclopent-2-en-1-one	Secondary alcohols
			277.2167	6.00	9,12,15,17-octadecatetraenoic acid	Lineolic acids and derivatives
			295.2267	6.30	(6Z,9Z)-11-(3-pentyloxiran-2-yl)undeca-6,9-dienoic acid	Long-chain fatty acids
			256.2641	7.30	Hexadecanamide	Fatty amides
			429.3733	9.27	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols

4.3.29 *Morinda citrifolia* L. LYMOOI 031

LC-MS/MS analysis of extract from *Morinda citrifolia* enabled the identification of 22 putative compounds (Table 4.67) belonging to different chemical families. It contains 2 putative primary metabolites and 20 putative secondary metabolites.

Table 4.67: List of putative compounds in LYMOOI 031, *Morinda citrifolia*, Precursor type: $(M+H)^+$, Plant Part: Fruit

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 031	Primary	Nucleic acids	268.1037	1.28	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
		Pigments	535.2708	9.16	Chlorins	Chlorins
	Secondary	N-containing compounds	144.1018	0.82	1-aminocyclohexane-1-carboxylic acid	L-alpha-amino acids
			158.1174	0.91	8-methyl-8-azabicyclo[3.2.1]octane-3,6-diol	Tropane alkaloids

Table 4.67 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 031	Secondary	N-containing compounds	124.0861	13.97	Benzene-1,2,4-triamine	Aniline and substituted anilines
		Phenolics	179.0701	0.93	3-(2-methoxyphenyl)-2-propenoic acid	Coumaric acids
			303.0504	3.60	2-(2,5-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one	Flavonols
			611.1599	3.61	7-{[(2S,3R,4S,5S,6R)-4,5-dihydroxy-6-(hydroxylmethyl)-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 4.67 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 031	Secondary	Phenolics	595.1660	3.77	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	171.1010	1.78	(4aR,6S,7R,7aS)-6-hydroxy-7-methyl-4,4a,5,6,7,7a-hexahydro-1H-cyclopenta[c]pyran-3-one	Terpene lactones
			455.3524	6.08	Eucalyptanoic acid	Triterpenoids
			439.3572	7.09	Triterpenoids	Triterpenoids

Table 4.67 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 031	Secondary	Terpenes	457.3676	7.09	3,9-dihydroxy-4,6~{a} ,6~{b},8~{a},11,11,14 ~{b}-heptamethyl-1,2, 3,4~{a},5,6,7,8,9,10,1 2,12~{a},14,14~{a}-te tradecahydropicene-4-c arbaldehyde	Triterpenoids
			411.3621	7.09	(3S,10R,13R)-10,13-di methyl-17-[(Z,2R)-5-pr opan-2-ylhept-5-en-2-y l]-2,3,4,9,11,12,14,15,1 6,17-decahydro-1H-cyc lopenta[a]phenanthren- 3-ol	Stigmastanes and derivatives
			203.1790	7.10	1,1,4,7-tetramethyl-1~ {a},2,3,5,6,7~{b}-hex ahydrocyclopropa[e]a zulene	5,10-cycloaromadendrane sesquiterpenoids

Table 4.67 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 031	Secondary	Terpenes	203.1793	7.33	8,8a-dimethyl-2-prop-1-en-2-yl-2,3,7,8-tetrahydro-1H-naphthalene	Eremophilane, 8,9-seco eremophilane and furoe remophilane sesquiterp enoids
			249.1848	7.35	Artemisinic acid methyl ester	Sesquiterpenoids
			445.3677	9.71	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
			409.3835	11.9	Ferna-7,9(11)-diene	Triterpenoids
		Others	229.1550	1.09	Fatty acid methyl esters	Fatty acid methyl esters
			236.1285	1.66	10-Hydroxydarlingine	Cycloheptapyrans
			429.3732	9.30	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols

4.3.30 *Oldenlandia auricularia* LYMOOI 015

LC-MS/MS analysis of extract from *Oldenlandia auricularia* enabled the identification of 17 putative compounds (Table 4.68) belonging to different chemical families. It contains 3 putative primary metabolites and 14 putative secondary metabolites.

Table 4.68: List of putative compounds in LYMOOI 015, *Oldenlandia auricularia*, Precursor type: $(M+H)^+$, Plant Part: Leaves

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 015	Primary	Nucleic acids	268.1044	1.60	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
		Proteins	166.0858	1.15	3-amino-3-phenylpropanoic acid	Beta amino acids and derivatives

Table 4.68 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 015	Primary	Pigments	601.4249	7.91	19-(3,4-dihydroxy-2,6,6 -trimethylcyclohexen-1- yl)-1-(4-hydroxy-1,2,2-t rimethylcyclopentyl)-4,8 ,13,17-tetramethylnonad eca-2,4,6,8,10,12,14,16, 18-nonaen-1-one	Xanthophylls
	Secondary	N-containing compounds	118.0861	0.65	3-(dimethylamino)propa noic acid	Trialkylamines
			144.1016	0.84	1-aminocyclohexane-1-c arboxylic acid	L-alpha-amino acids
			120.0806	1.07	2,3-dihydro-1~{H}-ind ole	Indolines
			188.0700	1.96	3-(1H-indol-3-yl)prop-2- enoic acid	Indoles
			205.0974	1.96	L-tryptophan	L-tryptophan

Table 4.68 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 015	Secondary	Phenolics	465.1030	3.14	2-(3,4-dihydroxyphenyl) -6-beta-D-Glucopyranos yl-3,5,7-trihydroxy-4H-1 -benzopyran-4-one	Flavonoid C-glycosides
			303.0497	3.55	2-(2,5-dihydroxyphenyl) -3,5,7-trihydroxychrome n-4-one	Flavonols
			303.0503	3.65	2-(3,4-dihydroxyphenyl) -3,7,8-trihydroxychrome n-4-one	Flavonols
		Terpenes	275.2004	5.27	(3E,5E,7E)-8-[(4R)-4-hy droxy-2,6,6-trimethylcyc lohex-1-en-1-yl]-6-methy locta-3,5,7-trien-2-one	Sesquiterpenoids
			409.3833	11.43	Ferna-7,9(11)-diene	Triterpenoids

Table 4.68 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 015	Secondary	Others	291.1956	5.06	Deoxy phytoprostane J1	Prostaglandins and related compounds
			293.2110	5.38	10-methoxyheptadec-1-en-4,6-diyne-3,9-diol	Long-chain fatty alcohols
			277.2162	5.84	9,12,15,17-octadecatetraenoic acid	Lineolic acids and derivatives
			279.2315	6.21	Octadeca-9,12,15-trienoic acid	Lineolic acids and derivatives

4.3.31 *Oldenlandia corymbosa* (L) LYMOOI 066

LC-MS/MS analysis of extract from *Oldenlandia corymbosa* enabled the identification of 42 putative compounds (Table 4.69) belonging to different chemical families. It contains 6 putative primary metabolites and 36 putative secondary metabolites.

Table 4.69: List of putative compounds in LYMOOI 066, *Oldenlandia corymbosa*, Precursor type: $(M+H)^+$, Plant Part: Whole Plant

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 066	Primary	Nucleic acids	268.1035	1.01	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
		Proteins	116.0705	0.63	(2Z)-2-(methylamino)but-2-enoic acid	Alpha amino acids
			166.0860	1.11	3-amino-3-phenylpropanoic acid	Beta amino acids and derivatives

Table 4.69 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 066	Primary	Proteins	207.1245	10.34	2-amino-5-(diaminomethylideneamino)-2-(fluoromethyl)pentanoic acid	Alpha amino acids
		Pigments	551.4257	8.98	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
			607.2923	9.36	Methyl pheophorbide a	Chlorins
	Secondary	N containing compounds	188.0700	1.11	3-(1H-indol-3-yl)prop-2-enoic acid	Indoles
			120.0805	1.12	2,3-dihydro-1~{H}-indole	Indolines
			205.0973	1.97	L-tryptophan	L-tryptophan

Table 4.69 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 066	Secondary	Phenolics	147.0439	0.60	3-phenylprop-2-yno ic acid	Benzene and substituted derivatives
			175.0387	1.95	2-Hydroxy-1,4- nap hthoquinone	Naphthoquinones
			253.0707	2.36	Desmethyldiaportinol	Isocoumarins and derivatives
			175.0387	2.62	4-hydroxynaphthale ne-1,2-dione	Naphthoquinones
			207.0652	2.63	(E)-5-(4-hydroxyphe nyl)-3-oxopent-4-eno ate	Hydroxycinnamic acids and derivatives
			163.0385	2.75	8-hydroxy-2H-chro men-2-one	Hydroxycoumarins
			163.0383	2.83	3-Hydroxycoumarin	Hydroxycoumarins
			189.0544	2.95	2,3-dihydrofuro[3,2-g]chromen-7-one	Psoralens
			197.1174	3.31	4-(3-hydroxybutyl)-2- methoxyphenol	Methoxyphenols
			371.1125	3.93	(7'S)-parabenzlactone	Dibenzylbutyrolactone lignans

Table 4.69 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 066	Secondary	Phenolics	353.1025	3.96	3-(2,4-dihydroxyphenyl)-5-hydroxy-8,8-dimeth ylpyrano[2,3-h]chromen -4-one	Pyranoisoflavonoids
			207.0653	4.03	4-(2-METHOXYPHENY L)-2-OXOBUT-3-ENOIC ACID	Cinnamic acids and derivatives
			311.0915	4.05	Pyranoxanthones	Pyranoxanthones
			329.1025	4.05	3,5-Dihydroxy-7-methox yflavanone 3-acetate	7-O-methylated flavonoids
			313.1074	4.75	3-(3,4-dimethoxyphenyl)- 7-methoxychromen-4-one	7-O-methylisoflavones
			191.0709	4.77	7-Methoxy-6-methyl-2H- 1-benzopyran-2-one	Coumarins and derivatives
		Terpenes	349.2007	4.35	(1,5,8a-trimethyl-2,8-dio xo-3a,4,5,5a,9,9a-hexahy dro-1H-azuleno[6,5-b]fur an-9-yl) 2-methylbutanoa te	Sesquiterpene lactones

Table 4.69 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 066	Secondary	Terpenes	275.2012	5.36	(3E,5E,7E)-8-[(4R)-4-hydroxy-2,6,6-trimethylcyclohex-1-en-1-yl]-6-methylocta-3,5,7-trien-2-one	Sesquiterpenoids
			411.3623	7.10	(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	7.11	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

Table 4.69 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 066	Secondary	Terpenes	309.2790	8.11	13E-Labdene-8alpha,15 -diol	Diterpenoids
			409.3831	11.69	Ferna-7,9(11)-diene	Triterpenoids
			409.3837	12.73	Sesterterpenoids	Sesterterpenoids
		Others	179.1070	3.00	(4S)-4-hydroxy-3-meth yl-2-[(2Z)-penta-2,4-di enyl]cyclopent-2-en-1- one	Secondary alcohols
			181.1225	4.50	4-hydroxy-3-methyl-2- [(2E)-pent-2-en-1-yl]cy clopent-2-en-1-one	Secondary alcohols
			291.1961	5.17	Deoxy phytoprostane J1	Prostaglandins and related compounds
			293.2116	5.38	10-methoxyheptadec-1- en-4,6-diyne-3,9-diol	Long-chain fatty alcohols
			221.1175	6.15	2-(1-hydroxycyclopenty l)-2-phenylacetic acid	Benzene and substituted derivatives
			279.2321	6.23	Octadeca-9,12,15-trieno ic acid	Lineolic acids and derivatives
			256.2639	7.26	Hexadecanamide	Fatty amides

Table 4.69 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 066	Secondary	Others	265.2527	7.43	Octadeca-9,12-dienal	Fatty aldehydes
			613.4830	8.95	(2S)-1-hydroxy-3-[(9Z,12 Z)-octadeca-9,12-dienoyl oxy]propan-2-yl (6Z,9Z,1 2Z,15Z)-octadeca-6,9,12, 15-tetraenoate	Lineolic acids and derivatives
			429.3732	9.26	2,5,7,8-tetramethyl-2-(4 ,8,12-trimethyltridecyl)c hromen-6-ol	Tocopherols

4.3.32 *Oldenlandia diffusa* (Willd.) Roxb LYMOOI 073

LC-MS/MS analysis of extract from *Oldenlandia diffusa* enabled the identification of 12 putative compounds (Table4.70) belonging to different chemical families. It contains 1 putative primary metabolites and 11 putative secondary metabolites.

Table 4.70: List of putative compounds in LYMOOI 073, *Oldenlandia diffusa*, Precursor type: $(M+H)^+$, Plant Part: Leaves

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 073	Primary	Nucleic acids	268.1043	1.64	2-(6-aminopurin-9-yl)-5-(hydroxymethyl)oxolane-3,4-diol	Adenosine
	Secondary	Phenolics	193.0495	1.34	7,8-dihydroxy-6-methyl-2 H-chromen-2-one	7,8-dihydroxycoumarins
			235.0605	2.22	4-methyl-2-oxo-2H-chromen-7-yl 2-hydroxyacetate	Coumarins and derivatives
			253.0708	2.37	Desmethyldiaportinol	Isocoumarins and derivatives
			175.0389	2.37	4-hydroxynaphthalene-1,2-dione	Naphthoquinones

Table 4.70 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 073	Secondary	Phenolics	207.0652	2.62	(E)-5-(4-hydroxyphenyl)-3-oxopent-4-enoate	Hydroxycinnamic acids and derivatives
			163.0387	2.79	3-Hydroxycoumarin	Hydroxycoumarins
			249.0757	2.94	4,9-dimethoxy-2,3-dihydrofuro[3,2-g]chromen-7-one	Psoralens
			189.0543	2.95	2,3-dihydrofuro[3,2-g]chromen-7-one	Psoralens
			287.0546	3.68	3,5,7-trihydroxy-2-(3-hydroxyphenyl)-4H-chromen-4-one	Flavonols
			207.0642	3.92	4-(2-METHOXYPHENYL)-2-OXOBUT-3-ENOIC ACID	Cinnamic acids and derivatives
		Others	221.1172	6.16	2-(1-hydroxycyclopentyl)-2-phenylacetic acid	Benzene and substituted derivatives

4.3.33 *Lantana camara* L. LYMOOI 035

LC-MS/MS analysis of extract from *Lantana camara* enabled the identification of 32 putative compounds (Table 4.71) belonging to different chemical families. It contains 1 putative primary metabolites and 31 putative secondary metabolites.

Table 4.71: List of putative compounds in LYMOOI 035, *Lantana camara*, Precursor type: $(M+H)^+$, Plant Part: Leaves

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 035	Primary	Pigments	601.4248	8.39	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
	Secondary	Phenolics	175.0386	1.56	4-hydroxynaphthalene-1,2-dione	Naphthoquinones
			163.0387	2.38	3-Hydroxycoumarin	Hydroxycoumarins

Table 4.71 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 035	Secondary	Phenolics	325.0921	2.84	Hydroxycinnamic acids	Hydroxycinnamic acids
			163.0389	3.47	8-hydroxy-2H-chromen-2-one	Hydroxycoumarins
			477.1027	3.48	Luteolin 7-methylglucuronide	Flavonoid-7-O-glucuronides
			301.0712	3.56	6-C-Methylkaempferol	Flavonols
			195.1013	3.57	2,5-Dimethoxy-4-(2-propenyl)phenol	Methoxyphenols
			301.0705	3.62	6,7-dihydroxy-2-(4-hydroxy-3-methoxyphenyl)chromen-4-one	3'-O-methylated flavonoids
			195.1016	3.71	2,3-Dimethoxy-5-(1E)-1-propenylphenol	Methoxyphenols

Table 4.71 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 035	Secondary	Phenolics	637.1773	3.95	7-[(2~{S},3~{R},4~{S},5~{S},6~{S})-6-[[(2~{R},3~{R},4~{R})-3,4-dihydroxy-4-(hydroxymethyl)oxolan-2-yl]oxymethyl]-3,4,5-trihydroxyoxan-2-yl]oxy-6-methoxy-3-(6-methoxy-1,3-benzodioxol-5-yl)chromen-4-one	dalpatein 7-O-beta-D-apiofuranosyl-(1->6)-beta-D-glucopyranoside
			463.1240	3.99	6-C-Methylkaempferol 3-glucoside	Flavonoid-3-O-glycosides
			491.1192	4.31	Luteolin 7-(6''-acetylglucoside)	Flavonoid-7-O-glycosides
			623.1973	4.44	Embinoidin	Flavonoid C-glycosides
			301.0706	4.67	5,7,8-Trihydroxy-2-(4-methoxyphenyl)-4H-1-benzopyran-4-one	4'-O-methylated flavonoids
			345.0969	5.87	2-(3,4-dihydroxyphenyl)-5-hydroxy-3,7-dimethoxy-6-methylchromen-4-one	7-O-methylated flavonoids

Table 4.71 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 035	Secondary	Terpenes	275.2000	5.51	(3E,5E,7E)-8-[(4R)-4-hydroxy-2,6,6-trimethylcyclohex-1-en-1-yl]-6-methylocta-3,5,7-trien-2-one	Sesquiterpenoids
			487.3421	6.60	(3S,4S,4aR,6aR,6bS,8aS,12aS,14aR,14bR)-3-hydroxy-4,6a,6b,11,11,14b-hexamethyl-1,2,3,4a,5,6,7,8,9,10,12,12a,14,14a-tetradecahydropicene-4,8a-dicarboxylic acid	Triterpenoids
			179.1431	7.47	3-{2,3-dimethyltricyclo[2.2.1.0^{2},^{6}]heptan-3-yl}propanal	Bicyclic monoterpenoids

Table 4.71 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 035	Secondary	Terpenes	433.3106	7.50	(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
			455.352	7.68	Eucalyptanoic acid	Triterpenoids
			435.3263	7.94	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

Table 4.71 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 035	Secondary	Terpenes	409.3837	11.54	Ferna-7,9(11)-diene	Triterpenoids
		Others	229.1547	1.10	Fatty acid methyl esters	Fatty acid methyl esters
			241.1548	1.27	1-hydroxy-6-(2-hydroxybutan-2-yl)-3-(2-methylpropyl)pyrazin-2-one	Pyrazines
			236.1280	1.73	10-Hydroxydarlingine	Cycloheptapyrans
			209.1168	2.60	(Z)-3-Oxo-2-(2-pentenyl)-1-cyclopenteneacetic acid	Cyclic ketones
			227.1279	2.69	2-[(1R,2R)-2-[(Z,4S)-4-hydroxypent-2-enyl]-3-oxocyclopentyl]acetic acid	Jasmonic acids
			181.1221	4.50	4-hydroxy-3-methyl-2-[(2E)-pent-2-en-1-yl]cyclopent-2-en-1-one	Secondary alcohols

Table 4.71 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 035	Secondary	Others	291.1953	5.17	Deoxy phytoprostane J1	Prostaglandins and related compounds
			429.3737	9.27	2,5,7,8-tetramethyl-2-(4, 8,12-trimethyltridecyl)ch romen-6-ol	Tocopherols
			591.4993	9.62	(2S)-2-(hexadecanoyloxy) -3-hydroxypropyl (9Z,12Z ,15Z)-octadeca-9,12,15-tri enoate	Lineolic acids and derivatives

4.3.34 *Phyla nodiflora* LYMOOI 001

LC-MS/MS analysis of extract from *Phyla nodiflora* enabled the identification of 23 putative compounds (Table 4.72) belonging to different chemical families. It contains 4 putative primary metabolites and 19 putative secondary metabolites.

Table 4.72: List of putative compounds in LYMOOI 001, *Phyla nodiflora*, Precursor type: $(M+H)^+$, Plant Part: Leaves

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 001	Primary	Nucleic acids	136.0618	0.96	7H-purin-6-amine	Adenine
		Proteins	160.0969	0.64	Methyl 5-hydroxypiperidine-2-carboxylate	Alpha amino acid esters
			166.0864	1.05	3-amino-3-phenylpropanoic acid	Beta amino acids and derivatives
		Carbohydrates	317.1234	1.64	2-[2-(3,4-dihydroxyphenyl)ethoxy]-6-(hydroxymethyl)oxane-3,4,5-triol	O-glycosyl compounds

Table 4.72 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 001	Secondary	N-containing compounds	104.1070	0.65	3-(dimethylamino)propan-1-ol	1,3-aminoalcohols
			144.1020	0.78	1-aminocyclohexane-1-carboxylic acid	L-alpha-amino acids
			120.0807	0.97	2,3-dihydro-1~{H}-indole	Indolines
			158.1172	1.06	8-methyl-8-azabicyclo[3.2.1]octane-3,6-diol	Tropane alkaloids
		Phenolics	465.1028	2.87	2-(3,4-dihydroxyphenyl)-6-beta-D-Glucopyranosyl-3,5,7-trihydroxy-4H-1-benzopyran-4-one	Flavonoid C-glycosides
			163.0388	3.47	4-hydroxychromen-2-one	4-hydroxycoumarins
			325.0919	3.47	Hydroxycinnamic acids	Hydroxycinnamic acids
			303.0496	3.63	2-(2,5-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one	Flavonols
			433.1129	3.66	Pueraria glycoside 1	Isoflavonoid C-glycosides
			433.1138	3.76	Kaempferol-3-O-rhamnoside	Flavonoid-3-O-glycosides

Table 4.72 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 001	Secondary	Phenolics	177.0543	3.79	3-(1,3-benzodioxol-5-yl)prop-2-enal	Benzodioxoles
			641.1503	4.13	Quercetin 3-(6"-ferulylglucoside)	Quercetin 3-O-(6\"-O-feruloyl)-glucoside
			611.1392	4.18	(6-{[2-(3,4-dihydroxyphenyl)-5,7-dihydroxy-4-oxo-4H-chromen-3-yl]oxy}-3,4,5-trihydroxyoxan-2-yl)methyl (2E)-3-(4-hydroxyphenyl)prop-2-enoate	Flavonoid 3-O-p-coumaroyl glycosides
			205.0858	6.42	7-ethoxy-4-methyl-2H-chromen-2-one	Coumarins and derivatives
		Terpenes	275.2005	6.15	(3E,5E,7E)-8-[(4R)-4-hydroxy-2,6,6-trimethylcyclohex-1-en-1-yl]-6-methylocta-3,5,7-trien-2-one	Sesquiterpenoids

Table 4.72 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 001	Secondary	Others	352.1756	2.18	19-Hydroxysenecionine	Macrolides and analogues
			179.1065	3.30	(4S)-4-hydroxy-3-methyl-2-[(2Z)-penta-2,4-dienyl]cyclopent-2-en-1-one	Secondary alcohols
			613.4835	9.21	(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	9.26	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols

4.3.35 *Stachytarpheta jamaicensis* (L) Vahl LYMOOI 019

LC-MS/MS analysis of extract from *Stachytarpheta jamaicensi* enabled the identification of 31 putative compounds (Table 4.73) belonging to different chemical families. It contains 3 putative primary metabolites and 28 putative secondary metabolites.

Table 4.73: List of putative compounds in LYMOOI 019, *Stachytarpheta jamaicensi*, Precursor type: $(M+H)^+$, Plant Part: Whole plants

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 019	Primary	Nucleic acids	268.1041	1.60	2-(6-aminopurin-9-yl) -5-(hydroxymethyl)ox olane-3,4-diol	Adenosine
		Proteins	166.0862	1.10	3-amino-3-phenylpro panoic acid	Beta amino acids and derivatives
		Pigments	607.2919	9.35	Methyl pheophorbide a	Chlorins

Table 4.73 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 019	Secondary	N-containing compounds	120.0807	1.09	2,3-dihydro-1~{H}-indole	Indolines
			188.0702	1.98	3-(1H-indol-3-yl)prop-2-enoic acid	Indoles
		Phenolics	243.0867	0.85	2,3-Dihydroxy-1-(4-hydroxy-3,5-dimethoxyphenyl)-1-propanone	Alkyl-phenylketones
			193.0492	1.26	7,8-dihydroxy-6-methyl-2H-chromen-2-one	7,8-dihydroxycoumarins
			209.0809	2.53	Methyl 3-(4-hydroxy-3-methoxyphenyl)prop-2-enoate	Coumaric acids and derivatives
			163.0399	3.04	3-Hydroxycoumarin	Hydroxycoumarins

Table 4.73 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 019	Secondary	Phenolics	479.1548	3.45	2-(3-hydroxy-4-methoxyphenyl)-5-methoxy-7-[3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxy-2,3-dihydrochromen-4-one	Flavonoid-7-O-glycosides
			325.0916	3.45	Hydroxycinnamic acids	Hydroxycinnamic acids
			463.0871	3.47	Kaempferol 3-glucuronide	Flavonoid-3-O-glucuronides
			447.0930	3.73	Apigenin-7-O-glucuronide	Flavonoid-7-O-glucuronides
			477.1026	3.79	5,7,4'-Trihydroxy-3'-methoxyflavone,Luteolin 3'-methyl ether 7-glucuronide	Flavonoid-7-O-glucuronides
			477.1029	3.80	Luteolin 7-methylglucuronide	Flavonoid-7-O-glucuronides

Table 4.73 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 019	Secondary	Terpenes	405.1398	0.87	2-[(2S,3R,4S)-3-ethenyl-5-methoxycarbonyl-2-[(2S,3R,4S,5S,6R)-3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxy-3,4-dihydro-2H-pyran-4-yl]acetic acid	Terpene glycosides
			219.1735	3.13	2-methyl-6-(4-methylphenyl)hept-2-en-4-ol	Sesquiterpenoids
			203.1790	4.38	Eremophila-1(10),8,11-triene	Eremophilane, 8,9-secoeremophilane and furoeremophilane sesquiterpenoids

Table 4.73 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 019	Secondary	Terpenes	221.1897	4.40	2-methyl-6-(4-methyl idenecyclohex-2-en-1-yl)hept-2-en-4-ol	Sesquiterpenoids
			203.1787	4.00	1,1,4,7-tetramethyl-1~{a},2,3,5,6,7~{b}-hexahydrocyclopropa[e]azulene	5,10-cycloaromadendrane sesquiterpenoids
			221.1894	4.65	[2R-(2alpha,4abeta,8abeta)]-1,2,3,4,4a,8a-hexahydro-alpha,alpha,4a,8-tetramethyl-2-naphthalenemethanol	Eudesmane, isoeudesmane or cycloeudesmane sesquiterpenoids

Table 4.73 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 019	Secondary	Terpenes	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
			353.2684	6.69	Tomentol	Sesquiterpenoids
			411.3620	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
			409.3832	11.89	Sesterterpenoids	Sesterterpenoids

Table 4.73 (Continued)

Taxa	Kind Of Metabolites	Class	Precursor m/z(Da)	Retention Time (min)	Putative Compound Name	Ontology
LYMOOI 019	Secondary	Terpenes	445.3682	9.72	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	177.0544	2.50	3-(1,3-benzodioxol-5-yl)prop-2-enal	Benzodioxoles
			325.0916	2.89	Benzofurans	Benzofurans
			277.2161	5.76	9,12,15,17-octadecatetraenoic acid	Lineolic acids and derivatives
			256.2634	7.07	Hexadecanamide	Fatty amides
			429.3731	9.29	2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)chromen-6-ol	Tocopherols

CHAPTER 5

DISCUSSION

5.1 Identification of 35 Local Medicinal Plants by Traditional Method

In this study, the characteristics observed most were whole plants (35 medicinal plants) and leaves (35 medicinal plants), followed by flowers (20 medicinal plants) and fruits (8 medicinal plants). According to Tiay Benyaphaichit and Riyamongkol (2014), flower recognition has reached an accuracy rate of over 80%. In this study, the flower is the most prominent and eye-catching part of the field trip collection. In this study, the identity of 20 medicinal plants such as *Andrographis paniculata*, *Calotropis gigantea*, *Catharanthus roseus*, *Clidemia hirta*, *Gendarussa ventricosa*, *Hibiscus mutabilis*, *Lantana camara*, *Melastoma malabathricum*, *Morinda citrifolia*, *Oldenlandia auricularia*, *Oldenlandia corymbosa*, *Oldenlandia diffusa*, *Orthosiphon aristatus*, *Phyla nodiflora*, *Plantago major*, *Rhinacanthus nasutus*, *Ruellia simplex*, *Stachytarpheta jamaicensis*, *Urena lobata* and *Vitex trifolia* can further identified by the flower characteristics. The characteristics of flowers also helped in discriminating two similar plant species: *Oldenlandia corymbosa* and *Oldenlandia diffusa* looked similar but produce different numbers of flowers. *Oldenlandia corymbosa* produces 2-5 flowers, while *Oldenlandia diffusa* only produces 1 flower.

Xiang et al. (2016) stated that fruit was the defining characteristic of angiosperms. In this study, fruit characteristics of 8 medicinal plants became the best species indicator for field trip, which further ensured the identities of *Clidemia hirta*, *Dioscorea bulbifera*, *Lantana camara*, *Melastoma malabathricum*, *Morinda citrifolia*, *Punica granatum*, *Urena lobata* and *Vitex trifolia*.

Jamil et al. (2015) indicated when the shape of a plant is fused with the colour and texture of the plant, the recognition rate can reach 94%. The plant of 35 species can be collected by observing the shape, colour, texture of the leaves during field trip, but there are three medicinal plants such as *Ocimum basilicum*, *Mentha spicata*, *Plectranthus amboinicus* that need to rub the leaves to further ensure its identity. *Ocimum basilicum* has a clove-like scent, *Mentha spicata* has a stronger mint flavour, *Plectranthus amboinicus* has a distinct oregano-like flavor and odor.

Although the morphology approach is considered a date method, it is still an absolute necessity when dealing with taxonomic issues. This is because morphology is the strongest indicator for visually identifying medicinal plants (Susetyarini et al., 2020). As Radford (1986) pointed out, morphology of medicinal plants is easily observable and easily obtainable. They thus tend to be used most frequently in taxonomic research.

The 35 species of medicinal plants in this study were identified by taxonomist, Dr Richard Chung after the field trip and each herbarium voucher was accompanied by the scientific name given. Medicinal plants with the same scientific name collected according to the previous list are subjected to deposit at Perdana Botanical Garden Kuala Lumpur.

5.2 Identification of 35 Local Medicinal Plants by Molecular-based Method: DNA barcoding

DNA barcoding is a new approach for the quick identification for any species according to extracting a DNA sequence from a sample of any organism and is now being applied to 35 local medicinal plants in this study. In the current study, DNA barcoding assists identification by using three candidate DNA barcodes. The candidates of DNA barcoding were evaluated in terms of primer universality and successful identification rate.

5.2.1 Universality of the Three Candidate Barcodes

In the experiment, *rbc*L performed best out of the three barcode markers. The fragment achieved 100% in both amplification and sequencing, showing its potential for universal decoding. Identical results were reported in the research of Youm et al. (2016), with 100% success in Korean *Schisandraceae*, and for medicinal plants of the Fabaceae and Poaceae family in Hind et al. (2018). In

Kang et al. (2017), the universality of *rbc*L can be explained by its highly conserved and low evolutionary level.

The amplification success rate of *mat*K, another core barcode, was the lowest among the three fragments in our study, indicating that this barcode has less universality compared to *rbc*L and ITS. The amplification rate was only 71.4 % and the sequenced success rate was only 84%. Similar pattern has been observed in previous research done by Bolson et al. (2015) for threatened woody angiosperm, with a 74% amplification and 86% sequencing success rate. Besides, there was low *mat*K amplification in desert plants (Maloukh et al., 2017), only amplifying 35% of taxa. Moreover, *mat*K was eliminated as potential barcode due to failure of amplification of 70% of the reference specimens in the study of molecular identification of root (Kool et al., 2012).

There were 94.3% of nuclear gene ITS amplifications were successful, however, neither of *Kyllinga brevifolia* nor *Barleria lupulina* were amplified. Only 14 out of 33 DNA barcodes were obtained through ITS sequencing, the sequencing success rate was 42.4%. It is similar to Tripathi et al. (2013), who reported that the sequencing success rate for the ITS (62%), is lower than the amplification rate (74%) for the ITS. In previous studies, such as Kang et al. (2017), reported that low sequencing rate have been observed. The success rate of their ITS sequencing in Tropical Cloud Forest of Hainan was 45.15%.

5.2.2 Discriminatory Rate of Three Candidate Barcodes

For the assessment of species discrimination ability, the BLAST method is used to determine sequence similarity. The query sequence is determined based on the percentage of similarity with the known sequence. When the query sequence of a sample comes from the expected species, it is considered correct; ambiguous identification represents the query sequence of a sample found to match the expected genus with several species; incorrect or no match identification represents the query sequence of a sample that does not match the expected genus or species.

Based on the BLAST result, the three regions successfully identified 12 plant samples using *rbc*L, 11 using *mat*K and 5 using ITS region, respectively. For those plant that successfully identified to species level by using *rbc*L are, *Andrographis paniculata*, *Rhinacanthus nasutus*, *Catharanthus roseus*, *Alocasia macrorrhizos*, *Ocimum basilicum*, *Mentha spicata*, *Punica granatum*, *Melastoma malabathricum*, *Morinda citrifolia*, *Oldenlandia corymbosa*, *Lantana camara*, and *Stachytarpheta jamaicensis*. For *mat*K are *Andrographis paniculata*, *Ocimum basilicum*, *Vitex trifolia*, *Mentha spicata*, *Plectranthus amboinicus*, *Punica granatum*, *Morinda citrifolia*, *Oldenlandia auricularia*, *Oldenlandia corymbosa*, *Oldenlandia diffusa*, and *Phyla nodiflora*. For ITS are *Catharanthus roseus*, *Orthosiphon aristatus*, *Hibiscus mutabilis*, *Oldenlandia corymbosa*, and *Phyla nodiflora*.

As a result of the present study, all of the single barcode's region had a discriminatory rate ranging from 30 to 100%. Among the analysed loci for genus level, *mat*K and ITS demonstrated comparable results of >90%, which is better than *rbc*L (71.4%). Three regions, however, remained weak in species identification rate ranging from 34% to 52%. Therefore, it is premature to make a final decision about which marker is a suitable use for plant identification in this study.

*rbc*L is a well-known barcode region due to its ability to easily amplify, sequence and align in most land plants, particularly discriminating medicinal plants at family and genus level (Li et al., 2014). The genus and species identification of *rbc*L region in this study were 71.4% and 34.3%, respectively. The discriminatory rate of *rbc*L region is below expected. This result was consistent with previous reports of Kang et al. (2017) and Ren, Xiang and Chen (2010), respectively, the study of tree species (41.5%) and *Betulaceae* species (10%).

*mat*K achieved 90.5% of genus-level identification and 52.4% of species identification. Although it showed the highest species identification rate in this study, it was only slightly better discriminatory power compared to *rbc*L and ITS. Recently, Carneiro de Melo Moura et al. (2019) reviews that the discrimination rate of *mat*K at different taxa ranges from 49% to 90%. However, it was reported that *mat*K can achieve 100% species identification success rate in woody plant species (Kress et al., 2010). Our result was similar to the report

of Jones et al. (2021). The species identification rate was considered near to the results of *Rosales* (47%) and *Malvales* (41%). But recently, *mat*K is not recommended for studies at the species level due to its modest discrimination ability (Cui et al., 2020).

ITS performed as an influential marker at the genus level, as it showed a high identification rate of 100% in this study. In comparison with other studies, like *Gentianaceae* (100%), *Angelica* (73.91%) and *mangrove* (66.48%) (Yuan et al., 2015; Zhang et al., 2016a; Wu et al., 2019), the species-level identification success rate in this study was low (35.8%). In this study, ITS's species identification rate was consistent with the Kang report, which is 47.2% of tree species. However, it was reported that ITS failed to distinguish *Zingiberaceae* species recently (Saha et al., 2020). In the worst case, there is even a report questioning the use of ITS and suggesting the exclusion of ITS (Santos, Alves and Alves, 2017).

5.2.3 Factors Influencing the Rate of Species Identification

For all three loci in the current study, species-level identification is lower than genus-level identification. Given this, DNA barcoding based solely on single markers may not reliably identify plant samples to the species level. Up-to-date, no consensus has emerged for a universal barcode for land plants (Singh et al., 2012). Maloukh et al. (2017) pointed out there is no single barcode region suitable to all plant taxa have been reported. CBOL Plant Working Group et al.

(2009) have been stated that no single locus meets CBOL's data standards and guidelines for locus selection, and as a result a synergistic combination of loci is required. In order to improve the efficiency of DNA barcoding, researchers are combining the most efficient barcode sequences into two-locus barcodes (Krawczyk, Szczecińska and Sawicki, 2014). This was further supported by the research for plant Piper nigrum, as there is no single locus able to resolve the three species and combination barcode approaches showed better resolution of the species (Parvathy et al., 2018). Besides, study of Mishra et al. (2017) also proposed that discriminatory rate of combined regions nearly 95%, which is much higher than single region barcodes, ranging from 30–70%. Nevertheless, combining barcodes of single-locus markers can make analysis much more difficult, especially if one of the targets does not amplify (Li et al., 2014).

Apparently, ability to identify species using barcoded loci is more difficult in medicinal plants than in animals, because the possibility of unclear plant species boundaries is increasing (Fazekas et al., 2009). Hybridization and polyploidy are examples of complex evolutionary processes commonly found in medicinal plants that make it difficult to define species boundaries (Rieseberg, Wood and Baack, 2006). However, these problems are not evenly distributed in all plant groups; hence, the species-level resolution is expected to be quite good in some groups and quite poor in others (Fazekas et al., 2012). According to Caetano Wyler and Naciri (2016), the difference in evolutionary history determines the success of DNA barcode barcoding, which is expected to vary among groups. There are some reports that mention the success of species identification may be related to plant evolution. For example: Liu et al. (2017)

reported that the species identification success rate of species complexes with gene flow is low. Caetano Wyler and Naciri (2016) reported that evolutionary history is the main factor affecting the success of DNA barcodes. Fazekas et al. (2012) indicates that frequent plant hybridization will result in lower levels of species discrimination. Another Braukmann et al. (2017) report also pointed out that hybridization is one of the influencing factors.

Another factor that may influence the species identification rate was the database. Some data in any public database will inevitably contain some erroneous data due to its inherent nature (Meiklejohn, Damaso and Robertson, 2019). Kozlov et al. (2016) have been stated that mislabelled sequences are difficult to identify, and they can lead to downstream errors because new sequences are often annotated with existing sequences. Besides, it also reported that the most common reason for misidentifications were the species absence in the reference library (Bell, Loeffler and Brosi, 2017). The search sequence of the missing species which cannot be identified, may assign to an incorrect species (Parmentier et al., 2013).

5.3 Putative Compounds of 35 Local Medicinal Plants

Plant medicinal parts are extracted by selective solvents using standard procedures to separate the medicinal active compounds (Handa et al., 2008; Azwanida, 2015). However, recommendation of suitable extraction solvent for individual plant materials is generally difficult (Truong et al., 2019). In this study,

active metabolites of 35 selected local medicinal plants extracted using chloroform, methanol and NaCl in double distilled water. NaCl was added in the experiment to separate the methanol and chloroform phase (Klein, Halliday and Pittet, 1980; Lepage and Roy, 1984). The lower layer contains almost 100% chloroform (non-polar), while the upper layer contains almost all methanol water (polar) (Eggers and Schwudke, 2016). This extraction protocol allows analysis of polar to non-polar metabolites from a single sample.

The presence of the natural compounds in the medicinal plants makes them an important source of molecules with medicinal properties (Garg, Faheem and Singh, 2020). According to our findings, most of the putative secondary compounds are known as “known unknown”. A “known unknown” is referred to a metabolite that has not yet been identified in the sample of interest but has been previously reported in a reference database or in the literature (Garcia-Perez et al., 2020). Nevertheless, we were able to detect some putative secondary known compounds. We used past records of known compounds and noticed that some putative secondary known compounds in this study are presumed to have medicinal properties. Seca and Pinto (2019) proposed that secondary compounds are reported to be used as single compounds or mixtures, and they are called effective and safe medicine. Therefore, it is necessary to review and point out the relative medicinal properties of the selected medicinal plants for future research.

According to the literature, the putative secondary known compounds detected in the medicinal plants in this study are different from the medicinal plants previously reported by researchers. Currently, only local medicinal plants that have been detected as having medicinal literature will be discussed in this section. Briefly, Table 5.1 summarizes medicinal plant extracts with potential putative known compounds and their associated previously reported medicinal properties.

Table 5.1: There are only six of thirty-five medicinal plant extracts correspond to identified relevant putative known compounds and their associated previously reported medicinal properties

No	Plant Extracts With Different Plant Part	Potential Putative Known Compounds	Potential Medicinal Properties	Reference(s)
1.	*Phyla nodiflora* leaf extract	4-hydroxychromen-2-one	Antibacterial	Behrami, 2019
2.	*Vitex trifolia* whole plant extract	4-hydroxychromen-2-one	Antibacterial	Behrami, 2019
3.	*Andrographis paniculata* leaf extract	6,7-Dehydroroyleanone	Anticancer	Garcia et al., 2018
			Anti-coronavirus	Diniz et al., 2021
		Apigenin-7-O-glucuronide	Antimutagenic	Baris et al., 2011
		Kahweol	Anti-carcinogenesis	Huber et al., 2002
			Anti-inflammation	Kim et al., 2004; Kim, Jung and Jeong, 2004
			Anti-atherosclerotic,	Kim et al., 2006
			Anti-tumor	Tao et al., 2008; Oh et al., 2009
		3,4-dimethoxybenzoic acid	Anticancer	Czarnecka et al., 2018
			Antimicrobial	Narasimhan et al., 2009
			Anti-inflammatory Antioxidant	Shin et al., 2013

Table 5.1 (Continued)

No	Plant Extracts With Different Plant Part	Potential Putative Known Compounds	Potential Medicinal Properties	Reference(s)
3.	*Andrographis paniculata* leaf extract	3,4-dimethoxybenzoic acid	Active ingredient for preparing desleucyl glycopeptides antibiotics	Blaskovich et al., 2018
			Tumor necrosis factor-alpha production inhibitor	Choi et al., 2014
			Starting materials for the production of ophthalmic dyes	Kumar and Thirumalesh, 2013
4.	*Lantana camara* leaf extract	4-hydroxynaphthalene-1,2-dione	Antifungal	Nagesh et al., 2017
5.	*Barleria lupulina* leaf extract	Trans-p-feruloyl-beta-d-glucopyranoside	Antioxidant	Materska and Perucka, 2005
		3,4-dimethoxy-trans-cinnamic acid	Antioxidant	Guo et al., 2011
		Dihydrosinapic acid	Anti-oxidative, may contribute to anti-tumor activity	Shimoji et al., 2002
		6-methylcoumarin	Anti-inflammatory	Cárdenas et al., 2017
		4-vinylphenol	Anti-angiogenic, anti-tumor	Yue et al., 2015
			Anti-metastatic	Leung et al., 2018

Table 5.1 (Continued)

No	Plant Extracts With Different Plant Part	Potential Putative Known Compounds	Potential Medicinal Properties	Reference(s)
5.	*Barleria lupulina* leaf extract	9-aminononanoic acid	Antiradical	Noumi et al., 2020
6.	*Ocimum basilicum* whole plant extract.	6-tuliposide B	Antibacterial	Shigetomi et al., 2010

LYMOOI 001 belongs to *Phyla nodiflora* leaf extract. Major components of *Phyla nodiflora* include alkaloids, glycosides, phenolic compounds, terpenoids, etc. (Jabeen et al., 2016). However, there are more phenolic compounds detected in LYMOOI 001 leaf extract and only 4-hydroxychromen-2-one (4-hydroxy-chromen-2-one) has medicinal properties with antibacterial effect (Behrami, 2019).

LYMOOI 006 belongs to *Vitex trifolia* whole plant extract. Previously, researchers have reported that *Vitex trifolia* contains more total phenolic compounds and their antioxidant characteristics would play a task in the prevention and treatment of cancer (Aweng et al., 2012). In this study, medicinal properties of the putative phenolic compounds detected in LYMOOI 006 whole plant extract are not yet been explored, except for: 4-hydroxychromen-2-one, previously reported to have antibacterial effects (Behrami, 2019).

LYMOOI 025 belongs to *Andrographis paniculata* leaf extract. A review of the literature reveals that an extract of *Andrographis paniculata* is more in diterpenoids and phenolics (Thoo et al., 2013). Our finding is consistent with previous report as LYMOOI 025 leaf extract contains more putative compounds of phenolics and terpenes compounds. Putative compounds with known medicinal properties detected in the leaf extract of LYMOOI 025 were 6,7-Dehydroroyleanone, Apigenin-7-O-glucuronide, Kahweol and 3,4-dimethoxybenzoic acid (Veratric acid). 6,7-Dehydroroyleanone reported has anticancer properties (Garcia et al., 2018) and anti- coronavirus activity (Diniz

et al., 2021). Apigenin-7-O-glucuronide reported having the function of antimutagenic activity (Baris et al., 2011). Kahweol have anti-carcinogenesis, anti-atherosclerotic, anti-tumor and anti-inflammation properties (Huber et al., 2002; Kim et al., 2004; Kim, Jung and Jeong, 2004; Kim et al., 2006; Tao et al., 2008; Oh et al., 2009). 3,4-dimethoxybenzoic acid (Veratric acid) reported have a wide range of activities, i.e., anti-cancer (Czarnecka et al., 2018), anti-microbial (Narasimhan et al., 2009), anti-inflammatory and anti-oxidant responses (Shin et al., 2013), as an active ingredient in the preparation of desleucyl glycopeptides antibiotics (Blaskovich et al., 2018), inhibitors of tumor necrosis factor-alpha production (Choi et al., 2014), and as a starting material in the production of ophthalmic dyes (Kumar and Thirumalesh, 2013).

LYMOOI 035 belongs to *Lantana camara* leaf extract. It is believed that the antioxidant activity is contributed by phenolic compounds, and it is shown that *Lantana camara* extracts has great potential for antioxidant activity (Mahdi-Pour et al., 2012). In 2014, scientists have been proposed that phenolic compounds are the main contributors to the antioxidant activity of *Lantana camara* leaf extracts (Kumar, Sandhir and Ojha, 2014). In this findings, LYMOOI 035 leaf extract was more in phenolic compound. Putative compounds with known medicinal properties detected in the leaf extract of LYMOOI 035 was 4-hydroxynaphthalene-1,2-dione, which proposed antifungal activity (Nagesh et al., 2017).

LYMOOI 036 belongs to *Barleria lupulina* leaf extract. *Barleria lupulina* Lindl. has been widely employed in traditional knowledge medication because of its abundance in polyphenolic compounds (Ismail-Suhaimy et al., 2021). They are known for their antioxidant properties (García-Pérez, Kasangana and Stevanovic, 2017). In this study, LYMOOI 036 leaf extract is rich in phenolic compounds. Putative compounds with known medicinal properties detected in the leaf extract of LYMOOI 036 were trans-p-feruloyl-beta-d-glucopyranoside, 3,4-dimethoxy-trans-cinnamic acid (3,4-dimethoxycinnamic acid), dihydrosinapic acid, 6-methylcoumarin, 4-vinylphenol and 9-aminononanoic acid. Trans-p-feruloyl-beta-d-glucopyranoside has antioxidant activity (Materska and Perucka, 2005). 3,4-dimethoxy-trans-cinnamic acid (3,4-dimethoxycinnamic acid) have antioxidant properties (Guo et al., 2011). Dihydrosinapic acid proposed has anti-oxidative compounds and may contribute to antitumor activity (Shimoji et al., 2002). 6-methylcoumarin showed anti-inflammatory activity (Cárdenas et al., 2017). 4-vinylphenol reported functions of anti-angiogenic, anti-tumor effect (Yue et al., 2015) and potential as an anti-metastatic agent for breast cancer (Leung et al., 2018). 9-aminononanoic acid has antiradical activity (Noumi et al., 2020).

LYMOOI 040 belongs to *Ocimum basilicum* whole plant extract. *Ocimum basilicum* extract contains phenolic compounds and flavonoids, which can be used as effective antioxidants, free radical scavengers, and metal chelating agents (Jayasinghe et al., 2003). Putative compounds with known medicinal properties detected in the whole plant extract of LYMOOI 040 was 6-

tuliposide B, which previously reported has antibacterial activity (Shigetomi et al., 2010).

In this study, four putative secondary known compounds (Apigenin-7-O-glucuronide, 9-aminononanoic acid, 4-hydroxychromen-2-one and 3-hydroxycoumarin) that can be detected in a variety of plant extracts are presented because these compounds are easily available for future research.

Apigenin derivatives are called antioxidant molecules (Edenharder and Grünhage, 2003). Apigenin-7-O-glucuronide is proposed to have antimutagenic activity (Baris et al., 2011). It is thought that antimutagenic activity is mainly because of their antioxidant activity (Nagy et al., 2009). According to our findings, Apigenin-7-O-glucuronide can be detected in LYMOOI 019 whole plant extract (*Stachytarpheta jamaicensis*) and LYMOOI 025 leaf extract (*Andrographis paniculata*).

Putatively identified 9-aminononanoic acid in LYMOOI 036 leaf extract (*Barleria lupulina*), LYMOOI 045 leaf extract (*Hibiscus mutabilis*) and LYMOOI 053 leaf extract (*Cycas revoluta*), reported has antiradical activity (Noumi et al., 2020).

Recently, 4-hydroxychromen-2-one (4-hydroxy-chromen-2-one) has attracted attention due to its ability to synthesize new derivatives with

antibacterial properties. Starting from 4-hydroxy-chromen-2-one, 4-Hydroxy-2-oxo-2H-chromene-3-sulfonic acid (4-methoxy-phenyl)-amide derivatives, N-[(4-Hydroxy-2-oxo-2H-chromen-3-yl)-(2-hydroxy-phenyl)-methylene]-acetami -de and 4-Hydroxy-3-[(6-nitro-benzothiazol-2-ylimino)-methyl]-chromen-2-one were synthesized. They showed evidence of antibacterial effect against *S. aureus*, *E.coli* and *B. Cereus* in the study of Behrami (2019). In our finding, 4-hydroxychromen-2-one can be found in LYMOOI 001 leaf extract (*Phyla nodiflora*) and LYMOOI 006 whole plant extract (*Vitex trifolia*).

3-hydroxycoumarin, a wide variety of industrial applications use these compound as starting materials or precursors (Yoda, 2020). A synthetic structure based on 3-hydroxycoumarin was made and 7-alkoxy-3-hydroxycoumarin was synthesized as a potent human 15-LOX-1 inhibitor (Alavi et al., 2018). Furthermore, in silico tests indicated that 3-hydroxycoumarin can inhibit the production of chitin synthase by the fungus, an enzyme that is essential to its survival (de Andrade Gonçalves et al., 2018). In addition, 3-hydroxycoumarin proved as an effectively inhibitor of tyrosinase, which is one of the key enzymes lead to melanin biosynthesis. Besides, 3-hydroxycoumarin is also considered as a new class of photoprotective drugs (de Araujo Leite et al., 2015). Moreover, 3-hydroxycoumarin derivatives may become antioxidant candidates (Bailly et al., 2004). In our study, 3-hydroxycoumarin can be detected in LYMOOI 006 whole plant extract (*Vitex trifolia*), LYMOOI 019 whole plant extract (*Stachytarpheta jamaicensis*), LYMOOI 025 leaf extract (*Andrographis paniculata*), LYMOOI 035 leaf extract (*Lantana camara*), LYMOOI 066 whole

plant extract (*Oldenlandia corymbosa*), LYMOOI 073 leaf extract (*Oldenlandia diffusa*).

This study successfully used the untargeted approach to initial screening the potential putative compounds obtained from different medicinal plants of different geographical locations, thereby classifying the putative compounds into different categories and listing potential local medicinal plants with known secondary putative compounds. It was found that specimens of same plant species growing under different environmental conditions will show great differences in the production and accumulation of the primary and secondary metabolites (Wink, 1988; Bennett and Wallsgrove, 1994; Theis and Lerdau, 2003; Edreva et al., 2008; Oh, Trick and Rajashekar, 2009; Ramakrishna and Ravishankar, 2011; Gutbrodt et al., 2012; Pavarini et al., 2012; Sampaio, Edrada-Ebel and Da Costa, 2016).This statement is consistent with the results of putative compounds we obtained from 35 local medicinal plants. The current production and accumulation results of primary and secondary metabolites are very different when compared with previous research reports due to growth in different environment conditions. Therefore, the metabolite profile of this study is very useful for future research. Researchers can further use the locations provided in the herbarium voucher to conduct research on medicinal plants of interest.

Chapter 6

Conclusion

This study is considered as an attempt to record the scientific basis of local medicinal plants used in Malaysia. Selected 35 local medicinal plants were successfully collected at Selangor, Negeri Sembilan and Johor for making herbarium voucher and used for DNA barcoding and metabolite profiling study. A macroscopic photograph set of each plant was recorded. The 35 herbarium vouchers were then successfully deposited at Perdana Botanical Garden Kuala Lumpur. For DNA barcoding analysis, the *rbc*L, *mat*K, and ITS loci showed an identification rate of 70-100% at the genus level, but only showed an identification rate of 30-52% at the species level. It was found that the use of DNA barcoding cannot replace the traditional taxonomic level in current study. Despite not yet identifying a suitable DNA barcode in this study, DNA barcoding is not an all or nothing endeavour and it revealed the applicability of universal primers to certain plant taxa. It successfully identified 12 medicinal plants at *rbc*L loci, 11 medicinal plants at *mat*K loci and 5 medicinal plants at ITS loci. For untargeted metabolite profiling, 35 metabolite profiles have been recorded and it was found that the majority of the putative secondary compounds are regarded as “known unknown” and only few “known” putative compounds have been found. The medicinal properties of “known” putative compounds were predicted from the findings of the previous articles. The interesting putative compounds were proposed to isolate and purify for functional assay in future.

To our knowledge, this research is the first to enhance the scientific information of the selected 35 medicinal plants by combining herbarium voucher, DNA barcodes and metabolite profiles.

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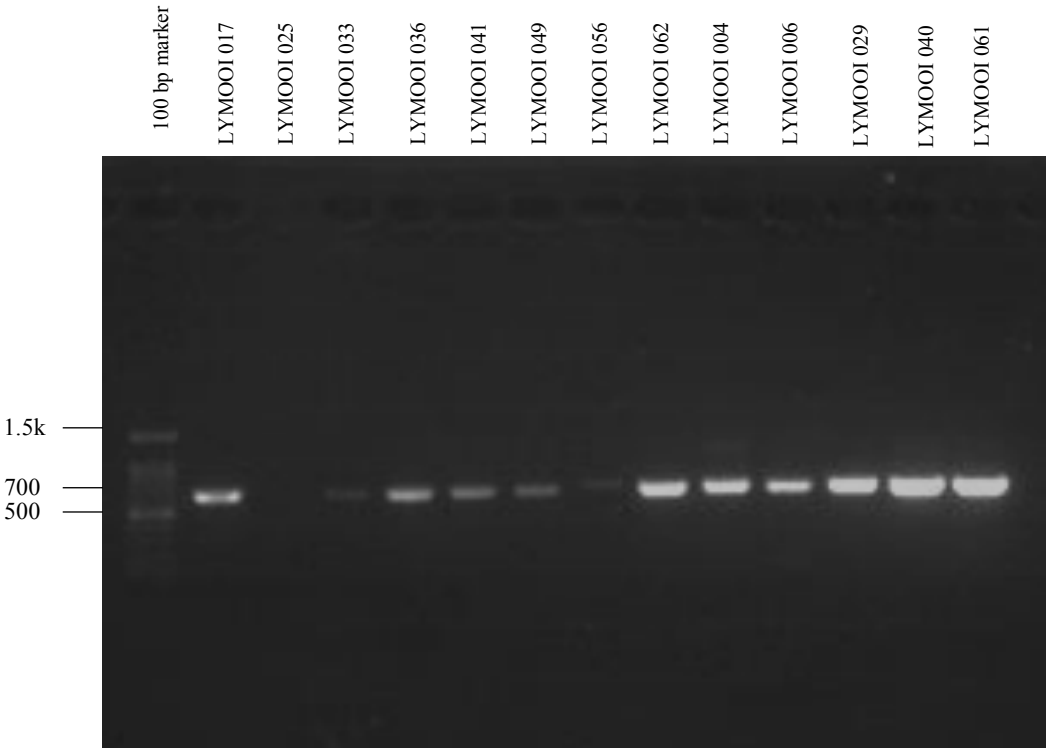
APPENDIX A

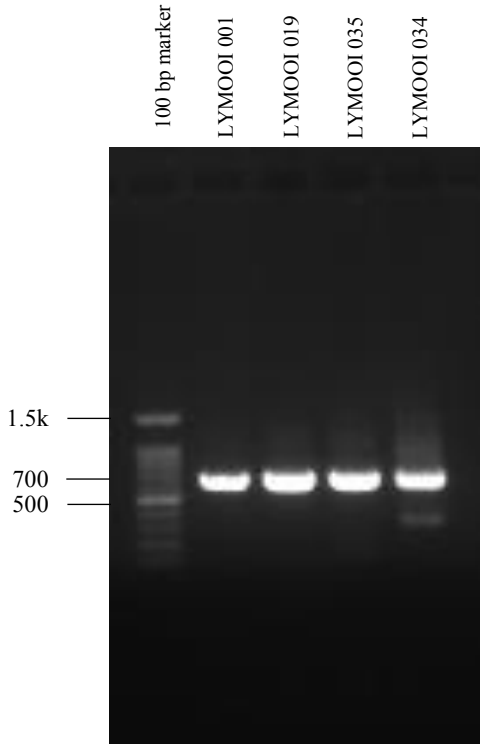
Agarose gel of PCR amplicons from plant DNA



Supplementary Figure 1: 1.5% 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 *Gendarussa ventricosa* (Wall.) Nees (LYMOOI 017), *Andrographis paniculata* (Burm.f.) Wall. ex Nees (LYMOOI 025), *Strobilanthes crispus* Blume (LYMOOI 033), *Barleria lupulina* Lindl. (LYMOOI 036), *Gendarussa vulgaris* Nees. (LYMOOI 041), *Clinacanthus nutans* (Burm.f) Lindau (LYMOOI 049) , *Ruellia simplex* C.Wright (LYMOOI 056), *Rhinacanthus nasutus* (L) Kurz (LYMOOI 062), *Mentha spicata* L. (LYMOOI 004), *Vitex trifolia* L. (LYMOOI 006), *Orthosiphon aristatus* (Blume) Miq. (LYMOOI 029), *Ocimum basilicum* L. (LYMOOI 040), and *Plectranthus amboinicus* (Lour.) Spreng (LYMOOI 061)

APPENDIX A

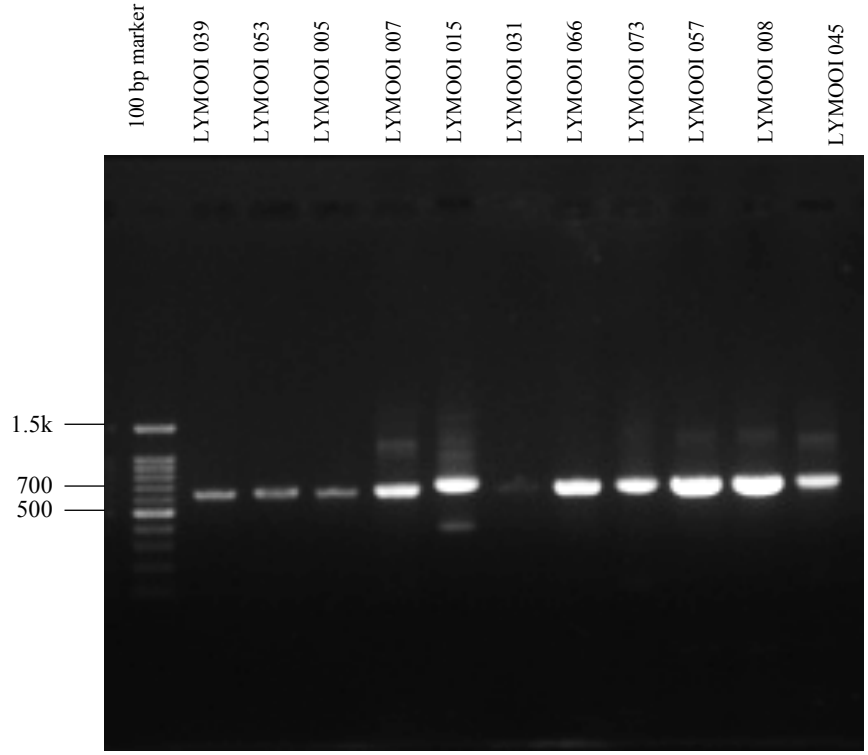
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 2: 1.5% 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 *Phyla nodiflora* (LYMOOI 001), *Stachytarpheta jamaicensis* (L) Vahl (LYMOOI 019), *Lantana camara* L. (LYMOOI 035), and *Plantago major* L. (LYMOOI 034)

APPENDIX A

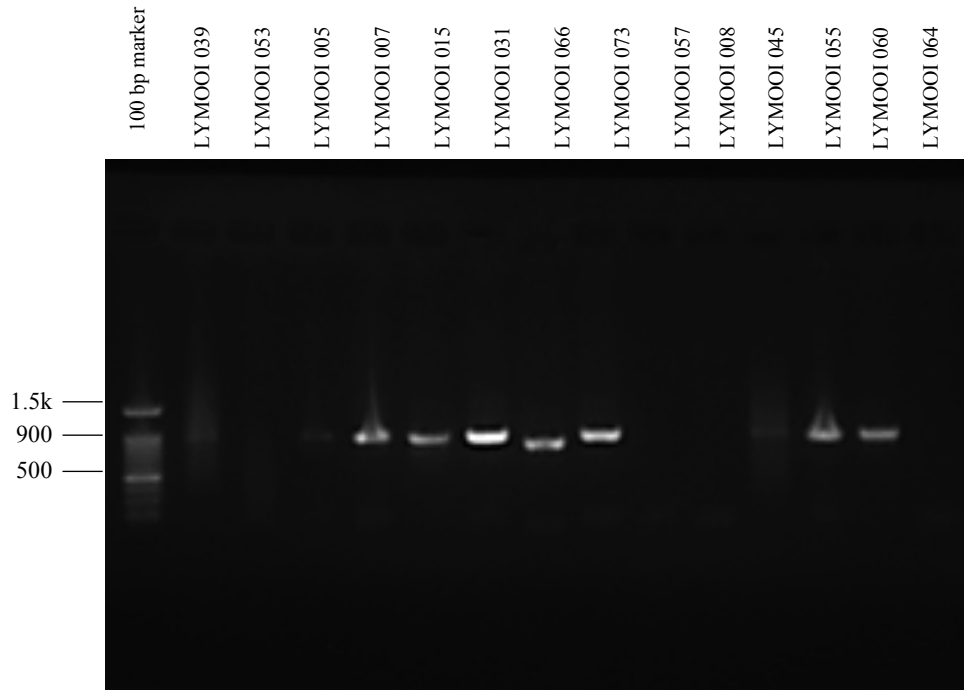
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 3: 1.5% 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 *Gynostemma pentaphyllum* (Thunb.) Makino (LYMOOI 039), *Cycas revoluta* (LYMOOI 053), *Kyllinga brevifolia* Robbt (LYMOOI 005), *Calotropis gigantea* (L.) W.T.Aiton (LYMOOI 007), *Oldenlandia auricularia* (LYMOOI 015), *Morinda citrifolia* L. (LYMOOI 031), *Oldenlandia corymbosa* (L) (LYMOOI 066), *Oldenlandia diffusa* (Willd.) Roxb (LYMOOI 073), *Catharanthus roseus* (L) G. Don (LYMOOI 057), *Urena lobata* (L.) (LYMOOI 008), and *Hibiscus mutabilis* L. (LYMOOI 045)

APPENDIX A

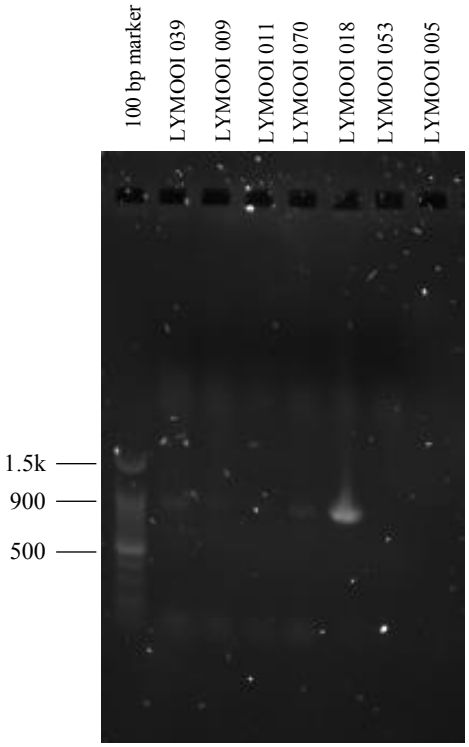
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 4: 1.5% 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 *Gynostemma pentaphyllum* (Thunb.) Makino (LYMOOI 039), *Cycas revoluta* (LYMOOI 053), *Kyllinga brevifolia* Robbt (LYMOOI 005), *Calotropis gigantea* (L.) W.T.Aiton (LYMOOI 007), *Oldenlandia auricularia* (LYMOOI 015), *Morinda citrifolia* L. (LYMOOI 031), *Oldenlandia corymbosa* (L) (LYMOOI 066), *Oldenlandia diffusa* (Willd.) Roxb (LYMOOI 073), *Catharanthus roseus* (L) G. Don (LYMOOI 057), *Urena lobata* (L.) (LYMOOI 008), *Hibiscus mutabilis* L. (LYMOOI 045), *Alocasia macrorhizos* (L.) G.Don (LYMOOI 055), *Typhonium flagelliforme* (Lodd.) Blume (LYMOOI 060), and *Rhaphidophora decursiva* (Roxb.) Schott (LYMOOI 064)

APPENDIX A

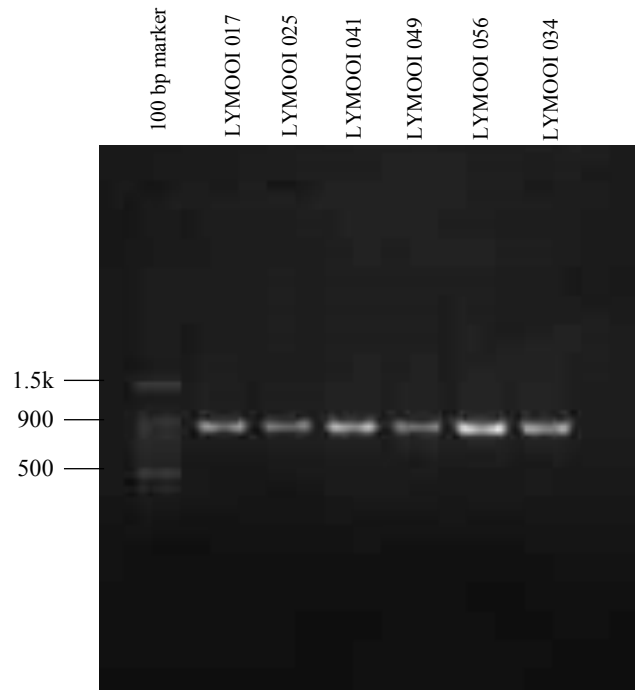
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 5: 1.5% 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 *Gynostemma pentaphyllum* (Thunb.) Makino (LYMOOI 039), *Melastoma malabathricum* L. (LYMOOI 009), *Clidemia hirta* (L.) D. Don (LYMOOI 011), *Punica granatum* L. (LYMOOI 070), *Dioscorea bulbifera* (L) (LYMOOI 018), *Cycas revoluta* (LYMOOI 053), and *Kyllinga brevifolia* Robbt (LYMOOI 005)

APPENDIX A

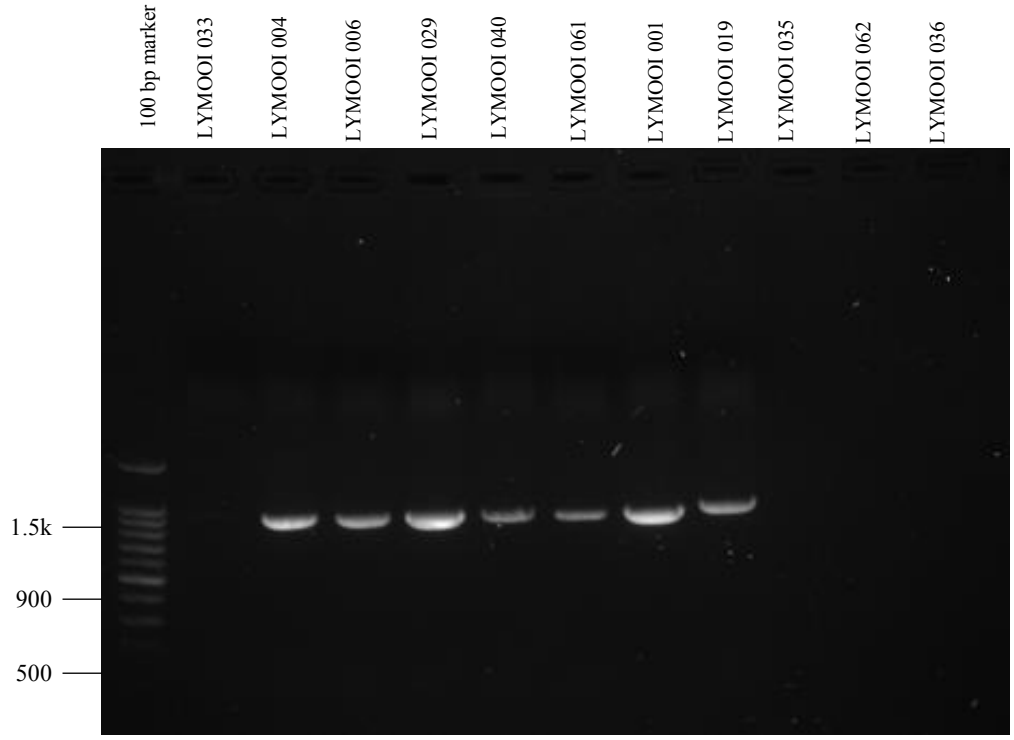
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 6: 1.5% 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 *Gendarussa ventricosa* (Wall.) Nees (LYMOOI 017), *Andrographis paniculata* (Burm.f.) Wall. ex Nees (LYMOOI 025), *Gendarussa vulgaris* Nees. (LYMOOI 041), *Clinacanthus nutans* (Burm.f) Lindau (LYMOOI 049), *Ruellia simplex* C.Wright (LYMOOI 056), and *Plantago major* L. (LYMOOI 034)

APPENDIX A

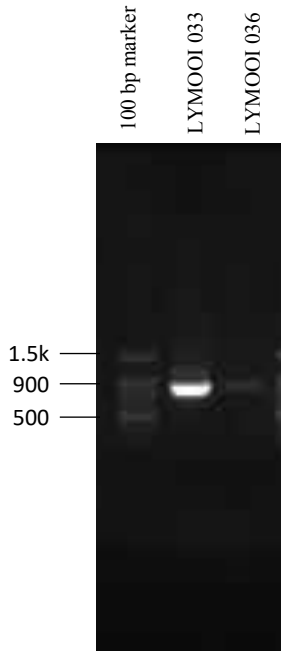
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 7: 1.5% 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 *Strobilanthes crispus* Blume (LYMOOI 033), *Mentha spicata* L. (LYMOOI 004), *Vitex trifolia* L. (LYMOOI 006), *Orthosiphon aristatus* (Blume) Miq. (LYMOOI 029), *Ocimum basilicum* L. (LYMOOI 040), *Plectranthus amboinicus* (Lour.) Spreng (LYMOOI 061), *Phyla nodiflora* (LYMOOI 001), *Stachytarpheta jamaicensis* (L) Vahl (LYMOOI 019), *Lantana camara* L. (LYMOOI 035), *Rhinacanthus nasutus* (L) Kurz (LYMOOI 062) and *Barleria lupulina* Lindl. (LYMOOI 036)

APPENDIX A

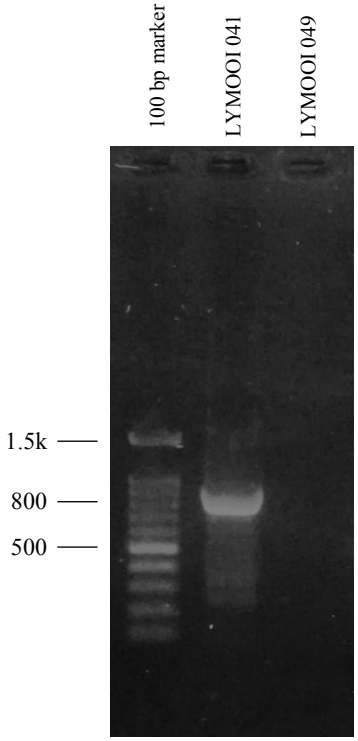
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 8: 1.5% 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 *Strobilanthes crispus* Blume (LYMOOI 033), and *Barleria lupulina* Lindl. (LYMOOI 036)

APPENDIX A

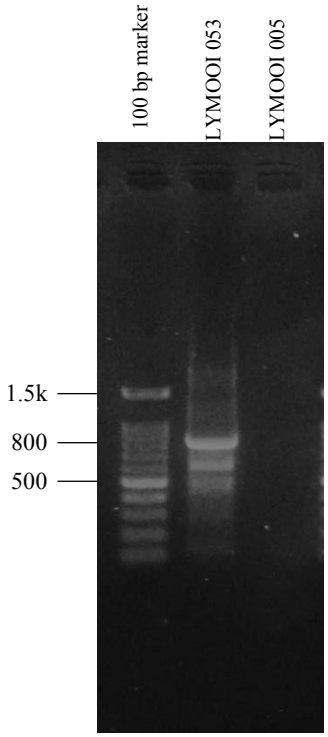
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 9: 1.5% 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 *Gendarussa vulgaris* Nees. (LYMOOI 041), and *Clinacanthus nutans* (Burm.f) Lindau (LYMOOI 049)

APPENDIX A

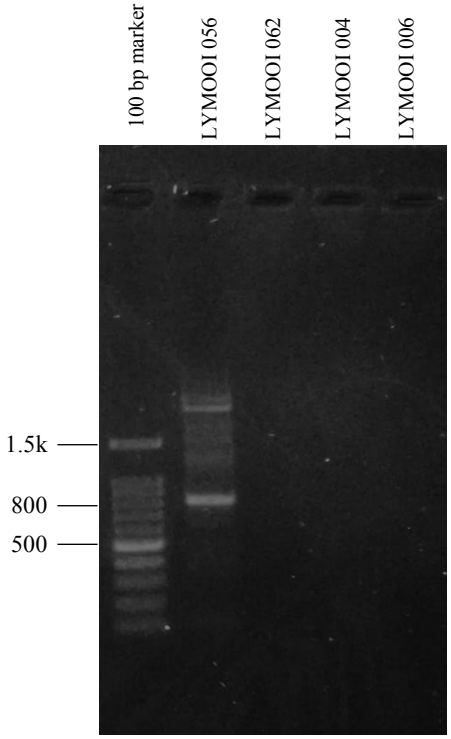
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 10: 1.5% 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 *Cycas revoluta* (LYMOOI 053), and *Kyllinga brevifolia* Robbt (LYMOOI 005)

APPENDIX A

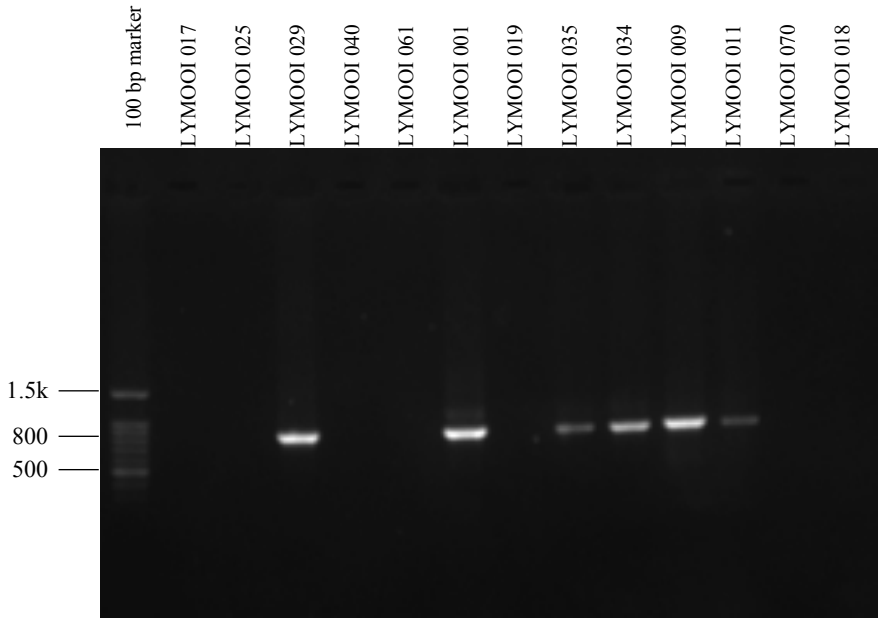
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 11: 1.5% 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 *Ruellia simplex* C.Wright (LYMOOI 056), *Rhinacanthus nasutus* (L) Kurz (LYMOOI 062), *Mentha spicata* L. (LYMOOI 004), and *Vitex trifolia* L. (LYMOOI 006)

APPENDIX A

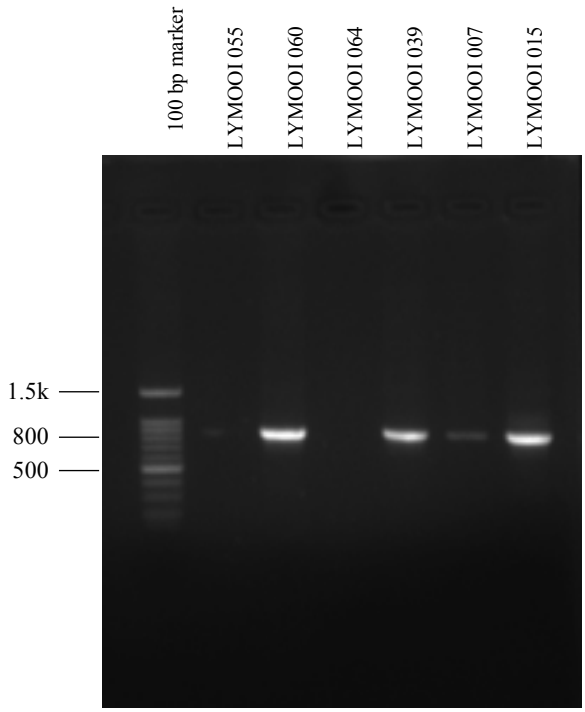
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 12: 1.5% 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 *Gendarussa ventricosa* (Wall.) Nees (LYMOOI 017), *Andrographis paniculata* (Burm.f.) Wall. ex Nees (LYMOOI 025), *Orthosiphon aristatus* (Blume) Miq. (LYMOOI 029), *Ocimum basilicum* L. (LYMOOI 040), *Plectranthus amboinicus* (Lour.) Spreng (LYMOOI 061), *Phyla nodiflora* (LYMOOI 001), *Stachytarpheta jamaicensis* (L) Vahl (LYMOOI 019) , *Lantana camara* L. (LYMOOI 035), *Plantago major* L. (LYMOOI 034), *Melastoma malabathricum* L. (LYMOOI 009), *Clidemia hirta* (L.) D. Don (LYMOOI 011), *Punica granatum* L. (LYMOOI 070) and *Dioscorea bulbifera* (L) (LYMOOI 018)

APPENDIX A

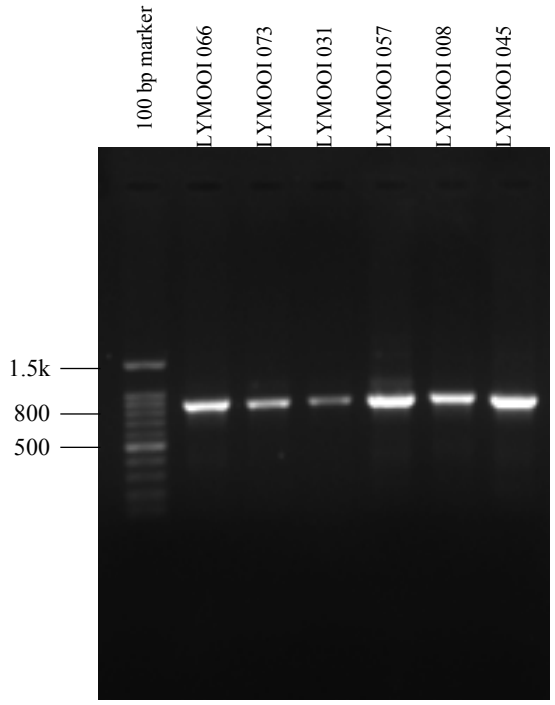
Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 13: 1.5% 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 *Alocasia macrorhizos* (L.) G.Don (LYMOOI 055), *Typhonium flagelliforme* (Lodd.) Blume (LYMOOI 060), and *Rhaphidophora decursiva* (Roxb.) Schott (LYMOOI 064), *Gynostemma pentaphyllum* (Thunb.) Makino (LYMOOI 039), *Calotropis gigantea* (L.) W.T.Aiton (LYMOOI 007), *Oldenlandia auricularia* (LYMOOI 015)

APPENDIX A

Agarose gel of PCR amplicons from plant DNA (continued)



Supplementary Figure 14: 1.5% 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 *Oldenlandia corymbosa* (L) (LYMOOI 066), *Oldenlandia diffusa* (Willd.) Roxb (LYMOOI 073), *Morinda citrifolia* L. (LYMOOI 031), *Catharanthus roseus* (L) G. Don (LYMOOI 057), *Urena lobata* (L.) (LYMOOI 008), *Hibiscus mutabilis* L. (LYMOOI 045)

APPENDIX B

Sequences per sample based on bidirectional primer

***Andrographis paniculata* LYMOOI 025**

>LYMOOI025_rbcLa_F/rbcLajf635R

ACAGAGACTAAAGCAAGTGTTTTTTTCAAAGCGGGTGTTAAAGAGTACAAATTGA
CTTATTATACTCCTGAATACGAAACCAAAGATACTGATATCTTGGCAGCATTCCGA
GTAACTCCTCAACCCGGAGTTCCGCCTGAAGAAGCAGGGGCAGCGGTAGCTGCCG
AATCTTCCACTGGTACATGGACAACCGTGTGGACTGATGGACTTACCAGCCTTGAT
CGTTACAAAGGGCGATGCTACAACATCGAGCCCGTTCTTGGCGAAACAGATCAAT
ATATTTGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACCAACA
TGTTTACTTCCATTGTAGGAAATGTATTTGGATTCAAAGCCCTGCGTGCTCTACGCC
TGGAAGATCTGCGAATCCCTACTGCTTATATTAAAACTTTCCAAGGTCCGCCTCAT
GGGATCCAAGTTGAGAGAGATAAATTGAACAAATATGGTCGTCCTCTGCTGGGAT
GTACTATTAAACCTAAATTGGGATTATCCGCTAAAAACTACGGCAGAGCATGTTAT
GAATGTCTTCGCGGTGGACTTGATTTTACCAAAGATGATGAGAACGTGAACTCCCA
GCCATTTATGCGTTG

>LYMOOI025_matK_390f/matK_1326r

AGACAATTTTTCACATTTATATCTTCTATTAGATATACAAATACCCCCACTTTGTCC
ATGTCGAAATCTTGGTTCAAGCTCTTTGCTATTGGTTAAAAGATGCCTCTTCTTTGC
ATTTATTACGATTCTTTCTCAACGAGTATTGTAATTGGAATACTCTTCTTAGTAGTA
GGCCAAAGAAAGCCGATTCCTCTTTTTCAAAAAGAAATCAAAGATTCTTTTTATTC
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TCTTCTCATTTCCGATCGACATCTTCTGGAGTTTTTTTTGAACGAATCTATTTCTATG
GAAAAATAGAACGTCTTAGGAACCTTTTAGTTAAGGTTAAGAATTTTCAGGCGAA
CCTATGGTTGGTCAAGGAACCTTGCATGCATTATATTAGGTATCAAAGAAGATTCA
TCTTGGCTTCAAAAGGAACGTCAGTTTTAATGAATAAATGGAAATGCTACCTTGTC
ACTTTTTGGCAATGGCATTTTTCGCTGTGGTTTCTTCCAAGAAGGGTTTATAGAACC
CAATTATCCAATCATTTCTTTGAATTTTTGGGCTATCTTTCAAGTGTCAGAATCAAA
CCTTCAGTGGTACGGAGCCAAATTCTTCAAAATGCATTTCCAATCAATAATGCTAT
TAACCAGTTTGATACCCGTATTCAAATTAGGTCTTTAATTGAGTCATTGGCTAAAG
CGAAATTTTGTAACCTATTAGGGCATCCTATCAGTAAGCCGGTTTGGGCTAATTTA
CCAGATTCAAATATTATTGAACGATTTGTGCGTATAGGCAGAAATCTTTCTCATTA
TCATAG

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Barleria lupulina* LYMOOI 036**

>LYMOOI036_rbcLa_F/rbcLajf635R

CCCCCAACAGAGACTAAAGCAAGTGTTGGATTCAAAGCGGGTGTTAAAGAGTACA
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TTCCGAGTAACTCCTCAACCCGGAGTTCCGCCTGAAGAAGCAGGGGCAGCGGTAG
CTGCCGAATCTTCCACTGGTACATGGACAACCGTGTGGACCGATGGACTTACCAGC
CTTGATCGTTACAAAGGGCGATGCTACAACATCGAGCCCGTTGCTGGCGAAACAG
ATCAATATATCTGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTA
CCAACATGTTTACTTCCATTGTAGGAAATGTATTTGGATTCAAAGCCCTGCGTGCT
CTACGTCTGGAAGATCTGCGAATCCCTACTGCTTATATTAAAACTTTCCAAGGTCC
GCCTCATGGGATCCAAGTTGAGAGAGATAAATTGAACAAATATGGTCGTCCTCTG
CTGGGATGTACTATTAAACCTAAATTGGGGTTATCCGCTAAAAACTATGGTAGAGC
ATGTTATGAATGTCTTCGTGGTGGACTTGATTTTACGAAAGATGATGAGAACGTGA
ACTCCCAGCCATTTATGCGTT

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Clinacanthus nutans* LYMOOI 049**

>LYMOOI049_rbcLa_F/rbcLajf635R

CAACAGAGACTAAAGCAAGTGTTGGATTCAAAGCGGGTGTTAAAGAGTACAAATT
GACTTATTATACTCCTGAATACGAAACCAAAGATACTGATATCTTGGCAGCATTCC
GAGTAACTCCTCAACCAGGAGTTCCGCCTGAAGAAGCAGGAGCCGCGGTAGCTGC
GGAATCTTCCACCGGTACATGGACAACCGTGTGGACCGATGGACTTACCAGTCTTG
ATCGTTACAAAGGGCGATGCTACAACATCGAGCCCGTTCTTGGCGAAACAGATCA
ATATATCTGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACCAA
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GTCTGGAAGATCTTCGAATCCCTCCTGCTTATATTAAAACTTTCCAAGGTCCACCTC
ATGGGATCCAAGTTGAGAGAGATAAGTTGAACAAGTATGGTCGTCCTCTGCTGGG
ATGTACTATTAAACCTAAATTGGGGTTATCCGCTAAAAACTATGGTAGAGCGTGTT
ATGAATGTCTTCGCGGTGGACTTGATTTTACCAAAGATGATGAGAACGTGAACTCC
CAGCCATTTATGCGTT

>LYMOOI049_matK_390f/matK_1326r

CTTTTTCGAAGACAATTTTCCACATTTAAGTCTTGTATTAGATATCCTAATACCCTA
CTCTGTTCACGTGGAAATCTTGGTTCAAATTCTTCGCTATTGGTTAAAAGATGCTTC
TTCTTTACATTTATTACGGTTTTTTCTCAACGAGTATTGTAATTGGAATACTCTTATT
AGGTTAAATAAAGCCAGTTCCTCTTTTTCAAAAAGAAATGAAAGATTATTCTTATT
CTTATATAATTCTCATGTAGGGGAATATGAATCCGTTTTATTCTTTTTACGTAACCA
ATCTTCTCATTTACGATCAACTTCTTTTGGAGTTTTTATTGAACGAATCTATTTCTAT
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CCTATGGTTGGTCAAGGAACCTTGCATGCATTATATTAGGTATCAAAGAAGGTTCA
TCTTGGCTTCAAAAGGGACGTCACTTTTCATGAATAAATGGAAATGGTACCTTGTC
ACTTTTTGGCAAGGGCATTTTTCGCTATGGTTTCATCCAAGAAGGATTTATAAAAA
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ACCTTCAGTGATACGGAGTCAAATTTTCGAAAATGCATTTCCAATCAATAATGCTA
TTAAGAAGTTGGATACCCTTATTCCAATTTTGCCAATGATTGCGTCATTGGCTAAA
GCAAAATTTTGTAACGTATTAGGCCATCCTATTAGTAAGTCGGTTTGGGCTGATTT
ATCAGATTCTAATATTATTCACCGATTTGGGCGTATATGCAGAAATCTTTCTCATTA
TCATAGCGGATCTTCTACAACAAAGAGTTTGTATCGGATAAAATATATACT

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Gendarussa ventricosa* LYMOOI 017**

>LYMOOI017_rbcLa_F/rbcLajf635R

ACAGAGACTAAAGCAAGTGTTGGATTCAAAGCGGGTGTTAAAGAGTACAAATTGA
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GTAACTCCTCAACCCGGAGTTCCGCCTGAAGAAGCAGGAGCCGCGGTAGCTGCGG
AATCTTCCACCGGTACATGGACAACCGTGTGGACCGATGGACTTACCAGTCTTGAT
CGTTACAAAGGGCGATGCTACAACATCGAGCCCGTTCTTGGTGAAACAGATCAAT
ATATCTGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACCAACA
TGTTTACTTCCATTGTGGGAAATGTGTTTGGATTCAAAGCCTTGCGTGCTCTACGTC
TGGAAGATCTTCGAATCCCTACTGCTTATATTAAAACTTTCCAAGGTCCGCCTCAT
GGGATCCAAGTTGAGAGAGATAAGTTGAACAAGTATGGGCGTCCCCTGCTGGGAT
GTACTATTAAACCAAAATTGGGGTTATCCGCTAAAAACTATGGTAGAGCGTGTTAT
GAATGTCTTCGCGGTGGACTTGATTTTACCAAAGATGATGAGAACGTGAACTCCCA
GCCATTTATGCGTTG

>LYMOOI017_matK_390f/matK_1326r

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GGTTCAAACTCTTCGCTATTGGTTAAAAGATGCTTCTTCTTTGCATTTATTACGGTT
TTTTCTCAACGAGTATTGTAATTGGAATACTATTATTAGGCTAAATAAAGTCAGTT
CCTCTTTTTCAAAAGGAGATGAAAGGTTATTCTTATTCTTATATAATTCTCATGTAG
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CATCTTTTGGAGTTTTTATTGGACGAATCTGTTTCTATGGAAAAATAGAATATCTTG
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CCTTGCATGCATTATATTAGGTATCAAAGAAGGTTTATCTTGGCTTCAAAAGGGAC
GTCACTTTTCATGAATAAATGGAAATGGTACCTTGTCACTTTTTGGCAAGGGCGTT
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CCAAATTTTGGAAAATGCATTTCCAATCAATAATGCTATTAAGAAGTTCGATACCC
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TAGGCCATCCTATTAGTAAGTCGGTTTGGGCTGATTTATCAGATTCTAATATTATTC
AACGATTTGGGCGTATATGCAGAAACCTTTCTCATTATCATAGCGGATCTTCTACA
ACAAAGAGTTTGTAT

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Gendarussa vulgaris* LYMOOI 041**

>LYMOOI041_rbcLa_F/rbcLajf635R

CAGAGACTAAAGCAAGTGTTGGATTCAAAGCGGGTGTTAAAGAGTACAAATTGAC
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TAACTCCTCAACCCGGAGTTCCGCCTGAAGAAGCAGGAGCCGCGGTAGCTGCGGA
ATCTTCCACCGGTACATGGACAACCGTGTGGACCGATGGACTTACCAGTCTTGATC
GTTACAAAGGGCGATGCTACAACATCGAGCCCGTTCTTGGCGAAACAGATCAATA
TATCTGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACCAACAT
GTTTACTTCCATTGTGGGAAATGTGTTTGGATTCAAAGCCCTGCGTGCTCTACGTCT
GGAAGATCTTCGAATCCCTCCTGCTTATATTAAAACTTTCCAAGGTCCGCCTCATG
GGATCCAAGTTGAGAGAGATAAGTTGAACAAGTATGGTCGTCCCTTGCTGGGATG
TACTATTAAACCGAAATTGGGGTTATCCGCTAAAAACTATGGTAGAGCGTGTTATG
AATGTCTTCGCGGTGGACTTGATTTTACCAAAGATGATGAGAACGTGAACTCCCAG
CCATTTATGCGTTG

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Rhinacanthus nasutus* LYMOOI 062**

>LYMOOI062_rbcLa_F/rbcLajf635R

CCCCAACAGAGACTAAAGCAAGTGTTGGATTCAAAGCGGGTGTTAAAGAGTACAA
ATTGACTTATTATACTCCTGAATACGAAACCAAAGATACTGATATCTTGGCAGCAT
TCCGAGTAACTCCTCAACCCGGAGTTCCGCCTGAAGAAGCAGGAGCCGCGGTAGC
TGCGGAATCTTCCACCGGTACATGGACAACCGTGTGGACCGATGGACTTACCAGTC
TTGATCGTTACAAAGGGCGATGCTACAACATCGAGCCCGTTCTTGGGGAAACAGA
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ACGTCTGGAAGATCTTCGAATCCCTACTGCTTATATTAAAACTTTCCAAGGTCCGC
CTCATGGGATCCAAGTTGAGAGAGATAAGTTGAACAAGTATGGTCGTCCCCTGCT
GGGATGTACTATTAAACCGAAATTGGGGTTATCCGCTAAAAACTATGGTAGAGCG
TGTTATGAATGTCTTCGCGGTGGACTTGATTTTACCAAAGATGATGAGAACGTGAA
CTCCCAACCATTTATGCGTT

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Ruellia simplex* LYMOOI 056**

>LYMOOI056_rbcLa_F/rbcLajf635R

CAACAGAGACTAAAGCTTTTGTTGGATTCAAAGCGGGTGTTAAAGAGTACAAATT
GACTTATTATACTCCTGAATATGAAACCAAAGATACTGATATCTTGGCAGCATTCC
GAGTAACTCCTCAACCGGGAGTTCCACCTGAAGAAGCAGGGGCCGCGGTAGCTGC
CGAATCTTCCACCGGTACATGGACAACCGTGTGGACCGATGGACTTACCAGCCTTG
ATCGTTACAAAGGGCGATGCTACAACATCGAGCCCGTTCCTGGCGAAGCAGATCA
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CATGGGATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGTCGTCCTCTGCTGG
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TATGAATGTCTTCGCGGTGGACTTGATTTCACCAAAGATGATGAAAACGTGAACTC
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>LYMOOI056_matK_390f/matK_1326r

CTTGGTTCAAACTCTTCGATATAGGGTAAAAGATGCCTCTTCTTTGCATTTATTACG
ATTCCTTATGAACGAGTATTGGAATCTTTTTATTAGGCCAAAGAAAGCCAGTTACT
CTTTTTCAAAAAGAAATCTAAGATTATTCTTATTCTTAGATAATTCTCATGTATGGG
AATATGAATCCATTTTCTTCTTTTTCCGTAACCAATCTTCTCATTTACGATCAACAT
CTTCTGGAGGTTTTCTTGAACGAATCGATTTCCATGGAAAAATAGAACATCTTTTG
AACATCTTTGTTTTTGTTAAGGTTAAGGATTTTCAGGTGAACCTATGGTTGGTCAA
GAAACCTTGCATGCATTATATTAGGTATCAAAGAAGATTCCTCTTGGCTTCAAAAG
GGACGTTCCATTTCATGAATAAATGGAAATGTTACCTTGTCACTTTTTGGCAATGG
CATTTTTCGCTGTGGTTTCATTCAAGAAGGATTTATAGAAAGCAATTATCCAATCA
TTTTCTTGAATTTGTGGGCTATCTTTCACGTGTGCTGATGAAACCTTCAGTCGTACG
GAGCCAAATTCTCGAAAATGCATTTCCAATCAATAATGCCATTAAGAAGTTCGATA
TTCTTATTCCAACTAGTCCTCTGATTGCGTCATTGGCTAAAGCAAAATTTTGTAACG
TATTCGGGCATCCTATTAGTAAGCCAGTTTGGGCTGATTTATCAGATTCTAATATTA
TCGACCGATTTGCGCGTATATGCAGAAATCTTTCTCATTATCATAGCGGATCTTCTA
TAAAAAAGAGTTTGTATCG

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Ruellia simplex* LYMOOI 056**

>LYMOOI056_ITS_5P/ITS_8P

CAATTCGGACAGCGAAGCCGCCCGATTCTCAAGTTGGGCTATTCCCGGTTCGCTCG
CCGTTACTAGGGGAATCCTTGTAAGTTTCTTTTCCTCCGCTTATTGATATGCTTAAA
CTCAGCGGGTAATCCCGCCTGACCTGGGGTCGCGGTCGAAAGCGCCAAGCGCAAT
TTGGGTCATTGGTGAAGCCCGATCGGACGACGCATTAAGGCACGATGGACAGCAA
GCGAGTTGAGCAATCAACCACCACTGGTCGCGACGTGCGTCGCCGAGGGATCCAA
TTTGGGCCAACCGCACCGAAGGTGTACGGGAGGCCAATTTCCGCTCCCGACTCACC
CGCTCTGTTTGAGCGGAGAGGTGGGGGCGACGCGATGCGTGACGCCCAGGCAGGC
GTGCCCTCGGCCCGAAGGCTTCGGGCGCAACTTGCGTTCAAAGACTCGATGGTTCA
CGGGATTCTGCAATTCACACCAAGTATCGCATTTCGCTACGTTCTTCATCGATGCG
AGAGCCGAGATATCCGTTGCCGAGAGTCGTTTTGACATTCAAGATACGCACCATAC
CCCCTTTGCGCACACCGCGTACGGGGCAACATAGGGAGTCGGGCGATTCATTTAG
GTTTTCCTTGGCGCGTTCCGCGCCGGGGTTCGTTAGCCCGCATGTCGTGCCTGGTG
GCACGCCGGCGGGGGGAGGGCCGAGACGGGGAGCATGCGCCCCACACGCCTTGG
CCCCAGCGTAGTTATTCACGTGTTCACGGTCTGCTGTGCAGGTTTCGACAATGATC
CTTCCGCAGGTTCACCTACGGAAACCTTG

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Strobilanthes crispus* LYMOOI 033**

>LYMOOI033_rbcLa_F/rbcLajf635R

ACAGAGACTAAAGCAAGTGTTGGATTCAAAGCGGGTGTTAAAGAGTACAAATTGA
CTTATTATACTCCTGAATATGAAACCAAAGATACTGATATCTTGGCAGCATTCCGA
GTAACTCCTCAACCGGGAGTTCCACCTGAAGAAGCAGGGGCCGCGGTAGCTGCCG
AATCCTCCACCGGTACATGGACAACCGTGTGGACCGATGGACTTACCAGCCTTGAT
CGTTACAAAGGGCGATGCTACAACATCGAGCCCGTTCTTGGCGAAGCAGATCAAT
ACATCTGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACCAACA
TGTTTACTTCCATTGTAGGAAATGTTTTTGGATTCAAAGCCCTGCGTGCTCTACGTC
TGGAAGATCTGCGAATCCCTGTTGCTTATGTTAAAACTTTCCAGGGTCCGCCTCAT
GGGATCCAAAGTGAGAGAGATAAATTGAACAAGTATGGTCGTCCTCTGCTGGGAT
GTACTATTAAACCTAAATTGGGGTTATCCGCTAAAAACTATGGTAGAGCGTGTTAT
GAATGTCTTCGCGGTGGACTTGATTTTACCAAAGATGATGAAAACGTGAACTCTCA
GCCATTTATGCGTT

>LYMOOI033_ITS_5P/ITS_8P

ATAAAAACGACGGGGCCGCGGCGCGTGGGGCGTTTGTTCCCCGCCGTCGGCCCCA
CCCCCTCCCGGCGCGCCATCCGGCGCGACGAGTGGGCTAACGAACCCCGGCGCGG
AACGCGCCAAGGAAAACCGAAACGAAGCCTCCGGCCCCCTCCTCCCGCCCCGTAC
GCGGTGCGCGCGGGAAGGGGGTGCGGTGCGCCTCCTTAATGTCAAAACGACTCTC
GGCAACGGATATCTCGGCTCTCGCATCGATGAAGAACGTAGCGAAATGCGATACT
TGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTCTTTGAACGCAAGTTGCGCCC
GAAGCCTTCGGGCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTCGCCCCC
CTCCTCCGCTCGAAAGATGCGGGTGCGGCGGGGGGCGGATGTTGGCCTCCCGTGC
GTCCTTGTGCGGTTGGCCCAAATTGTATCCCCCGGCGACGCACGTCGCGACCAGTG
GTGGTTGATTGCTCAACTCGCTTGCTGTCCGTCGTGCCCCAGTGCGTCGTCCGACC
GGGCATCACGAAAGACCCAAGGCGCTAGCTGCGCTTCCGACGGCGACCCCAGGTC
AGGCGGGATTACCCGCTGAGTTTAAGCATATCAATAAGCGGAGGAAAAGAAACTT
ACAAGGATTCCCCTAGTAACGGCGAGCGAACCGGGAATAGCCCAACTTGAGAATC
GGGCGGCCCCGCCGTCCGAATTGTA

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Catharanthus roseus* LYMOOI 057**

>LYMOOI057_rbcLa_F/rbcLajf635R

AGAGACTAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGAGTACAAATTGACT
TATTATACTCCTGAATACGAAACCAAAGATACTGATATCTTGGCAGCATTCCGAGT
AACTCCTCAACCTGGAGTTCCACCCGAAGAAGCAGGGGCTGCGGTAGCTGCTGAA
TCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGACTTACCAGCCTTGATCG
TTACAAAGGGCGATGCTACCACATCGAGCCCGTTCCTGGAGAAGAAGATCAATAT
ATTGCTTATGTAGCTTACCCCTTAGACCTTTTTGAAGAAGGTTCTGTTACTAACATG
TTTACTTCCATTGTAGGTAATGTATTTGGGTTCAAAGCCCTACGCGCTCTACGTCTG
GAAGATTTGCGAATCCCTACGGCTTATATTAAAACCTTCCAAGGCCCGCCTCATGG
GATCCAGGTTGAGAGAGATAAATTGAACAAATATGGTCGTCCCCTGTTGGGATGT
ACTATTAAACCTAAATTGGGGTTATCCGCTAAAAACTACGGTAGGGCATGTTATGA
ATGTCTTCGTGGTGGACTTGATTTTACCAAAGATGATGAAAACGTGAACTCCCAAC
CGTTTATGCGT

>LYMOOI057_matK_390f/matK_1326r

AATACCCCACCCCGTTCATCTGGAAATCTTGGTTCAAACCCTTCGCTATTGGGTAA
AAGATGCCCCTTCTTTGCACTTATTACGATTCTTTCTCCGCGAGTATTGGAATTGGA
ATAATCTTATTGCTACAAAGAACCTCAGTTTTGATTTTTTAATAAAAAGAAATCAA
AGATTCTTCTTCTTCTTATATAATTTTTATGTATGTGAATACGAATCCATTTTCGTCT
TTCTCTATAACCAATCTTCTCATTTACGATCAACATCTTTTGGGGTCCTTCTTGAAC
GAATCCATTTCTATGGAAAAATAGAACGTCTTGTCGAAGTATTTGCTAAGGATTTT
CTGGCCAACTTAGGCTTGTTCAAAGATCCTTTCATGCATTATGTTAGGTATCAAGG
AAAATCCATTTTGGTTTCAAAAGGGCCGTCTCTTTGGATAAATAAATGGAAATCTT
ACCTTGTCAACTTTTGGCAATGTTATTTTGACCTGTGGTTTCACTCGGAAAGGGTCT
ATATAAAACAATTGTCCAATCATTCTCTTGACTTTATGGGTTATCTTGTAAATGTGC
GACTAAACCCTTCAATGGTACGGGGTAAAATGCTAGAAAATGCATTTCTAATCAAT
AATGCTATTAAGCAATTCGATACCCTTGTTCCAATTCTTCCTCTGATTAGATCATTG
GCTAAAGCGAAATTTTGTAACCTATTAGGACATCCTATTAGTAAGCTGGTTCGGAC
TGATTTATCAGATTCTGATATTCTGGACAGATTTGGGCGGATATGCAGAAACCTTT
CTCATTAT

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Catharanthus roseus* LYMOOI 057**

>LYMOOI057_ITS_5P/ITS_8P

CAAGGTTTCCGTAGGTGAACCTGCGGAAGGATCATTGTCGAATCCTGTAAAGCAA
ACCGGCGAACTTGTTCTTAACTCGGGCCTCGAGCAAGGGGTCTCTAGGGACTACCT
GCTCGTTGCCCCCTCGGCCTGCCGAGTGCCCTTGGGCAACCGGTCGTGCCTAACAA
CAAACCCCGGCGCGGAAAGCGCCAAGGACTACTCAAGTGGGATTGCCTTCCCTAG
GTCGGCCCGTTCGCGGTGCTGTCCTTGGGAGCTAAGGCACCTTTGTAAACCAAAAC
GACTCTCGGCAACGGATATCTAGGCTCTCGCATCGATGAAGAACGTAGCAAACTG
CGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGT
TGCGCCCGAAGCCATTAGGCCGAGGGCACGTCTGCCTGGGCGTCACGCATCCCGT
CGCCCTCCCCTCGCCTCGTCCATCTGTGGATGACTCGGCGCTTGAGGGAGGACGTA
TATTGGCCTCCCGTGCATTACTCGCGGTTGGCCTAAATCTTGGTCCCTTGCTGCGGA
CGTCACGACAAGTGGTGGTTGAAATCCTCAACTCGAATGCGAGTCGTGACGAGAA
CCGCGGTCTAGGTGTCCGAACGACCCCTGTTGCTAGCCCTTCCCCCTCGAAAGAGC
AGGAGCGCTTGCCACGACTGCGACCCCAGGTCAGGCGGGACTACCCGCTGAGTTT
AAGCATATCAATAAGCGGAGGAAAAGAAACTAACTAGGATTCCCTTAGTAACGGC
GAGCGAACCGGGAAAAGCCCAAGCTTAGAATCGGGCGGCTCCGCC

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Alocasia macrorhiza* LYMOOI 055**

>LYMOOI055_rbcLa_F/rbcLajf635R

ACAGAGACTAAAGCAAGTGCTGGATTCAAAGCTGGTGTTAAAGATTACAAATTGA
CTTATTATACTCCTGACTATGCGACAAAAGATACTGATATCTTGGCAGCATTCCGA
GTAACTCCTCAACCTGGAGTTCCGCCTGAAGAAGCAGGGGCTGCAGTAGCTGCCG
AATCTTCTACTGGTACATGGACAACTGTGTGGACTGATGGACTTACCAGTCTTGAT
CGTTACAAAGGACGATGCTACCACATCGAAGCCGTTCCTGGGGAGGAAAATCAAT
ATATTGCTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACCAACA
TGTTTACTTCTATTGTAGGTAATGTTTTTGGGTTTAAAGCTTTACGAGCTCTACGTC
TAGAAGATTTGCGAATTCCTCCCGCTTATTCCAAAACTTTCCAAGGCCCGCCTCAC
GGTATCCAAGTTGAAAGAGATAAATTGAACAAGTATGGTCGTCCCCTATTGGGAT
GTACGATTAAACCAAAATTGGGATTATCCGCGAAAAACTACGGTAGAGCGGTTTA
TGAATGTCTCCGCGGTGGACTTGATTTTACCAAGGATGATGAAAACGTGAACTCAC
AACCATTTATGCGT

>LYMOOI055_matK_390f/matK_1326r

GAGGACAAATTATCACATTTAAATTGTATATCAGATATACTAATACCTTATCCCGT
ACATCTAGAAATCTTGGTTCAAATTCTACAATGCTGGATACAAGATGTTCCTTATT
TACATTTATTACGATTTTTTTTTCACGAATATTATAATTGGAATAATCTCATTACTC
CAAAGAAATCTAACTATTATGGTTTTTCGAAAGAGAATCCAAGACTTTTTTTGTTC
CTATATAATTCTTATGTAGTTGAATGCGAATTCATATTAGTTTTTCTCCGTAAACAA
TCCTCTTATTTACGATCAACATCTTCTGGAACCTTTCTTGAGCGAACACATTTCTAT
GAAAAAATAGAACAACATCTCGTAGTACTTTGTTGTAATGATTTTCAGAAAACCCT
ATGGTTGTTCAAGGATCCTTTCATACATTATGTTAGATATCAAGGAAAATTAATTC
TGGCTTCAAAAGGGACTCATCTTCTGATGAAGAAATGGAAATCTTACTTTGTCAAT
TTTTGGCAATGTCATTTTCACTTTTGGTCTCAACCCAGTAGGATCCACATAAGCCA
ATTCTCAAACTTTTCTTTCTATTTTCTGGGTTATCTTTCAAGTGTCCTAATAAATCCT
TCAGCGGTAAAGAGTCAAATGCTAGAGAGTTCTTTTTTAATAGATACTGTTACTAA
AAAATTCGAAACTATAGTTCCAATTATTCCAATGATTGGATCATTGTCAAAAGCTA
AATTTTGTAACGTATCGGGGAATCCTATTAGTAAGCCAGTTTGGGCCGATTTGTCG
GATTCTGATATTATTGATCGATTTGGTCGGATATGTAGAAATCTTTCTCATTATTAC
AGTGGGTCTTC

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Rhaphidophora decursiva* LYMOOI 064**

>LYMOOI064_rbcLa_F/rbcLajf635R

CCCAACAGAGACTAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGATTACAAA
TTGACTTATTATACTCCTGACTATGAGACAAAAGATACTGATATCTTGGCAGCATT
CCGAGTAACTCCTCAACCCGGAGTTCCGCCTGAAGAAGCAGGGGCTGCAGTAGCT
GCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACTGATGGACTTACCAGCCT
TGATCGTTACAAAGGACGATGCTACCACATCGAACCCGTTGTTGGGGAGGAAGAT
CAATATATTGCTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACT
AACATGTTTACTTCCATTGTGGGTAATGTATTTGGGTTTAAAGCTTTACGAGCTCTA
CGTCTGGAGGATTTGCGAATTCCTACTTCTTATTCCAAAACTTTCCAAGGCCCGCCT
CACGGCATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGTCGTCCCCTATTGG
GATGTACGATTAAACCAAAATTGGGATTATCCGCGAAAAACTACGGTAGAGCGGT
TTATGAATGTCTCCGCGGTGGACTTGATTTTACCAAGGATGATGAAAACGTGAACT
CACAACCATTTATGCGTT

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Typhonium flagelliforme* LYMOOI 060**

>LYMOOI060_rbcLa_F/rbcLajf635R

CAACAGAGACTAAAGCAAGTGCTGGATTCAAAGCTGGTGTTAAAGATTACAAATT
GACTTATTATACTCCTGACTATGAGACAAAAGATACTGATATCTTGGCAGCATTCC
GAGTAACTCCTCAACCCGGAGTTCCGCCTGAAGAAGCAGGGGCTGCAGTAGCTGC
CGAATCTTCTACTGGTACATGGACAACTGTGTGGACTGATGGACTTACCAGTCTTG
ATCGTTACAAAGGACGATGCTACCACATCGAAGCCGTTCCTGGGGAGGAAAATCA
ATATATTGCTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACCAA
CATGTTTACTTCTATTGTAGGTAATGTTTTTGGGTTTAAAGCTTTACGAGCTCTACG
TCTAGAGGATTTGCGAATTCCTCCCGCTTATTCCAAAACTTTCCAAGGCCCGCCTC
ACGGTATCCAAGTTGAAAGAGATAAATTGAACAAGTATGGCCGTCCCCTATTGGG
ATGTACGATTAAACCAAAATTGGGATTATCCGCGAAAAACTACGGTAGAGCGGTT
TATGAATGTCTCCGCGGTGGACTTGATTTTACCAAGGATGATGAAAACGTGAACTC
ACAACCATTTATGCGTT

>LYMOOI060_matK_390f/matK_1326r

GAGGACAAATTATCACATTTAAATTGTGTATGTGTATCAGATATACTAATACCCTA
TCCCGTACATCTAGAAATTTTGGTTCAAATTCTACAATGCTGGATACAAGATGTTC
CTTCTTTACATTTATTACGATTCTTTTTTCAGGAATATTATAATTGGAATAATCTCA
TTACTCCAAAGAAATCTAACTATTATGGTTTTTCGAAAGATAATCCAAGACTTTTTT
TGTTCCTATATAATTCTTATGTAGTTGAATGCGAATCCATATTAGTTTTTCTCCGTA
AACAATCCTCTTATTTACGATCAACATCTTACGGAATCTTTCTTGAGCGAACACAT
TTCTATGAAAAAATAGAACAACATCTCGTAGTGCTTTGTTGTAATGATTTTCAGAA
AACCCTATGGTTGTTCAAGGATCCTTTCATACATTATGTTAGATATCAAGGAAAAT
CAATTCTGGCTTCAAAAGGGACTCATCTTCTGATGAAGAAATGGAAATCTTACTTT
GTCAATTTTTGGCAATGTCATTTTCACTTTTGGTCTCAACCCAGTAGGATCCACATA
AGCCAATTCTCAAAATTTTCTTTCCACTTTCTGGGTTATCTTTCAAGTGTCCCCAAA
AATCCTTTAGCGGTAAAGAGTCAAATGCTAGAGAGTTCTTTTTTTATAGATACTGT
TACTAAAAAATTCGAAACTATAGTTCCAATTATTCCAATGATTGGATCATTGTCAA
AAGCGAAATTTTGTAACGTATCGGGGAATCCTATTAGTAAGCCGGTTTGGGCCAAT
TTGTCAGATTCTGATATTATTGATCGATTTGGTCGTATATGTAGAAATCTTTCTCAT
TATTACAGT

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Calotropis gigantea* LYMOOI 007**

>LYMOOI007_rbcLa_F/rbcLajf635R

AGAGACTAAAGCAAGTGTTGGATTCAAAGCCGGTGTTAAAGAGTACAAATTGACT
TATTATACTCCTGAATACGAAACAAAAGATACTGATATCTTGGCAGCATTCCGAGT
AACTCCTCAACCCGGAGTTCCACCTGAAGAAGCAGGGGCCGCGGTAGCTGCCGAA
TCTTCTACTGGTACATGGACAACTGTTTGGACCGATGGACTTACCAGCCTTGATCG
TTACAAAGGGCGATGCTACCACATCGAGGCCGTTCCTGGAGAAGAAGATCAATAT
ATTGCTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACTAACATG
CTTACTTCCATTGTAGGTAATGTATTTGGGTTCAAAGCCCTACGCGCTCTACGTCTG
GAAGATTTGCGAATCCCTCCGGCTTATATTAAAACCTTCCAAGGCCCGCCGCATGG
CATCCAGGTTGAGAGAGATAAATTGAACAAATACGGTCGTCCTCTGTTGGGATGT
ACTATTAAACCAAAATTGGGGTTATCAGCTAAAAACTATGGTAGAGCGGTTTATG
AATGTCTTCGTGGTGGACTTGATTTTACCAAAGATGATGAAAACGTGAACTCCCAA
CCGTTTATGCGTTG

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Gynostemma pentaphyllum* LYMOOI 039**

>LYMOOI039_rbcLa_F/rbcLajf635R

CAACAGAGACTAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGATTATAAATT
GACTTATTATACTCCTGACTATGAAACCAAAGATACTGATATCTTGGCAGCATTCC
GAGTAACTCCTCAACCCGGAGTTCCACCCGAGGAAGCAGGGGCCGCTGTAGCTGC
TGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGGCTTACCAGTCTTG
ATCGTTACAAAGGACGATGCTACGACATCGAGCCTGTTGCTGGAGAAGAAAATCA
ATTTATTGCTTATGTAGCTTATCCCTTAGACCTTTTTGAAGAAGGTTCTGTTACTAA
CATGTTTACTTCCATTGTGGGTAATGTTTTTGGGTTCAAGGCCCTGCGCGCTCTACG
TCTGGAGGATTTGCGAATCCCTCCTGCTTATTCTAAAACTTTCCAAGGCCCGCCTC
ATGGTATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGCCGCCCCCTATTGGG
ATGTACTATTAAACCAAAATTGGGATTATCCGCTAAGAATTATGGTAGAGCAGTTT
ATGAATGTCTACGCGGTGGACTTGATTTTACCAAAGATGACGAAAACGTGAATTCC
CAACCATTTATGCGTT

>LYMOOI039_ITS_5P/ITS_8P

GTAACAAGGTTTCCGTAGGTGAACCTGCGGAAGGATCATTGTCACACCTGAACAA
ATGAACGACCCGCGAACGTGTTTACGAATCGGGGGTGGGGCGGTCCTCTGCGGCC
GTCGCACCCCTCGCTTCGGGGGGGATCGTGCGTGCACGCCCCCCCTCGACGCTACA
AACAAAACCCCGGCGCAGACCGCGCCAAGGAATCATAATGAGATCGCTTGCCCCC
GACCCCGGTCTCGGTGTGTCGGGGGCGATGCATTCTGTCGTATTTACAACGACTCT
CGGCAACGGATATCTCGGCTCTCGCATCGATGAAGAACGTAGCGAAATGCGATAC
TTGGTGTGAATTGCAGGATCCCGCGAACCACCGAGTCTTTGAACGCAAGTTGCGCC
CGGAGCCATCCGGCCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCTGCCCCCA
CAAACCCCCCCTCCACTGTTTAACGATTTTGGAGGAGGTGGGATGTTGGGGCACAT
ATTGGCCTCCCGCACGCACCGTCGCGCGGATGGCTTAAATTCGAGTCCTCGGCGCC
TGTCGTCGTGACAACACGGTGGTTGATTTATCATTCGCACGTGTCGCGATCCCAGT
TGCGCGTTCATGAGGCCTCCTTCATGGTAGCTGTCATCAAAACTCTTACCGTACGA
GCGAAGGCCGTCCTGAAAAGGATGACCATCCTCTCGACGCGACCCCAGGTCAGGC
GGGACTACCCGCTGAGTTTAAGCATATCAATAAGCGGAGGAAAAGAAACTTACAA
GGATTCCCCTAGTAACGGCGAGCGAACCGGGAATAGCCCAGCTTGAAAATCGGG
CGCCCTCGGCGTTCGAATTGTAGT

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Cycas revoluta* LYMOOI 053**

>LYMOOI053_rbcLa_F/rbcLajf635R

AACAGAGACTAAAGCAAGTGTTGGATTTAAAGCTGGTGTTAAAGATTACAGATTA
ACTTATTACACTCCTGAATATCAAACCAAAGATACCGATATCTTAGCAGCGTTCCG
AGTAACTCCTCAACCTGGAGTGCCGCCTGAGGAAGCGGGAGCTGCAGTAGCCGCT
GAATCTTCCACTGGTACATGGACCACTGTTTGGACCGATGGACTTACCAGTCTCGA
TCGTTACAAGGGGCGATGCTATGACATCGAGCCCGTTCCTGGGGAGGAAAATCAA
TTTATTGCCTATGTAGCTTACCCCTTAGACCTCTTTGAAGAAGGTTCTGTTACTAAC
ATGTTCACTTCCATTGTAGGTAATGTATTTGGATTCAAAGCCCTACGAGCTCTACG
CCTAGAAGATTTGCGAGTTCCTCCTGCTTATTCCAAAACTTTCCAAGGTCCACCTC
ATGGTATCCAAGTTGAAAGAGATAAATTAAACAAATATGGCCGTCCTCTATTGGG
ATGTACCATTAAACCCAAATTGGGTTTATCTGCCAAAAACTATGGTAGAGCAGTTT
ATGAATGTCTTCGTGGTGGACTTGATTTTACCAAAGATGATGAGAACGTAAATTCC
CAACCATTTATGCGTT

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Kyllinga brevifolia* LYMOOI 005**

>LYMOOI005_rbcLa_F/rbcLajf635R

AGAGACTAAAGCTAGTGTTGGGTTTAAAGCAGGGGTTAAAGATTACAAACTTACT
TATTATACTCCTGAGTACGAAACCAAAGATACTGATATCTTGGCAGCGTTCCGAGT
AACTCCTCAACCTGGAGTCCCTCCTGAAGAAGCAGGAGCTGCAGTAGCGGCGGAA
TCTTCTACTGGTACATGGACAACTGTTTGGACTGATGGACTTACCAGTCTTGATCG
TTACAAAGGGCGATGCTATCATATCGAACCTGTTGCTGGAGAAGAAAATCAATAT
ATTGCCTATATAGCTTATCCTTTAGACCTTTTCGAAGAAGGTTCTGTTACTAACATG
TTTACTTCTATTGTAGGTAATGTATTTGGTTTCAAAGCCTTACGAGCTCTACGCTTG
GAAGACTTACGAATTCCTCCTGCTTATTCAAAAACTTTCCAAGGTCCACCTCACGG
TATCCAAGCTGAAAGAGATAAGTTGAACAAGTATGGTCGTCCTCTATTGGGATGTA
CTATTAAACCAAAATTGGGATTATCCGCAAAGAATTACGGTAGAGCATGTTATGA
ATGTCTACGTGGTGGACTTGATTTTACCAAAGATGATGAAAACGTAAACTCACAAC
CATTTATGCGTTG

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Dioscorea bulbifera* LYMOOI 018**

>LYMOOI018_rbcLa_F/rbcLajf635R

CAACAGAGACTAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGATTATAAATT
GACTTATTATACTCCTGACTACGAAACCAAAGATACTGATATCTTAGCGGCATTCC
GAGTAACTCCTCAACCTGGGGTTCCGCCCGAAGAAGCAGGAGCTGCAGTAGCCGC
CGAATCGTCCACCGGTACATGGACAACTGTGTGGACTGATGGACTTACCAGTCTTG
ATCGTTACAAAGGACGATGCTACCACATCGAGAGCGTTGTTGGGGAGGAAGACCA
ATATATTGCTTATGTAGCTTATCCTTTAGACCTTTTTGAGGAAGGTTCTGTTACCAA
TATGTTTACTTCCATTGTAGGTAATGTATTTGGTTTCAAAGCCCTACGAGCCCTACG
TCTGGAGGATCTGCGAATTCCTACTTCTTATTCCAAAACTTTCCAAGGCCCACCGC
ATGGCATCCAAGTTGAAAGAGATAAGTTGAACAAGTACGGCCGTCCCCTATTGGG
ATGCACTATTAAACCAAAATTGGGGTTATCCGCAAAGAACTACGGCAGAGCCGTT
TATGAATGTTTACGTGGTGGACTTGATTTTACCAAGGATGATGAAAATGTGAACTC
ACAACCATTTATGCGTT

>LYMOOI018_matK_390f/matK_1326r

TCTTAGAGGATAAATCATCACATTTAAATTATGTGTCAGATATATTAATACCCCAT
CCCATCCATCTGGAAATCCTGGTTCAAATACTTCAATGCTGGACTCAAGATGTTTC
CTCTTTGCATTTATTGCGATTCTTTCTCCACGAATATCATAATTCGAATAGTTTCAT
TACTCCGAAAAAACCTATTTACGTGATTTCAATTTCAAAAGAAAATAAAAGATTTT
TTCGATTCCTATATAATTCTTATGTATTTGAATGTGAATTTGTATTAGTTTTTTTTCA
TAAACAATCCTCTTATTTACGATCAAGGTCCTCTGGAGTCTTTCTTGAGCGAACAC
ATTTCTATGGAAAAATGGGGCATTTTTTAGTAGTGTGTTGTAATTATTTTCAGAAG
ACCCAATGGTTCTTCAAAGATCCTTTTCTGCATTATGTTCGATATCAAGGAAAAGC
AATTCTGGTGTCAAAGGGAACTCGTCTTTTGATGAGGAAATGGAGATCTTACCTTG
TCCATTTTTGGCAATATTATTTTCAATTTTGGTCTCATCCGCATAGGATTCATATAA
ACCAATTATCAAATTATTCCTTCTGTTTTCTGGGTTATCTTTCAAATGTACTAATAA
ATTTTTCCGCGGTAAGGAGTCAAATGCTAGAAAATGCATTTGTAATAGATACTCTT
ACTAAGAAATTTGATACCAGAGTTTCAGTTATTGCTCTTATTCGATCATTGTCTAAA
GCGAAATTTTGTACCGTATCCGGGCATCCTATTAGTAAGTCAATATGGACAAATTT
ATCAGATTTGGATATTATTCATCGATTTGGTTGGATATGTAGAAATCTTTCTCATTA
TCACAGTGGATCCTCAAAAAAACAGAGTTTGTATAGAATAAAGTATATACTT

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Ocimum basilicum* LYMOOI 040**

>LYMOOI040_rbcLa_F/rbcLajf635R

AACAGAGACTAAAGCAAGTGTTGGATTCAAAGCGGGTGTTAAAGAGTACAAATTG
ACTTATTATACTCCTGAATACGAAACCAAAGATACTGATATCTTGGCAGCATTCCG
AGTAACTCCTCAACCTGGAGTTCCGCCTGAAGAAGCAGGGGCCGCGGTAGCTGCC
GAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGACTTACCAGCCTTGA
TCGTTACAAAGGGCGATGCTACCACATCGAGCCCGTTGTTGGAGAAAAAGATCAA
TATATCTGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACTAAC
ATGTTTACTTCCATTGTAGGAAATGTATTTGGATTCAAAGCCCTACGTGCTCTACGT
CTGGAAGATCTGCGAATTCCTCCTGCTTATGTTAAAACTTTCCAAGGCCCGCCTCA
TGGGATCCAAGTTGAGAGAGATAAATTGAACAAGTACGGTCGTCCTCTGCTGGGA
TGTACTATTAAACCTAAATTGGGATTATCTGCTAAAAACTATGGTAGAGCGGTTTA
TGAATGTCTTCGCGGTGGACTTGATTTTACCAAAGATGATGAGAACGTGAACTCCC
AGCCATTTATGCGTTG

>LYMOOI040_matK_390f/matK_1326r

TATTCCCTTTTTAGAGGACAATTTTTCACATTTAAATTTTGTATTAGATATACTAAT
ACCTCACTCTGTCCATGTGGAAATCTTGATTCAAACTCTTCGCTATTGGGTAAAAG
ATGTTTCTTCTTTGCATTTATTACGAGTTTTTCTCAATCAATATTGTAGTCTTATTAC
TTCAAAGAAAGTCAGCTCCTCTTTGTCAAAAAGAAATCAAAGATTCTTTTTTTTCTT
ATATAATTCTCATGTATGTGAATACGAATCTATTTTCGTCTTTCTACGTAACCAATC
TTTTCATTTACGATCAACATCTTCTGGAGTTCTTCTTGAACGAATCTATTTCTATAT
AAAAATAGAACGTCTTGTGAACGTCTTTGTTAAGGATTTTCGGGCGAACCTACGGT
TGGTCGAGGAACCCTGCATGCATTATATTAGGTATCAAGGAAAATCCATTCTGGCT
TCAAAAGGGACATCTCTTTTCATGAATAAATGGAAATTTTACCTTGTCACTTCTTG
GGAATGGCATTTTTTGGTGTGGTTTCATCCAAGAAGGATTTGTATAAACCAATTTT
CCAGGCATTCCCTTGAAATTTTTGGCTATCTTTCAAACGTGCAAACGGACCCTTCC
GTGGTACGGAGTCAGATTCTAGAAAATGCATTTCTAATCAATAATGCTATTAGGAA
GCTCGATACCCTTGTTCCAATTATTCCTCTGATTGCGAAATTGGCTAAAGAGAAAT
TTTGTAACGTATTGGGGCATCCCAGTAGTAAGCCGATTTGGGCTGATTTATCAGAT
TCTAATATTATTGACCGATTTGGGCGTATATGCAGAAATATTTCTCATTATCATAGC
GGATCTTCCAAAAAAAAGAGTTTGTATCGAATAAAGTATATACTTC

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Orthosiphon aristatus* LYMOOI 029**

>LYMOOI029_rbcLa_F/rbcLajf635R

AGAGACTAAAGCAAGTGTTGGATTCAAAGCGGGTGTTAAAGAGTACAAATTGACT
TATTATACTCCTGAATACGAAACCAAAGATACTGATATCTTGGCAGCATTCCGAGT
AACTCCTCAACCTGGAGTTCCGCCTGAAGAAGCAGGGGCCGCGGTAGCTGCCGAA
TCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGACTTACCAGCCTTGATCG
TTACAAAGGGCGATGCTACAACATCGAGCCCGTTGTTGGAGAAAAAGATCAATAT
ATCTGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACTAACATG
TTTACTTCCATTGTAGGAAATGTATTTGGATTCAAAGCCCTACGTGCTCTACGTCTG
GAAGATCTGCGAATTCCTGTTGCTTATGTTAAAACTTTCCAAGGCCCGCCTCATGG
GATCCAAGTTGAGAGAGATAAATTGAACAAGTACGGTCGTCCTCTGCTGGGATGT
ACTATTAAACCTAAATTGGGGTTATCTGCTAAAAACTATGGTAGAGCGGTTTATGA
ATGTCTTCGCGGTGGACTTGATTTTACCAAAGATGATGAGAACGTGAACTCCCAGC
CATTTATGCGTTA

>LYMOOI029_matK_390f/matK_1326r

CCCTTTTTAGAGGACAATTTTTCACATTTAAATTTTGTGTTAGATATACTAATACCT
CACTTTGTCCATGTGGAAATCTTGATTCAAACTCTTCGCTATTGGGTAAAAGATGT
TTCTTCTTTGCATTTATTACGAGTTTTTCTCAACCAATATTGTAGTCTTATTACTTCA
AAGAAAGTCAGCTCCTCTTTGTCAAAAAGAAATCAAAGATTCTTTTTTTTCTTATAT
AATTCTCATGTATGTGAATACGAATCTATTTTCGTCTTTCTACGTAACCAAACTTTT
CATTTACGATCAACATCTTCTGGAGTTCTTCTTGAACGAATCTATTTTTATATAAAA
ATAGAACGTCTTGTGAACGTCTTTGTTAAGGACTTTCGGGCGAACCTATGGTTGGT
CGAGGAACCCTGCATGCATTATATTAGGTATCAAGGAAAATCCATTCTGGCTTCAA
AAGGGACATCTCTTTTCATGAATAAATGGAAATTTTACCTTGTCACTTTTTGGGAA
TGGCATTTTTTGGTGTGGTTTCATCCAAGAAGGATTTGTATAAACCAATTTTCCAA
GCATTCCCTTGAAATTTTTGGCTATCTTTCAAACGTGCAAACGGGCCCTTCCGTGGT
ACGGAGTCAGATTTTAGAAAATGCATTTCTAATCAATAATGCTATTAAGAAGCTCG
ATACCCTTGTTCCAATTATTCCTCTGATTGCGAAATTGGCTAAAGAGAAATTTTGT
AACGTATTGGGGCATCCCATTAGTAAGCCGATTTGGGCTGATTTATCAGATTCTAA
TATTATTGACCGATTTGGGCGTATATGCAGAAATATTTCTCATTATCATAGCGGAT
CTTCCAAAAAAAAGAGTTTGTATCGAATAAAGTATATACTTC

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Orthosiphon aristatus* LYMOOI 029**

>LYMOOI029_ITS_5P/ITS_8P

AACAAGGTTTCCGTAGGTGAACCTGCGGAAGGATCATTGTCGAAACCTGCAAAGC
AGACCGCGAACACGTTTCTAACTCACTCTCCCGCCGGCGCGGGCGCACCCGTGCCT
TGCGTCGTGCGGGCTAACGAACCCCGGCGCGGAATGCGCCAAGGAAAACCGAACG
TAGCGTCGGCCCCCCTCGCCCCGTTTGCGGGTCGTGCGGGGGGCGCGGACGTCTAT
CGAATGTCAAAACGACTCTCGGCAACGGATATCTCGGCTCTCGCATCGATGAAGA
ACGTAGCGAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGT
CTTTGAACGCAAGTTGCGCCCGAAGCCATTAGGCCGAGGGCACGTCTGCCTGGGC
GTCACGCATCGCGTCGCCCCCCTCCCCGCGCTCTGCGCTCGGGACGGGGGACGGAT
ATTGGCCTCCCGTGCGCCCCGTCGTGCGGCCGGCCCAAATGCGATCCCCCGGCGAC
TCGCGTCGCGACAAGTGGTGGTTGAACATCTCAATCTCGCGTCTCGTCGCGCCGCC
GAATCGTCCGTACGGGCATCGAAATTGACCCAAAGGCGTGGCCCCCGAGCCACGC
TCTCGACCGCGACCCCAGGTCAGGCGGGATTACCCGCTGAGTTTAAGCATATCAAT
AAGCGGAGGAAAAGAAACTTACAAGGATTCCCCTAGTAACGGCGAGCGAACCGG
GAATAGCCCAACTTGAGAATCGGGCGGCCACGCCGTCCGAATTGT

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Vitex trifolia* LYMOOI 006**

>LYMOOI006_rbcLa_F/rbcLajf635R

CAACAGAGACTAAAGCAAGTGTTGGATTCAAAGCGGGTGTTAAAGAGTACAAATT
GACTTATTATACTCCTGAATACGAAACCAAAGATACTGATATCTTGGCAGCATTCC
GAGTAACTCCTCAACCCGGAGTTCCGCCTGAAGAAGCAGGGGCCGCGGTAGCTGC
CGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGACTTACCAGCCTTG
ATCGTTACAAAGGGCGATGCTACCACATCGAGCCCGTTCTTGGAGAAAAAGATCA
ATATATCTGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACTAA
CATGTTTACTTCCATTGTAGGAAATGTATTTGGATTCAAAGCCCTGCGTGCTCTAC
GTCTGGAAGATCTGCGAATCCCTACTGCTTATATTAAAACTTTCCAAGGCCCGCCT
CATGGGATCCAGGTTGAGAGAGATAAATTGAACAAGTATGGTCGTCCTCTGTTGG
GATGTACTATTAAACCAAAATTGGGGTTATCTGCTAAAAACTATGGTAGAGCAGTT
TATGAATGTCTTCGCGGTGGACTTGATTTTACCAAAGATGATGAGAACGTGAACTC
CCAGCCATTTATGCGTT

>LYMOOI006_matK_390f/matK_1326r

CCCTTTTAGAGGACAATTTTTCACATTTAAATTTTGTGTTAGATATACTAATACCTC
ACCCCGTCCATGTGGAAATCTTGGTTGAAACTCTTCGCTATTGGGTAAAAGATGCT
TCTTCTTTGCATTTATTACGAGTCTTTCTCAACGAATATTGTAATTGGAATAGTCTT
ATTACTCCAAAGAAAGCCAGTTCCTCTTTTTCAAAAAGAAATCAAAGATTAGTCTT
ATTCTTATATAATTCTCATGTATGTGAATACGAATACATTTTCGTCTTTCTACGTAA
CCAATCTTTTCATTTACGATCAACATCTTCTGGAGTTCTTCTTGAACGAATCTATTT
CTATGTAAAAATAGAACGTCTTGTGAACGTCTTTGTTAAGGATTTTTGGTCGAACC
TATGGTTGGTCAAGGAACCTTGCATGCATTATATTAGGTATCAAAGAAAATCCATT
CTGGCTTCAAAAGGAACATCTCTTTTCATGAATAAATGGAAATTTTACTTTGTCAC
TTTTTGGCAACGGCATTTTTCGCTGTGGTTTCATCCAAGAAGGATTTATATAAACC
AATTATCCAATCATTCCCTTGCATTTTTGGGCTATCTTTCAAGCGTGCGAATGAACC
CTTCCGTGGTACGGAGTCAAATTCTAGAAAATTCATTTCTAATCAATAATGCTATT
AAGAAGTTCGATACCCTTGTGCCAATTATTCCTCTGAGTGCGTCATTGGCTAAAGC
AAAGTTTTGTAACGTATTAGGGCATCCCATTAGTAAGCCGATTCGGGCGGATTTAT
CGGATTCTAATATTATTGACCGATTTGGGCGTATATGCAGAAATCTTTCTCATTATC
ATAGCGGATCTTCCAAAAAAAAGAGTTTGTATCGAATAAAGTATATACTTC

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Mentha spicata* LYMOOI 004**

>LYMOOI004_rbcLa_F/rbcLajf635R

CAGAGACTAAAGCAAGTGTTGGGTTCAAAGCGGGTGTTAAAGAGTACAAATTGAC
TTATTATACTCCTGAATACGAAACCAAAGATACTGATATCTTGGCAGCATTCCGAG
TAACTCCTCAACCCGGAGTTCCGCCTGAAGAAGCAGGGGCCGCGGTAGCTGCCGA
ATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGACTTACCAGCCTTGATC
GTTACAAAGGGCGATGCTACCACATTGAGCCCGTTCCTGGAGAAAAAGATCAATA
TATCTGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACTAACAT
GTTTACTTCCATTGTAGGAAATGTATTTGGATTCAAAGCCCTACGTGCTCTACGTCT
GGAAGATCTGCGAATTCCTGTTGCTTATGTTAAAACTTTCCAAGGCCCGCCTCATG
GGATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGTCGTCCTCTGCTGGGATG
TACTATTAAACCTAAATTGGGGTTATCTGCTAAAAACTACGGTAGAGCGGTTTATG
AATGTCTTCGCGGTGGACTTGATTTTACCAAAGATGATGAGAACGTGAACTCCCAG
CCATTTATGCGTTG

>LYMOOI004_matK_390f/matK_1326r

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CTTTCTCAACGAATATTGGAATTGGAATAGTCTTCTTACTCCAAAGAAAGTCAGCT
TCTCTTTGTCAAAAAGAAATCAAAGGTTATTTTTTTTCTTATATAATTCTCATGTAT
GTGAATACGAATCTATTTTCGTCTTTCTACGTAACCAATCTTTTCATTTACGATCAA
CATCTTCTGGAGTTCTTCTTGAACGAATCTATTTCTATATAAAAATAGAACGTCTTA
TGAACGTCTTTGTTAAGGATTTTCGGGCGAACCTATGGTTGGTCGAGGAACCCTGC
ATGCATTATATTAGGTATCAAAGAAAATCCATTCTGGCTTCCAAAGGGACATCCCT
TTTCATGAATAAATGGAAATTAAACCTTGTCACTTTTTGGCAATGGCATTTTTCTGT
GTGGTTTCATCCAAGAAGGATTTGGATAAACCAATTTCCCAAGCATTCCCTTGAAA
TTTTGGGTTATCTTTCAAACGTGCAAATGAACCCTTCCGTGGTACGGAGTCAAATT
CTAGAAAATTCATTTCTAATCAATAATGCTATTAAGAAGCTCGATACTCTTGTTCC
AATTATTCCTCTGATTGCGGAATTGGCTAAAGCTAAATTTTGTAATGTATTGGGGC
ATCCCATTAGTAAGCCGATTCGGGCTGAGTTATCAGATTCTAATATTATTGACCGA
TTTTCACGTATATGCAGAAATATTTCTCATTATCATAGCGGATCTTGCAAAAAAAG
GAGTTTGTATCGAATAAAGTATATACTTCG

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Plectranthus amboinicus* LYMOOI 061**

>LYMOOI061_rbcLa_F/rbcLajf635R

CAACAGAGACTAAAGCAAGTGTTGGATTCAAAGCGGGTGTTAAAGAGTACAAATT
GACTTATTATACTCCTGAATACGAAACCAAAGATACTGATATCTTGGCAGCATTCC
GAGTAACTCCTCAACCTGGAGTTCCGCCTGAAGAAGCAGGGGCCGCGGTAGCTGC
CGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGACTTACCAGCCTTG
ATCGTTACAAAGGGCGATGCTACCACATCGACCCCGTTCTTGGAGAAAAAGATCA
ATATATCTGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACTAA
CATGTTTACTTCCATTGTAGGAAATGTATTTGGATTCAAAGCCCTACGTGCTCTAC
GTCTGGAAGATCTGCGAATTCCTACTGCTTATATTAAAACTTTCCAAGGCCCGCCT
CATGGGATCCAAGTTGAGAGAGATAAATTGAACAAGTACGGTCGTCCTCTGCTGG
GATGTACTATTAAACCTAAATTGGGGTTATCTGCTAAAAACTATGGTAGAGCGGTT
TATGAATGTCTTCGCGGTGGACTTGATTTTACCAAAGATGATGAGAACGTGAACTC
CCAGCCATTTATGCGTT

>LYMOOI061_matK_390f/matK_1326r

ACATTTAAATTTTGTATTAGATATACTAATACCTCACTCTGTTCATGTGGAAATCTT
GATTCAAACTCTTCGCTATTGGGTAAAAGATGTTTCTTCTTTGCATTTATTACGAGT
CTTTCTCAACCAATATTGTAGTCTTATTACTCCAAAGAAAGTCAGCTCCTCTTTGTC
AAAAAGAAATCAAAGATTATTTCTTTTCTTATATAATTCTCATGTATGTGAATACG
AATCTATTTTCGTCTTTCTACGTAACCAATCTTTTCATTTACGATCAACATCTTCTG
GAGTTTTTCTTGAACGAATTTATTTCTATATAAAAATAGAACGTCTTGTGAACGTCT
TTGTTAAGGATTTTCGGGCGAACCTATGGTTGGTCGAGGAACCCTGCATGCATTAT
ATTAGGTATCAAGGAAAATGCATTCTGGCTTCAAAAGGGACATCTCTTTTCATGAA
TAAATGGAAATTTTACCTTGTCACTTTTTGGCAATGGCATTTTTTGGTGTGGTTTCA
TCCAAGAAGGATTTGTATAAACCAATTTTCCAAGCATTCCCTTGAAATTTTTGGCT
ATCTTTCAAACGTGCAAACGGGCCCTTCCGTGGTACGGAGTCAGATTCTAGAAAAT
GCATTTCTAATCAATAATGCTATTAAGAAGCTCGATACCCTTGTTCCAATTATTCCT
CTGATTGTGAAATTGGCTAAAGAGAATTTTTGTAACGTATTGGGGCATCCCATTAG
TAAGCCGATTTGGGCTGATTTATCAGATTCTAATATTATTGACCGATTTGGGCGTA
TATGCAGAAAAATTTCTCATTATCATAGCGGATCTTCAAAAAAAAAGAGTTTGTAT
CGAATAAAGTATATAC

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Punica granatum* LYMOOI 070**

>LYMOOI070_rbcLa_F/rbcLajf635R

CAACAGAGACTAAAGCAAGTGTTGGATTCAAAGCCGGTGTTAAAGATTATAAACT
GACTTATTATACTCCTGAATATGAAACCAAAGATACTGATATCTTGGCAGCATTCC
GAGTAACTCCTCAACCTGGAGTTCCGCCTGAGGAAGCAGGGGCTGCAGTAGCCGC
TGAATCTTCTACTGGTACCTGGACAACTGTGTGGACCGATGGGCTTACCAGCCTTG
ATCGTTATAAAGGAAGATGCTACCACATCGAGCCTGTTGCTGGAGAAGAAAATCA
ATATATATGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACTAA
TATGTTTACTTCCATTGTGGGTAATGTATTTGGGTTCAAAGCCCTGCGCGCTCTACG
TCTGGAGGATCTGAGAATCCCTACTGCATATACTAAAACTTTCCAAGGCCCGCCTC
ATGGTATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGTCGTCCCCTATTGGG
ATGTACTATTAAACCTAAATTGGGGTTATCCGCTAAGAACTACGGTAGAGCGGTTT
ATGAATGTCTTCGTGGTGGACTTGATTTTACGAAGGATGATGAGAACGTGAACTCA
CAACCATTTATGCGTT

>LYMOOI070_matK_390f/matK_1326r

TCCTTTTCTAGAGGACCAATTTTCACATTTAGATTATGTGTCAGATGTATTAATACC
CTCCTTTTCTAGAGGACCAATTTTCACATTTAGATTATGTGTCAGATGTATTAATAC
CCTATCCTATCCATTTTGAAATCTTGGTTCAAACCCTTCGCTACTGGGTGAAGGAT
GCCTCTTCTTTACATTTATTACGTTTCTTTTTCTACGAGTATTGTAATTGGAATAGTC
TTATTACTCCCCAAAAACATATTTCCATTTTTGTAAAAGGTAATCCAAGATTATTCT
TGTTCCTATATAATTCTTATGCATGTGAATACGAATCCATCTTCCTTTTTCTCCGTA
ATCAATCTTCTCATTTCCGGTCAACATCTTCTGGAGTCTTTTTTGAGCGAATATATT
TCTATGTAAAAATAGAACATCTTGTTGAAGTTTTTTTTGATAATGATTTTCGGGACA
TTCGATCCTTCTTCAAGGATTCTTTCATGCATTATGTTAGATATCAAGGAAAATCA
ATTCTGGCTGCAAAAGATACACCTTTTCTGATGAATAAATGGAAATATTACCTTGT
CAATTTATGGCAATATCATTTTTACGTGTGGTCTCAACCAGGAAGGATCAATCTAA
ACCAATTAGGCAAGTATTCTCTTGACTTTTTGGGCTATTTTTCAAACGTGCAACTAA
CTTTTTCAGTAGTACGAAGTCAAATGCTAGAAAATTCATTTATAATAAATACTGTT
ATGAAGAAGCTCGAAACAATAGTTCCAATTATTCCTTTGATTGGATCCTTGTCTAA
AGCGAAATTTTGTAACGTATTAGGGTATCCCGTTAGTAAGTCGACCCGGACTGATT
CATCAGATTCTGATATTATCGACCGATTTGTGCGTATATGCAGAAATCTTTCTCATT
ATCACAGCGGATCCTCAAAAAAAAAGAGTTTATATCGAATAAAGTATATACTTC

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Hibiscus mutabilis* LYMOOI 045**

>LYMOOI045_rbcLa_F/rbcLajf635R

ACAGAGACTAAAGCAGGTGTTGGATTCCAAGCCGGTGTTAAAGAGTATAAATTGA
CTTATTATACTCCTCAATATGAAGTCAAAGATACTGATATCTTGGCAGCCTTCCGA
GTAACTCCTCAACCCGGAGTTCCGCCTGAGGAAGCAGGGGCCGCGGTAGCTGCTG
AATCTTCTACTGGTACATGGACAACCGTGTGGACCGATGGGCTTACCAGCCTTGAT
CGTTACAAAGGGCGATGCTACCACATTGATCCCGTTCCTGGAGAAGACGATCAAT
ATATATGTTATGTAGCTTACCCCTTAGACCTTTTTGAAGAAGGTTCTGTTACTAACA
TGTTTACTTCCATTGTGGGTAATGTATTTGGGTTCAAAGCCCTGCGCGCTCTACGTC
TAGAGGATCTGCGAATCCCTACTGCTTATATTAAAACTTTCCAAGGCCCGCCTCAT
GGCATCCAGGTTGAAAGAGATAAATTGAACAAGTATGGTCGCCCCCTATTAGGAT
GTACTATTAAACCTAAATTGGGGTTATCCGCTAAGAACTACGGTAGAGCAGTTTAT
GAATGTCTACGCGGCGGACTTGATTTTACCAAAGATGATGAGAATGTGAACTCCC
AACCATTTATGCGTTG

>LYMOOI045_ITS_5P/ITS_8P

CCTGCGGAAGGATCATTGTCGAGACCTGCACAGCAGAACGACCCGCGAACGTGTT
ATCAACAAACAATGGGAGCGGGTGCGGCGGCATCCTTGCACGTCGTCCCCTCCTTG
CCTCGGAGCCCCGTTCCGCTGTCTCCCCCATGCCGCAAGGTGTTGCGGGAGGGGCG
ACCCCGTGTCTCCGGGGCCAAACGAACAACCCCCGGCGCGAATCGCGCCAAGGAA
ATGGAATGAAAAGGTGCGCGTACCCTGTCGCCGCCCCGTTCGCGGCGCGCGTGCG
GCAGGGACGCTGCAACTTCGTCGTGAATACACAAAACGACTCTCGGCAACGGATA
TCTCGGCTCTCGCATCGATGAAGAACGTAGCGAAATGCGATACTTGGTGTGAATTG
CAGAATCCCGTGAACCATCGAGTCTTTGAACGCAAGTTGCGCCCCAAGCCATTAG
GCCGAGGGCACGTCTGCCTGGGTGTCACGCATCGTTGCTCCCATCCAACCCTTACC
CACGGGGTAATCGGTTGAGGTGTGGGCGGACAATGGCCTCCCGTGCGCACACCGC
TCGCGGTTGGCCTAAAATCGAGTCATCGGCGACCAAGGTGCCGCGACGATCGGTG
GTAATGCTTCGAGCTGCCTCGTTTCTAGTCGCGCGCTCCCGCTGACCTAGGCTCCTC
GACCCTTTCGGCACCGCAAGCACGGTGCTCGCATCGCGACCCCAGGTCAGGCGGG
ATTACCCGCTGAGTTTAAGCATATCAATAAGCGGAGGAAAAGAAACTTACCAGGA
TTCCCTTAGTAACGGCGAGCGAACCGGGA

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Urena lobata* LYMOOI 008**

>LYMOOI008_rbcLa_F/rbcLajf635R

CAACAGAGACTAAAGCAGGTGTTGGATTCAAAGCCGGTGTTAAAGAGTATAAATT
GACTTATTATACTCCTCAATATGAAGTCAAAGATACTGATATCTTGGCAGCCTTCC
GAGTAACTCCTCAACCCGGAGTTCCGCCTGAGGAAGCAGGGGCCGCGGTAGCTGC
TGAATCTTCTACTGGTACATGGACAACCGTGTGGACCGATGGGCTTACCAGCCTTG
ATCGTTACAAAGGGCGATGCTACCACATTGATCCCGTTCCTGGAGAAGAGGATCA
ATATATATGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACTAA
CATGTTTACTTCCATTGTGGGTAATGTATTTGGGTTCAAAGCCCTGCGCGCTCTACG
TCTAGAGGATCTGCGAGTCCCTACTGCTTATATTAAAACTTTCCAAGGCCCGCCTC
ATGGCATCCAGGTTGAAAGAGATAAATTGAACAAGTATGGTCGCCCCCTATTAGG
ATGTACTATTAAACCTAAATTGGGGTTATCCGCTAAGAACTACGGTAGAGCAGTTT
ATGAATGTCTACGTGGCGGACTTGATTTTACCAAAGATGATGAGAATGTGAACTCC
CAACCATTTATGCGTTG

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Clidemia hirta* LYMOOI 011**

>LYMOOI011_rbcLa_F/rbcLajf635R

CAACAGAGACTAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGATTACAACAG
AGACTAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGATTATAGACTGACTTAT
TATACTCCTGAATATCAAGTCAAACCTACTGATACCTTGGCAGCATTCCGAGTAAC
TCCTCAACCTGGAGTCCCGCCTGAAGAAGCAGGGGCTGCGGTAGCTGCTGAATCTT
CTACTGGTACATGGACAACTGTGTGGACCGATGGGCTTACCAGCCTTGATCGTTAT
AAAGGAAGATGCTACAACATCGAGCCGGTTGCTGGAGAAGAAAATCAATATATAT
GCTATGTAGCTTACCCCTTAGACCTTTTTGAAGAAGGTTCTGTTACTAATATGTTTA
CTTCAATTGTAGGGAATGTATTTGGCTTCAAAGCCCTTCGCGCTCTACGTCTGGAG
GATTTGCGAATCCCTATTTCCTACGTTAAAACTTTCCAAGGACCGCCCCATGGCAT
CCAAGTTGAGAGAGATAAATTGAACAAGTACGGACGTCCCCTATTGGGATGTACT
ATTAAACCGAAATTAGGTTTATCCGCTAAGAATTACGGTAGAGCAGTTTATGAATG
TCTTCGTGGTGGACTTGATTTTACGAAAGATGATGAGAACGTAAACTCACAACCAT
TTATGCGTT

>LYMOOI011_ITS_5P/ITS_8P

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GCGAATCGTCATTGCGTACTAGACAGAGCCCGTGAGCACCTAACGCTCATGGGGC
TCGCGTCGCGTCGGCGCGGGTGTCCTCGAGACCCGCGTCGTACCGGCGGACAAAC
AATGTCAGCACGGATCGTGCCAAGGAGCTTTATTGAGAGAATCGTCGTCCCCGCG
CCTTTGATAGTCCTCGATGCGGGACGGGGGGCGGGGGACGTACGCAATCTCTACC
CAAAGTCTAAACGACTCTCGGCAACGGATATCTCGGCTCTTGCATCGATGAAGAA
CGTAGCGAAATGCGATACTTGGTGTGAATTGCAGAATCCCGCGAACCATCAATTCT
TTGAACGCAAGTTGCGCCCGAAGCCATACGGCCGAGGGCACGCCTGCCTGGGTGT
CGTGAATCCCCTTGCCCCAAGGCACCCGCATGAGCGTTGGCGGGGATATATGCTCG
GGCGCAGAATATGGCCTCCCGTGGGATCGGCATGCACGGCATGTCGAGGTGCGGT
TGGCCGAAAATCGAGCATGGCGGTGACGGGCACCACGGCGTTCGGTGGATCGAAT
GAGATTGGCTGCGCCGTGGGCTCGGCATGCGGCGGGCTCCGGACTTTTATTATCCC
CGAGTGCGATCCCAGGTCAGGCGGGGCTACCCGCTGAGTTTAAGCATATCAATAA
GCGGAGGAAAAGAAACTAACGAGGATTCCCTTAGTAGCGGCGAGCGAACCGGGA
AGAGCCCAGCGTGAAAATCGTCCGTCATCGGCGGCCGAATTGTAG

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Melastoma malabathricum* LYMOOI 009**

>LYMOOI009_rbcLa_F/rbcLajf635R

AGAGACTAAAGCATATGTTGGATTCAAAGCTGGTGTTAAAGATTATAGACTGACTT
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ACTCCTCAACCTGGAGTTCCGCCTGAAGAAGCAGGGGCTGCGGTAGCTGCTGAAT
CTTCTACTGGTACATGGACAACTGTGTGGACCGATGGGCTTACCAGCCTTGATCGT
TATAAAGGAAGATGCTACAACATCGAGCCGGTTGCTGGAGAAGAAAATCAATATA
TATGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACTAATATGT
TTACTTCAATTGTAGGGAATGTATTTGGCTTCAAAGCCCTTCGCGCTCTACGTTTGG
AGGATTTGCGAGTCCCTACTGCCTATATTAAAACTTTCCAAGGACCGCCTCATGGC
ATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGACGTCCCCTATTGGGATGTA
CTATTAAACCGAAATTAGGCTTATCCGCTAAGAATTATGGTAGAGCAGTTTATGAA
TGTCTTCGTGGTGGACTTGATTTTACGAAAGATGATGAGAACGTAAACTCACAACC
ATTTA

>LYMOOI009_ITS_5P/ITS_8P

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ACGACCCGCGAACCGTCCCCACCTACCGAACGGAGGTCGCGAGCCGAAACGCTCG
CGTCCCTCGCGTCGCGTCGGCGCGGGCCTTCCCCGGAGGCCGGCGTCGTCCCGACA
AACGAACATCGTCGGCACGAATCGTGCCAAGGACCCGTAAAAGGCGAGAATCGCC
GTCCCCGGCCCCCGGTCGTTCTCGGCGGGGGGCGCGGGACGCGCGCGATCTCTGCT
CTAAGTCTTTAATGACTCTCGGCAACGGATATCTCGGCTCTTGCATCGATGAAGAA
CGTAGCGAAATGCGATACTTGGTGTGAATTGCAGAATCCCGCGAACCATCAATTCT
TTGAACGCAAGTTGCGCCCGAAGCCATTTGGCCGAGGGCACGCCTGCCTGGGCGT
CGTGAATCCCCTTGCCCCCCGGAACCCGCGCGAGCATCGTCGCGGGTTTTCCCGGG
CGCAGAATATGGTCTCCCGTCGCATCGGCGTGCGCGGCACGCCGTGGTACGGTTG
GCCGAAAATCGAGCATTGCGACGTCGGGCTGCACGGCGCTAGGTGGATCGAACGC
GATTGGCTGCGCCGTGGTCCCGTCGTGCCGCGGGCTCAGGACTAGGACGGTTCCCC
AGTGCGATCCCAGGTCAGGCGGGGCTACCCGCTGAGTTTAAGCATATCAATAAGC
GGAGGAAAAGAAACTAACGAGGATTCCCTTAGTAGCGGCGAGCGAACC

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Plantago major* LYMOOI 034**

>LYMOOI034_rbcLa_F/rbcLajf635R

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GTAACTCCGCAACCTGGAGTTCCCCCTGAAGAAGCAGGGGCTGCGGTAGCGGCCG
AATCTTCAACTGGTACATGGACAACTGTGTGGACCGACGGACTTACCAGTCTTGAT
CGTTACAAAGGGCGATGCTACCACATTGAGCCCGTTCCTGGAGAAGCAGATCAAT
ATATCTGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGGTCTGTTACTAACA
TGTTTACTTCCATTGTAGGAAATGTATTTGGATTCAAAGCCCTGCGTGCTCTACGTC
TGGAAGATCTACGAATCCCTGTTGCTTATGTTAAAACTTTCCAAGGCCCGCCTCAC
GGGATCCAAGTTGAGAGAGATAAATTGAACAAGTACGGTCGTCCCCTGTTGGGAT
GTACTATTAAACCTAAATTGGGGTTATCTGCTAAAAACTATGGTAGAGCATGTTAT
GAATGTCTTCGTGGTGGACTTGATTTTACCAAAGATGATGAGAACGTGAACTCCCA
GCCATTTATGCGTT

>LYMOOI034_matK_390f/matK_1326r

TAGAAGACAATTTTTCACATTTCGATTTTGTGTTAGATATCCTAATCCCCTACCCTG
TCCATGTAGAAATCTTGGTGCAAACCCTTCGCTATTGGGTAAAAGATGCCCCTTCT
TTGCATTTCTTACGATTCTTTCTCAACGAGTATTGGAGTCTTAGTACTCTAAATAAA
GCCGGTTTAAAACGAAATCAAAGATTCTTTTTATTCTTATATAATTCTTATGTATGT
GAATACGAATCCATTTTCATATTTTTACGTAACCAATCTTCTCATTTACAATCAACA
TCTTTTGGAGTTCTTCTTGAACGAATCTATTTCTATGGAAAAATAGAATGTCTGGG
GAGCGTCCTTCTTAAGGTTACGGATTGTCAGGTGAACCTTTGGTTGGTCCAAGAAC
CTTGCATGCATTATGTTAGATATCAAAGAAAATGCATTCTGGCTTCAAAAGGGACG
TCTCTTTTTATGAATAAATGGAAATGTTATCTTGTCACTTTTTGGCAATGGCATTTT
TCCCTCTGGTTTCATCCACGAAGGATTTCTATAAATCCATTATACAACCATCTCCTT
GAATTTGCGGGCTACCTTTCAAGCGCCCGAATGAATCCTGCAATGGTACGGAGTCA
AATTCTAGAAAATTCATTTCTAATCAATAATGCTATTAAGAAGGTTGATACCCTTA
TTCCTATTATGCCTCTGGTTAAGTCATTGGCTAAAGCGCAATTTTGTAACCTATTAG
GGCATCCCACCAGTAAGCCGGTTTGGGCTGATTTATCAGATTCAAATATTAGAAAC
CGATTTGGGCATATATGCAGAAATATTTCTCATTATTATAGTGGATCTTCA

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Plantago major* LYMOOI 034**

>LYMOOI034_ITS_5P/ITS_8P

GTAACAAGGTTTCCGTAGGTGAACCTGCGGAAGGATCATTGTCGATATCTAAAAA
GTAGACCTGTGAACACGTGTTTAACATGAACGTTGCCTCGTTGGGCTGGAGCAATC
CACTCTTCGTGACACCGTGCCTGCCCGGTGCTTGCACTTGGTGGGCTAACGAAACC
CGGCGCGGCAAGCGCCAAGGAAAACAAAATGGAAGCGTTGCTCCCCGTGACTCCC
GTTCGCGGTGTGGTTTTGGGGATGTGATGTATCTTGAAAGTCAAAACGACTCTCGG
CAACGGATATCTCGGCTCTCGCATCGATGAAGAACGTAGCGAAATGCGATACTTG
GTGTGAATTGCAGAATCCCGTGAACCATCGAGTCTTTGAACGCAAGTTGCGCCCGA
TGCCTTCGGGCTGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTAC
ACCAATTTGGTGAGGGGGCGGATAATGGCATCCCGTTAGCTCGGTTTGCCCAAAA
AGGATCCCTCATCGATGGATGTCACAACCAGTGGTGGTTGAAAGATCATTGGTGCC
GTTGTGCTTCACTCCGTCGCATGCTTGGGCATCGTTACAAAACAATGGTGCTAACG
CGCCTTCGACCGCGACCCCAGGTCAGACGGGACTACCCGCTGAGTTTAAGCATATC
AATAAGCGGTGGAGAAGAAACTTACAAGGATTCCCCTAGTAACGGCGAGCGAACC
GGGAATAGCCCAACTTGAGAATCGGGCGGCCACGCCGTCCGAATTGTAGTC

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Morinda citrifolia* LYMOOI 031**

>LYMOOI031_rbcLa_F/rbcLajf635R

CAGAGACTAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGAGTACAAATTGAC
TTATTATACTCCTGAATACGAAACCAAAGATACTGATATCTTGGCAGCATTCCGAG
TAACTCCCCAACCTGGAGTTCCACCGGAAGAAGCAGGGGCCGCGGTAGCTGCCGA
GTCTTCTACTGGTACATGGACAACTGTATGGACGGATGGACTTACCAGTCTTGATC
GTTACAAAGGGCGATGCTACCACATCGAGCCAGTTCCTGGAGAAGAAGATCAATA
TATTGCTTATGTAGCTTACCCGTTAGACCTTTTTGAGGAAGGTTCTGTTACTAACAT
GTTTACTTCCATTGTAGGTAATGTATTTGGGTTCAAAGCCCTGCGCGCTCTGCGTCT
GGAAGATTTGCGAGTTCCCATTTCTTATATTAAAACCTTCCAAGGCCCGCCTCATG
GCATTCAAGTCGAGAGAGATAAATTGAACAAGTATGGTCGTCCCCTGTTGGGATG
TACTATTAAACCGAAATTAGGTTTATCTGCTAAAAACTATGGTAGAGCAGTTTATG
AATGTCTTCGTGGTGGACTTGATTTTACCAAAGATGATGAAAACGTGAACTCCCAA
CCATTTATGCGTTG

>LYMOOI031_matK_390f/matK_1326r

CGAAGTATATACTTTATTCGATACAAAATCTTTTTTTTTGAAGACCCGCTATGATAA
TGAGAAAGGTTTCTGCATATATACCCAAAGCGTTCAATCATATCAGAATCTGATAA
ATCAGTCCAAACCGGCTTACTAAGGGGATGTCCTAATAGGTTACAAAATTTCGCTT
TAGCCAATGATCTAATAAGAGGAATAATTGGAACAAGCATATCCAATTTCTTAATA
GCATTATTAATTAGAAATGAATTTTCTAGCATTTGACCCCGTACCATTGCCGGATTT
AGTCGCACACTTGAACGATAGCCCACAAAGTCAAGTGAATGATTAGAAAATTGAT
TTATATAAACCCTTCCCGAGCGAAACCACAGATCAAAGTGATATTGCCAAAAATT
GACAAGATAAGATTTCCATTTATTCATCAAAAGAGGTGTACCCTTTGAAAGCAGA
ATTGATTTTCCTTGATACCTAACATACTGCATGAAAGGGTCTGTGAACAGCCATAG
ACTAACCCGAAAATCCTTAGCAACAACTTCTACAAGACGTTCTTTTTTTCCATAAA
AATAAAGTCGTTCGAGAAATAATACAAAAGATGTTGATTGCAAATGCGAAGATTG
GTTACGGAGAAAGGCCAAAATGGATTCGTATTCATATACATGAGAATTATATAAT
AAGAAAAAAAATCTTTTATTTCTTTTTGGTGAAAAATGGGATTTCTTTGTAGCACT
AAGAGTCCAATATTCGTGGAAAAATAATCGTAATAAATGCAAGGCGGAGGCATCT
TTTACCCAATAATGAAGGGTTTGAACCAGAATTTCCAGATGGACGGCGCGGGGT
ATTAGTATATCTAACACAG

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Oldenlandia auricularia* LYMOOI 015**

>LYMOOI015_rbcLa_F/rbcLajf635R

CAGAGACTAAAGCAAATGTTTTTTTCAAAGCTGGTGTTAAAGAGTACAAATTAACT
TATTATACTCCTGAATACGAAACCAAAGATACTGATATCTTGGCAGCATTCCGAGT
AACTCCTCAACCAGGAGTTCCACCGGAAGAAGCAGGGGCCGCGGTAGCTGCCGAG
TCTTCTACTGGTACATGGACAACTGTATGGACGGATGGACTTACCAGTCTTGACCG
TTACAAAGGACGATGCTATCACATCGAGCCAGTTCCTGGAGAAGAAGATCAATTT
ATTGCTTATGTAGCTTACCCTTTAGATCTTTTTGAAGAAGGTTCTGTTACTAACATG
TTTACTTCCATCGTAGGTAATGTATTTGGGTTCAAAGCCCTGCGCGCCCTACGTCTG
GAAGATTTGCGAATTCCCATTGCTTATGTTAAAACCTTCGAAGGGCCACCTCACGG
CATTCAGGTCGAGAGAGATAAATTGAACAAGTACGGTCGTCCTTTATTGGGATGTA
CTATTAAACCTAAATTAGGTTTATCTGCTAAAAACTATGGTAGAGCATGTTATGAA
TGTCTTCGTGGTGGACTTGATTTTACTAAAGATGATGAAAACGTGAACTCTCAACC
ATTTATGCGTTG

>LYMOOI015_matK_390f/matK_1326r

GAGAATAACCTTTTACATTTGAATTCTGTATTATATATACTAATACCCCGCGCCGT
ACACCTGGAAATTTTGGTTAAAACCCTTCGTTATTGGGTAAAAGATGCTTCTGCTT
TGCATTTATTACGATTATTTTTCCACGAGTATTGGAGTTGGGCTACTCTTAGTGTTA
CAAAGAAACCTCATTTTTATTTTTTACCAAAAACAAATCAAAGATTTTTTTTCTTAT
TATATAATTCTCATGCGTATGAATATGAATCCATTTTAGACTTTCTGCGTAACCAAT
CTTCTCATTTGCGATCAACATCTTTTGTATTCTTTCTTGAACGACTTTTTTTTTATGG
AAAAAAAGAACGTCTTGTAAAAGCCGTTGAGAAGGATTTGCGGGTTAGTCTATGT
CTGTTCACAGATCCTTTCATGCATTATGTTAGGTATCAAGGAAAAGCAATTCTGGT
TTCAAAGGATACACCTCTTTTGATGAAAAAATGGAAATTTTATCTTGTCCATTTTTG
GCAATATTACTTTGATCTGTGGTTTCACTCGGGAAGGTTTTCTATAAATCCATTTCT
CAACCACTCACTTGACTTTATGGCCTATCTTTCAAGTGTGCGACTAAACTCGATAA
TGGTACGGGGCCAAATGCTAGAAAATTCATTTCTAATTAAGAATTCTATTAAAAAA
TTGGATACGCTTGTTCCAATTATTCTTCTTATTCGATCATTGGCTAAAGCTAAATTT
TGTAACCCATTAGGACATCCAATTAGTAAGGCGGCTTGGACTGATTTATCAGATTC
TGATATGATTAATCGGTTTGGGTATATATGCAGAAACCTTTCTCATTATTATAGCG
GGTCTTCAAAAAAAAAGAGTTTGTATCGAATAAAGTATATACT

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Oldenlandia auricularia* LYMOOI 015**

>LYMOOI015_ITS_5P/ITS_8P

ACAAGGTTTCCGTAGGTGAACCTGCGGAAGGATCATTGTCGATGCCCTAAGACCA
CCGCGAACACGTTATAAAAAACTCTCGGGGAGACGAAGGGCTAACGCCCACAATT
TCTCCGAAGCCAACTAAACATCCGGCGCGAAAAGCGCCAAGGACTACTTGAAAGG
ATCGTCTGCATCCTCCCGCGGCCTCCGCGGTGCGGGTGCGGCACGTCTGAATCGTA
TAACCAATATGACTCTCGGCAACGGATATCTAGGCTCTCGCATCGATGAAGAACGT
AGCGAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTG
AACGCAAGTTGCGCCCGAAGCCATTAGGCTGAGGGCACGTCTGCCTGGGCGTCAC
GCATCGTCGCCACCTCCCCCTCTTTTTATGATCGAGTCGGGGGCGGCGGAATTTGG
CCCCCCGCGCTCTGCCGAGCGAGGCCGGCCTAAATAAGAGTCCTCCTTTCGGGACG
TCACGACTTGTGGTGGTTGAAATTCTCAACTCGATCGGTGTCGTGTCTCAACCCGT
CGCGGAGCGTACTCCGAGACCCTGGAGCCTTAAGGCCCTCGACAATGACCCCAGG
TCAGGCGGGATTACCCGCTGAGTTTAAGCATATCAATAAGCGGAGGAAAAGAAAC
TAACAAGGATTCCCTTAGTAACGGCGAGCGAACCGGGAACAGCCCAAGCTTAGAA
TCGGACGGCTTCGCTGTTCGAATTGT

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Oldenlandia corymbosa* LYMOOI 066**

>LYMOOI066_rbcLa_F/rbcLajf635R

TAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGAGTACAAATTAACTTATTATA
CTCCTGAATACGAAACCAAAGATACTGATATCTTGGCAGCATTCCGAGTAACTCCT
CAACCCGGAGTTCCACCGGAAGAAGCAGGGGCCGCGGTAGCTGCCGAGTCTTCTA
CTGGTACATGGACAACTGTATGGACCGATGGACTTACCAGTCTTGACCGTTACAAA
GGACGATGCTACCACATCGAGCCAGTTCCTGGAGAAGAAGATCAATTTATTGCTTA
TGTAGCTTACCCTTTAGATCTTTTTGAAGAAGGTTCTGTTACTAACATGTTTACTTC
CATCGTAGGTAATGTATTTGGGTTCAAAGCCCTGCGCGCCCTACGTCTGGAAGATT
TGCGAATTCCAATTGCTTATGTTAAAACCTTCGAAGGGCCGCCTCACGGTATTCAG
GTCGAGAGAGATAAATTGAACAAGTATGGTCGTCCCCTATTGGGATGTACTATTAA
ACCTAAATTAGGTTTATCTGCTAAAAACTACGGTAGAGCATGTTATGAATGTCTTC
GTGGTGGACTTGATTTTACTAAAGATGATGAAAACGTGAACTCTCAACCATTTATG
CGTT

>LYMOOI066_matK_390f/matK_1326r

TCCATCTAGAAATTTTGGTTCAAACCCTTCGTTATTGGGTAAAAGATGCTTCTGCTT
TGCATTTATTACGATTAGTTTTCCACGAGTATTGGAGTTGGGCTACTATTAGTGTTA
CAAAGAAACCTCATTTTGATTTTTCACCAAAAAGAAATCAAAGATTTTTTTTCTTAT
TATATAATTCTCATGCGTATGAATATGAATCTATTTTAGACTTTTTGCGTAACCAAT
CTTCTCATTTGCGATCAACATCTTTTGTATTCTTTCTTGAACGACTTTTTTTTTATGG
AAAAAAAGAACGTTTTGTAAAAGTCGTTGAGAAGGATTTGCGGATTAGTCTATGT
CTGTTCACGGATCCTTTCATGCATTATGTCAGGTATCAAGGAAAGGCAATTCTGGT
TTCAAAGGATACACCTCTTTTGATGAAGAAGTGGAAATCTTATCTTGTCAATTTTT
GGCAATGTCACTTTGATCTATGGTTTCACTCGGGAAGGATTTCGCTAAATCCATTT
CTCAACCATTCACTTGACTTTATGGCATATCTTTCAAGTGTGCAACTAAACTCGGT
AATGGTACGGGGCCAAATGCTAGAAAATGCATTTCTAATCAAAAATTCTATTAAG
AAATTAGATACACTTGTTCCAATTATTCCTCTTATTCGATCATTGTCTAAAGCTAAA
TTTTGTAACCCATTAGGACATCCAATTAGTAAGGCGGCTTGGACTGATTTATCGGA
TTCTGATATGATTAATCGGTTTGGGTATATATGCAGAAACCTTTCTCATTATTATAG
CGGGTCTTC

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Oldenlandia corymbosa* LYMOOI 066**

>LYMOOI066_ITS_5P/ITS_8P

AGTCGTAACAAGGTTTCCGTAGGTGAACCTGCGGAAGGATCATTGTCGAATCCTGC
AAACGACCGCGAACACGTTTTTATAAACCCGCGGGGCACGGACGGACTCCCGTCT
GGCCGTTGCCCCGCACCCAACAAAACTTCCGGCGCGGAAAGCGCCAAGGACTACA
CAAAAGGATCGTCCGCATCCCCCGGCGGTTTCCGTTGGGCGGGTGTGACGTGTCTG
AATCGTATAACCAATACGACTCTCGGCAACGGATATCTAGGCTCTCGCATCGATGA
AGAACGTAGCGAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCG
AGTTTTTGAACGCAAGTTGCGCCCGAAGCCATTTGGCTGAGGGCACGCCTGCCTGG
GCGTCACGCATCGTCGCCACCCCCCTCGCAATGCGAAGCGCGGGGTGACGGAAGT
TGGCCTCCCGTGTCTCCTGGCAGCGCGGCCGGCCTAAATTCGAGTCCTCCGTTCGG
AGACGTCACGACTAGTGGTGGTTGAAAACTTCATCCCGATCGAAGCCGTGGCTCTT
GCCGACGCGGGGCGTGCTCAAAGACCCTAGAGCCTCTCGAGGCCCTCGACCATGA
CCCCAGGTCAGGCGGGACTACCCGCTGAGTTTAAGCATATCAATAAGCGGAGGAA
AAGAAACTAACAAGGATTCCCTTAGTAACGGCGAGCGAACCGGGAATAGCCCAAG
CTTAGAATCGGACGGCCCTGCCGTTCGAATTGTAG

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Oldenlandia diffusa* LYMOOI 073**

>LYMOOI073_rbcLa_F/rbcLajf635R

ACAGAGACTAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGAGTACAAATTAA
CTTATTATACTCCTGAATACGAAACCAAAGATACTGATATCTTGGCAGCATTCCGA
GTAACTCCTCAACCCGGAGTTCCACCGGAAGAAGCAGGGGCCGCGGTAGCTGCCG
AGTCTTCTACTGGTACATGGACAACTGTATGGACCGATGGACTTACCAGTCTTGAC
CGTTACAAAGGACGATGCTACCACATCGAGCCAGTTCCTGGAGAAGAAGATCAAT
TTATTGCTTATGTAGCTTACCCTTTAGATCTTTTTGAAGAAGGTTCTGTTACTAACA
TGTTTACTTCCATCGTAGGTAATGTATTTGGGTTCAAAGCCCTGCGCGCCCTACGTC
TGGAAGATTTGCGAATTCCAATTGCTTATGTTAAAACCTTCGAAGGGCCGCCTCAC
GGTATTCAGGTCGAGAGAGATAAATTGAACAAGTATGGTCGTCCCCTATTGGGAT
GTACTATTAAACCTAAATTAGGTTTATCTGCTAAAAACTACGGTAGAGCATGTTAT
GAATGTCTTCGTGGTGGACTTGATTTTACTAAAGATGATGAAAACGTGAACTCTCA
ACCATTTATGCGTT

>LYMOOI073_matK_390f/matK_1326r

GAGAACAATCTTTTACATTTGAATTCTGCATTAGATATACTAATACCCCGCGCCGT
GCATCTGGAAATTTTAGTTCAAACCCTTCGTTATTGGGTAAAAGATGCTTCGGCTT
TGCATTTCTTACGATTATTTTTCCACGAGTATTGGCGTTGGGCTACTCTTAGTGTTA
CAAAGAAACCTCGTTTTGATTTTTCACCAAAAAGAAATCAAAGATTTTTTTTCTTAT
TATATAATTCTCATGCGTATGAATACGAATCCATTTTGGACTTTCTGCGTAACCAAT
CTTCTCATTTGCGATCAATATCTTTTGTATTCTTTCTTGAACGACTTTATTTTTATGG
AAAAAAAGAACGGCTTGTAAAAGTCGTTGAGAAGGATTTTCGGGTTAGTCTATGT
CTGTTCACGGATCCTTTCATGCATTATGTTAGGTATCAAGGAAAGGCAATTCTGGT
TTCAAAGGATACACCTCTTGTGATGAAGAAATGGAAATCTTATGTTGTCAATTTTT
GGCAATATCACTTTGATCTGTGGTTTCATTCGGCAAGGGTTTCTATAAATCCATTTC
TCAACCATTCACTTGACTTTATGGGCTATCTTTCAAGTGTGCGACTAAACCCAGTA
ATGGTACGGGGCCAAATGCTAGAAAATGCATTTCTAATCAAGAATTCTATTAAGA
AATTAAATACGCTTGTTCCAATTCTTCCTCTTATTCGATCATTATCTAAAGCTAAAT
TTTGTAACCCATTAGGGCATCCAATTAGTAAGGCGGCTTGGACTGATTTATCAGAT
TCTGATATGATTAATAGGTTTGGGTATATATGCAGAAACCTTTCTCATTATTATA

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Oldenlandia diffusa* LYMOOI 073**

>LYMOOI 073_ITS_5P/ITS_8P

AACAAGGTTTCCGTAGGTGAACCTGCGGAAGGATCATTGTCGAATCCTGCAAACG
ACCGCGAACACGTTTTTATAAACCCGCGGGGCACGGACGGACTCCCGTCTGGCCG
TTGCCCCGCACCCAACAAAACTTCCGGCGCGGAAAGCGCCAAGGACTACACAAAA
GGATCGTCCGCATCCCCCGGCGGTTTCCGTTGGGCGGGTGTGACGTGTCTGAATCG
TATAACCAATACGACTCTCGGCAACGGATATCTAGGCTCTCGCATCGATGAAGAA
CGTAGCGAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTT
TTGAACGCAAGTTGCGCCCGAAGCCATTTGGCTGAGGGCACGCCTGCCTGGGCGT
CACGCATCGTCGCCACCCCCCTCGCAATGCGAAGCGCGGGGTGACGGAAGTTGGC
CTCCCGTGTCTCCTGGCAGCGCGGCCGGCCTAAATTCGAGTCCTCCGTTCGGAGAC
GTCACGACTAGTGGTGGTTGAAAACTTCATCCCGATCGAAGCCGTGGCTCTTGCCG
ACGCGGGGCGTGCTCAAAGACCCTAGAGCCTCTCGAGGCCCTCGACCATGACCCC
AGGTCAGGCGGGACTACCCGCTGAGTTTAAGCATATCAATAAGCGGAGGAAAAGA
AACTAACAAGGATTCCCTTAGTAACGGCGAGCGAACCGGGAATAGCCCAAGCTTA
GAATCGGACGGCCCTGCCGTTCGAATTGT

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Lantana camara* LYMOOI 035**

>LYMOOI035_rbcLa_F/rbcLajf635R

AGAGACTAAAGCAGGTGTTGGATTCAAAGCGGGTGTAAAAGAGTACAAATTGACT
TATTATACTCCTGAATACGAAACCAAAGATACTGATATCTTGGCAGCATTTCGAGT
AACTCCTCAACCTGGAGTTCCACCTGAAGAAGCGGGGGCCGCGGTAGCTGCCGAA
TCTTCTACGGGTACATGGACAACTGTGTGGACCGATGGACTTACCAGCCTTGATCG
TTACAAAGGGCGATGCTACAACATCGAGCCCGTTCCTGGAGAACCAGATCAATAT
ATTTGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCGGTTACGAACATG
TTTACTTCCATCGTAGGAAATGTATTTGGATTCAAAGCCCTACGTGCTCTACGTCTG
GAAGATCTGCGAATCCCTGTTGCTTATGTTAAAACTTTCCAAGGCCCACCTCATGG
GATCCAATCTGAGAGAGATAAATTGAACAAGTATGGTCGTCCCCTGTTGGGATGT
ACTATTAAACCTAAATTGGGGTTATCTGCTAAAAACTATGGTAGAGCATGTTATGA
ATGTCTTCGCGGTGGACTTGATTTTACCAAAGATGATGAGAACGTGAACTCCCAGC
CATTTATGCGTTG

>LYMOOI035_ITS_5P/ITS_8P

GTAACAAGGTTTCCGTAGGTGAACCTGCGGAAGGATCATTGTCGAAACCTGCAAA
GCAGACCGCGAACACGTTAAATAAACTCTTCGGGTCCGTGGTGCGGGGGCTAGCC
CCCCATCGCGGTGCCCTCCCCCGTCGCCGCGAGCGTAAGCAACCGGCGAGCGGGC
TAACAAAACCCCGGCGCGGGATGCGCCAAGGAAAATAAATCAACGAAGCGTCCG
CCCTCTCGTTGCCCCCGTTCGCGGTGTGCACCGGAGTCGCGTACGTCTCTTGAATG
TCATAACGACTCTCGGCAACGGATATCTCGGCTCTCGCATCGATGAAGAACGTAGC
GAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTCTTTGAAC
GCAAGTTGCGCCCGAAGCCATTAGGCCGAGGGCACGTCTGCCTGGGCGTCACGCA
TCGCGTCGCCCCACTCCCCCGCTCCCCATACGGGGACGGGCACGAGCGGGGCGGA
TAATGGCCTCCCGTGCGCCGATAGGTGCGCGGCTGGCCCAAATGCGATCCCTCGGC
GACGCACGTCACGACCTTTGGTGGTTGAACACTCAACTCGCGCAACTGTCGTGCGA
CGGCGTCGTCCGCTCGGGAATCCATACGACCCCGATGGTGCTAGCGTGCACCTCCG
ACCGCGACCCCAGGTCAGGCGGGATTACCCGCTGAGTTTAAGCATATCAATAAGC
GGAGGAAAAGAAACTTACAAGGATTCCCCTAGTAACGGCGAGCGAACCGGGAAT
AGCCCAACTTGAAAATCGGGCGGCCACGCCGTCCGAATT

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Phyla nodiflora* LYMOOI 001**

>LYMOOI001_rbcLa_F/rbcLajf635R

AACAGAGACTAAAGCAAGTGTTGGATTCAAAGCGGGTGTAAAAGAGTACAAATTG
ACTTATTATACTCCTGAATACGAAACCAAAGATACTGATATCTTGGCAGCATTTCG
AGTAACTCCTCAACCTGGAGTTCCACCTGAAGAAGCAGGGGCCGCGGTAGCTGCC
GAATCTTCTACGGGTACATGGACAACTGTGTGGACCGATGGACTTACCAGCCTTGA
TCGTTACAAAGGGCGATGCTACAACATCGAGCCCGTTCCTGGAGAACCAGATCAA
TATATTTGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCGGTTACGAAC
ATGTTTACTTCCATCGTAGGAAATGTATTTGGATTCAAAGCCCTACGTGCTCTACG
TCTGGAAGATCTGCGAATCCCTGTTGCTTATGTTAAAACTTTCCAAGGCCCGCCTC
ACGGGATCCAATCTGAGAGAGATAAATTGAACAAGTATGGTCGTCCCCTGTTGGG
ATGTACTATTAAACCTAAATTGGGGTTATCTGCTAAAAACTATGGTAGAGCGTGTT
ATGAATGTCTTCGCGGTGGACTTGATTTTACCAAAGATGATGAGAACGTGAACTCC
CAGCCATTTATGCGTTG

>LYMOOI001_matK_390f/matK_1326r

CCTTTTTAGAGGACAATTTTTCACATCTAAATTTAGTATTAGATATACTAATACCCC
ACCCTGTCCATGGGGAAATCTTGGTTCAAACTCTTCGCTACTGGGTCAAAGATGCC
TCTTCTTTGCATTTATTACGATTCTTTCTCAATGAGTATTGTAATAGTCTTATTACTC
CAACGAAAGCGAGTTCCTCTTTTTTAAAAAGAAATCAAAGATTATTCTTATTCTTA
TATAATTCTCATGTATCTGAATATGAATCCATTTTCGTCTTTCTACGTAACCAATCT
TCTCATTTACGATCAACATCTTCTGGAGTTCTTCTTGAACGAATCTATTTCTATCGA
AAAATAAAACGTCTTGTGAACGTCTTTCTTAAGGTTAAGGGTTTTCAGGCCAACCT
GTGCTTGGGCAACGAACCTTGCATGCATTGTATTAGGTATCAAAGAAAATCCAGTC
TGGCTTCAAAAGGGACGTCTCTTTTCATGAATAAATGGAAATGCTATCTTGTCACT
TTTTGGCAATGGCATTTTTCGCTGTGGTTTCATCCAAGAAGGATTTATATAAATCA
ATTATCCAAGCATTCCCTTGATTTTTTGGGTTATCATTCAAGTGTGCGAATGAACTC
TTCCATGGTACGGAGTCAAATTCTAGAAAATTCATTTCGAATCAATAATGCTATTA
AAAAGTTCGATACCCTTCTTCCAATTATTCCAATGATTTCGTCATTGGCTAAAGCG
AAATTTTGTAACGTATTAGGGCATCCCATTAGTAAGCCGGTTCGGGCTGATTTATC
CGATTCGAATATTCTTGACCGATTTGGGCGTATATGCAGAAATCTTTCTCATTATCA
TAGCGGATCTTCCAAAA

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Phyla nodiflora* LYMOOI 001**

>LYMOOI001_ITS_5P/ITS_8P

AGGTTTCCGTAGGTGAACCTGCGGAAGGATCATTGTCGAAACCTGCAAAGCAGAC
CGCGAACACATTTCATAAAATCATCGAGTCCGCAGTGCGGGGTCTAACCCCTCCAG
TTGTGGTACCTTCCCCGGCCGCCGTGAGTGAAAGCGATCGGCGAGCGGGCTAACA
AAACCCCGGCGCGGGATGCGCCAAGGAAAATAAATCAATGAAGCGTCGCCCCCCG
ATGCCCCCGTCCGCGGTGTGGCATCGGAGGACCGTACGTCTCGTGAATGTCATAAC
GACTCTCGGCAACGGATATCTCGGCTCTCGCATCGATGAAGAACGTAGCGAAATG
CGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTCTTTGAACGCAAGT
TGCGCCCGAAGCCATTAGGCCGAGGGAACGTCTGCCTGGGCGTCACGCATCCCGT
CGCCCCACTCTCCCGCTTCCCGAATGTGGATGGGCATGAGTGGGGCGGATAATGGT
CTCCCGTGCACTCTCGTGCGCGGCTGGCCCAAATGTGATCCCTCGGCGACGCACGT
CACGACCAGTGGTGGTTGAACACTCAACTCGCGCAACTGTCGTGCGACGGCGTCG
TCCATTCGGGAATCCACACGACCCCATGGTGCACGCCCCGTGCGCGCACCTCCGAC
CGCGACCCCAGGTCAGGCGGGACTACCCGCTGAGTTTAAGCATATCAATAAGCGG
AGGAAAAGAAACTTACAAGGATTCCCTTAGTAACGGCGAGCGAACCGGGAATAGC
CCAACTTGAAAATCGGGCGGCCACGCCGTCCGAAT

APPENDIX B

Sequences per sample based on bidirectional primer (continued)

***Stachytarpheta jamaicensis* LYMOOI 019**

>LYMOOI019_rbcLa_F/rbcLajf635R

AACAGAGACTAAAGCAAGTGTTGGATTCAAAGCGGGTGTTAAAGAGTACAAATTG
ACTTATTATACTCCTGAATACGAAACCAAAGATACTGATATCTTGGCAGCATTCCG
AGTAACTCCTCAACCTGGAGTTCCGCCTGAAGAAGCAGGGGCCGCAGTAGCTGCC
GAATCTTCTACTGGTACATGGACAACCGTGTGGACCGATGGACTTACCAGCCTTGA
TCGTTACAAAGGGCGATGCTACCACATCGAGCCCGTTCCTGGAGAAGCAGATCAA
TATATCTGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACTAAC
ATGTTTACTTCCATTGTAGGAAATGTATTTGGATTCAAAGCCCTACGTGCTCTACGT
CTGGAAGATCTGCGAATCCCTGTTGCTTATGTTAAAACTTTCCAAGGCCCGCCTCA
TGGGATCCAATCTGAGAGAGATAAATTAAACAAGTATGGTCGTCCCCTGTTGGGA
TGTACTATTAAACCTAAATTGGGGTTATCTGCTAAAAACTACGGTAGAGCATGTTA
TGAATGTCTTCGCGGTGGACTTGATTTTACCAAAGATGATGAGAACGTGAACTCCC
AGCCATTTATGCGTTGG

>LYMOOI019_matK_390f/matK_1326r

ATTTTGTCTTAGATATATTAATACCCCACCCCGTCCATGCGGAAATCTTGGTTCAA
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AACGAGTATTGTAATTGGAATAGTCTTATTACTCCAAGGAAAGCCAGTTCCTCTTT
TTCAAAAAGAAACCAAAGATTATTCTTATTCTTATATAATTCTCATGTATGTGAAT
ATGAATCCATTTTTGTCTTTCTACGTAACCAATCTTCTCATTTACGATCAACATCTT
CTGGAGTTCTTCTTGAACGAATCTATTTCTATGGAAAAATAGAACGTCTTGTGAAC
ATCTTTGTTAAGGTTAAGGATTTTCAGGCAAACCTATGGTTGGTCAAGGAACCTTG
CATGCATTATATTAGGTATCAAAGAAAATCCATTCTGGCTTCAAAAGGGACGTCTC
TTTTCATGAATAAATGGAAATGCTATCTTGTCACTTTTTGGCAATGGCATTTTTCAC
TGTGGTTTCATCCAAGAAGGATTTATATAAACCAATTATCCAATCATTCCCTTGATT
TTTTGGGCTATCTTTCAAGTGTGCGAATGAACCCTTCGGTGGTACGGAGTCAAATT
CTAGAAAATTCATTTCTAATCAATAATGCTATTAAGAAGTTCGATACCCTTGTTCC
AATTATTCCTCTGATTGCATCATTGGCTAAAGCGAAATTTTGTAACGTATTAGGGC
ATCCCATTAGTAAGCCGGTTTGGTCTGATTTATCAGATTCTAATATTATTGATCGAT
TTGGGCGTATATGCAGAAACCTTTCTCATTATCATAGCGGATCTTCCAAA