

## ETHNO MEDICINAL USES AND ANTIMICROBIAL PROPERTIES OF *MELASTOMA MALABATHRICUM*

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### ABSTRACT

*The purpose of this article was to review the ethno medicinal uses and antimicrobial properties of three varieties of Melastoma malabathricum. The paper also discussed the development and progression to engineer new drugs and also made a few recommendations on 1) botanical nomenclatures of 3 varieties of Melastoma malabathricum 2) The test organisms used for antimicrobial activity 3) Solvents for extractions to obtain more bioactive components 4) Further laboratory approaches. There are many synthetic bioactive components that are commercially available (e.g. flavonoids) and the studies show how these could develop directly from the synthetic bioactive components. However, the interest is to discover new bioactive components which are very active to inhibit the growth of pathogens and also modify and develop those natural bioactive components synthetically to increase activity and to reduce side effects on the consumer.*

### 1.0 Introduction

Pure compounds found in Malaysia's natural diversity can be developed into new drugs to fight infectious and autoimmune diseases. Plants have been selected as one of the most promising sources of antimicrobial agents because they resist bacterial harassments using several defence substances (Wang, 2008). Medicinal plants are known to produce bioactive molecules which react and inhibit bacterial and fungal growth (Copra *et. al.*, 1992; Bruneton, 1995). The family Melastomataceae has been demonstrated to have antiviral and cytotoxic activity (Lohezic-Le *et. al.*, 2002), anti-oxidant and anti-cancer activity (Susanti, 2007), anti- hypertensive activity (Cheng, 1993), anti-nociceptive, anti-inflammatory and anti- pyretic properties (Zakaria, 2006) and antibacterial and antifungal activity (Copra *et. al.*, 1992; Bruneton, 1995).

### 2.0 Southeast Asian Genus *Melastoma* (Melastomataceae)

The genus *Melastoma* (Melastomataceae) comprises 22 species, two subspecies and three varieties. Those species are *M.beccarianum*, *M.bensonii*, *M.crinium*, *M.cyanoides*, *M.dodecandrum*, *M.imbricatum*, *M.malabathricum* (subspecies *malabathricum* and *normale*), *M.minahassae*, *M.moluccanum*, *M.montanum*, *M.muticum*, *M.orientale*, *M.pellegrinianum*, *M.perakense*, *M.sabahense*, *M.saigonense*, *M.sanguineum* (varieties *sanguineum*, *laevifolium* and *ranauense*), *M.septemnerium*, *M.setigerum*, *M.tetramerum*, *M.toppingii*, *M.velutinosum*. Table 1.0 illustrates the species that found in Malaysia and the morphological variability.

**Table 1.0: The Species that Found in Malaysia and the Morphological Variability (Meyer, 2001)**

Species	Shrub	Leaves	Petals	Fruits
<i>M.beccarianum</i>	<b>Size:</b> Up to 6m tall; <b>Shape:</b> young branches quadraangular; <b>Color:</b> bark brown.	<b>Size:</b> 3.2 – 13 by 0.6 – 2.3cm <b>Shape:</b> Lanceolate;	<b>Size:</b> 27-30 by 21 - 24mm <b>Shape:</b> Obovate; <b>Color:</b> Violet in color	<b>Size:</b> 8-16 by 8 – 15mm. <b>Shape:</b> Campanulate, fleshy capsule, splitting longitudinally at maturity. Ovary as long as hypanthium.
<i>M.crinium</i>	<b>Size:</b> Up to 5m tall <b>Shape:</b> young branches quadraangular <b>Color:</b> bark grey-brown	<b>Size:</b> 10 – 21 by 4.5 – 9cm. <b>Shape:</b> Elliptic or ovate.	<b>Size:</b> <b>Shape:</b> <b>Color:</b> Violet in color. Shape: Obovate- cuneate; 16-20(34) by 11 -16 (-30)mm	<b>Size:</b> 9-12 by 7-10mm <b>Shape:</b> Campanulate, fleshy capsule, rupturing irregularly longitudinally at maturity, exposing the solid, orange placenta.
<i>M. imbricatum</i>	<b>Size:</b> Up to 3m tall; <b>Shape:</b> young branches quadraangular; <b>Color:</b> bark grey-brown	<b>Size:</b> 13.5 – 19.5 (-26) by 4.5 – 8cm (-10.5) cm. <b>Shape:</b> Elliptic to lanceolate.	<b>Size:</b> <b>Shape:</b> <b>Color:</b> Violet in color. Shape: Cuneate; 13 by 10mm	<b>Size:</b> 7-11 by 7-11mm, <b>Shape:</b> Fleshy capsule, rupturing irregularly transversally at maturity, exposing the dark soft pulp with orange seeds.
<i>M.malabathricum</i> subsp. <i>Malabathricum</i>	<b>Size:</b> Up to 5m tall <b>Shape:</b> young branches quadrangular <b>Color:</b> bark grey or brown	<b>Size:</b> 6 – 15 by 2 – 6.5cm <b>Shape:</b> Elliptic to lanceolate.	<b>Size:</b> <b>Shape:</b> <b>Color:</b> Violet in color; seldom white. Shape : Obovate; 15-35 by 10 - 22mm	<b>Size:</b> 6.5-11.5 by 5-10.5mm <b>Shape:</b> Fleshy capsule, rupturing irregularly transversally at maturity, exposing the soft dark blue pulp with orange seeds.
<i>M.malabathricum</i> subsp. <i>Normale</i>	<b>Size:</b> Up to 4m tall <b>Shape:</b> young branches quadrangular. <b>Color:</b> bark brown	<b>Size:</b> 6-20 by 3-8cm. <b>Shape:</b> Lanceolate.	<b>Size:</b> <b>Shape:</b> <b>Color:</b> Violet in color; Shape: Obovate- cuneate; 22-27 by 17-20mm.	<b>Size:</b> 7-10 by 7-10mm. <b>Shape:</b> Fleshy capsule, opening irregularly transversally at maturity, exposing the soft dark blue pulp with orange seeds.
<i>M.minahassae</i>	<b>Size:</b> Up to 2m tall <b>Shape:</b> young branches subquadrangular. <b>Color:</b> Not stated.	<b>Size:</b> 5-10 by 2.5 – 4.5cm. <b>Shape:</b> Ovate or lanceolate.	<b>Size:</b> <b>Shape:</b> <b>Color:</b> Violet in color; Shape: Obovate- cuneate; 40 by 35mm	<b>Size:</b> Not stated. <b>Shape:</b> Fleshy capsule, rupturing irregularly longitudinally at maturity
<i>M.muticum</i>	<b>Size:</b> Up to 3m tall <b>Shape:</b> young branches subquadrangular <b>Color:</b> Bark brown	<b>Size:</b> 8.5-13 by 3-5cm. <b>Shape:</b> Elliptic to lanceolate.	<b>Size:</b> <b>Shape:</b> <b>Color:</b> Violet in color; Shape: Obovate- cuneate; 19-20 by 11-12mm	<b>Size:</b> 10-14 by 10-11mm. <b>Shape:</b> Fleshy capsule, rupturing irregularly longitudinally at maturity
<i>M.perakense</i>	<b>Size:</b> Up to 5m tall <b>Shape:</b> young branches quadrangular <b>Color:</b> bark dark brown	<b>Size:</b> 11-18.5 by 4-7.5cm. <b>Shape:</b> Elliptic.	<b>Size:</b> <b>Shape:</b> <b>Color:</b> Violet in color; Shape: Obovate- cuneate; 30-34 by 14-26mm	<b>Size:</b> 11-14 by 10-13mm <b>Shape:</b> Fleshy capsule, rupturing irregularly longitudinally at maturity
<i>M.sabahense</i>	<b>Size:</b> Up to 20m tall <b>Shape:</b> young branches	<b>Size:</b> 7.5-14.5 by 2.2-5.5cm. <b>Shape:</b> Lanceolate.	<b>Size:</b> 33-37 by 27 - 30mm <b>Shape:</b> Obovate <b>Color:</b> Pink to blue-lilac	<b>Size:</b> 10-12 by 10-12mm <b>Shape:</b> Campanulate fleshy capsule,

	subquadrangular <b>Color:</b> Bark brown.		in color.	rupturing irregularly longitudinally at maturity
<i>M.sanguineum</i> var. <i>Sanguineum</i>	<b>Size:</b> Up to 10m tall <b>Shape:</b> young branches quadrangular <b>Color:</b> bark brown or grey.	<b>Size:</b> 2.8 – 17.4 by 1- 5.8 cm. <b>Shape:</b> Lanceolate or elliptic, seldom ovate.	<b>Size:</b> 33-46 by 22-32mm <b>Shape:</b> Cuneate-obovate <b>Color:</b> Violet in color.	<b>Size:</b> <b>Shape:</b> Campanulate fleshy capsule, 8-19 by 8-18mm, rupturing irregularly longitudinally at maturity. Exposing the solid, yellow pulp with orange seeds.
<i>M.sanguineum</i> var. <i>Ranauense</i>	<b>Size:</b> Up to 3m tall <b>Shape:</b> young branches quadrangular <b>Color:</b> bark brown or grey	<b>Size:</b> 5.5-11.5 by 2-3cm. <b>Shape:</b> Lanceolate.	<b>Size:</b> 11-15 by 10-12mm <b>Shape:</b> Campanulate <b>Color:</b> Violet in color.	<b>Size:</b> 11-15 by 10-12mm. <b>Shape:</b> Campanulate fleshy capsules
<i>M.velutinsum</i>	<b>Size:</b> 3-10m tall <b>Shape:</b> young branches subquadrangular. <b>Color:</b> Bark brown.	<b>Size:</b> 7-14 by 4-6.5cm. <b>Shape:</b> Elliptic to ovate.	<b>Size:</b> 8-17mm by 6-8mm <b>Shape:</b> Obovate; <b>Color:</b> Violet in color	<b>Size:</b> 9-13 by 8-10mm. <b>Shape:</b> Campanulate fleshy capsules.

### 2.1 *Melastoma Malabathricum* L: Classification and Nomenclature

*M.malabathricum* belongs to the family Melastomataceae and has many common names including *Senduduk* in Malaysia, Straits Rhododendron in Singapore, *Keduduk*, *Senggani*, *Lingangadi* (Murut), *Gata – Gata* (Kadazandusun), and *Mang Kre* (Thailand).

#### Figure 1.0: Taxonomic Hierarchy of *M.Malabathricum* L.

Kingdom	: <a href="#">Plantae</a> –Plants
Subkingdom	: <a href="#">Tracheobionta</a> –Vascular plants
Superdivision	: <a href="#">Spermatophyta</a> –Seed plants
Division	: <a href="#">Magnoliophyta</a> –Flowering plants
Class	: <a href="#">Magnoliopsida</a> –Dicotyledons
Subclass	: <a href="#">Rosidae</a>
Order	: <a href="#">Myrtales</a>
Family	: <a href="#">Melastomataceae</a> –Melastome family
Genus	: <a href="#">Melastoma</a> L.
Species	: <a href="#">Melastoma malabathricum</a> L.

*M. malabathricum* L. comprises two subspecies, namely, *M. malabathricum* Linn ssp. *malabathricum* and *M. malabathricum* Linn ssp. *normale*. (Meyer, 2001). *Melastoma malabathricum* is a plant of the family of Melastomaceae. It is a meter tall shrub with lots of branches and also can grow up to a height of about 3 to 6m (Zakaria, 1994). The flowers grow in 5 to 10 clusters and have 5 petals (Susanti, 2007; Zakaria, 1994). There are 3 varieties of *M. malabathricum*, classified by the colours of the flower petals i.e: light-pink magenta, dark – purple magenta and white (Susanti, 2007).

### 3.0 Ethno Medicinal Uses of *Melastoma Malabathricum*

Many parts of *M. malabathricum* have been used in herbal remedies for the treatment of various human ailments. The Malay population in Malaysia have used the leaves and shoots of *M. malabathricum* for the treatment of wounds, post-natal care, and prevention of

scars from small pox infection, stomach ulcers, dysentery and diarrhoea (Sulaiman, 2004). The aqueous root extracts of *M. malabathricum* have been used to relieve toothaches and the leaf extract has been reported to possess anti-inflammatory, anti-ulcerogenic and hypotensive effects (Susanti, 2007; Zakaria, 2006). The decoctions of the leaves and shoots have been reported to have antihelminthic and antispasmodic action (Sulaiman, 2004). The crude extract of *Melastoma malabathricum* has been used as an astringent for the treatment of diarrhoea and has also been used for post-partum treatment and treatment of haemorrhoids (Susanti, 2007). A paste of pounded leaves is applied to cuts and wounds as an antihemorrhagic agent and styptic. A tea made from the flowers is used to ease stomach-ache and root decoction is taken for measles. Scars left by small cuts are rubbed on with the plant's purple flowers and this is also used as a face wash (Fasihuddin, 2003). The white petal variety of *Melastoma malabathricum* has been reported to have miraculous healing properties but it is rarely found (Corner, 1951).

Some of the ethno medicinal uses of *Melastoma malabathricum* have been experimentally studied and proved by some researchers. The Table 2.0 shows the list of experimental studies to demonstrate ethno medicinal uses of *Melastoma malabathricum*.

**Table 2.0: The List of Experimental Studies to Demonstrate Ethno Medicinal Uses of *Melastoma Malabathricum***

Year	Title	Part used	Variety of plant used based on petal colour	Solvent used for extraction	References
1995	Medicinal plants from Riau Province, Sumatra, Indonesia. Part2: Antibacterial and antifungal activity.	Crude mixtures of flower, leaves and stem	Not specified	Methanol	Grosvenor <i>et. al.</i>
2002	Antiviral and cytotoxic activities of some Indonesia plants.	Aerial parts	Not specified	Methanol	Lohezic-Le Devehat <i>et. al.</i>
2004	Antinociceptive effect of <i>Melastoma malabathricum</i> ethanolic extract in mice.	Crude mixture of bark and leaves	Not specified	Ethanol	Sulaiman <i>et. al.</i>
2006	Antinociceptive, anti-inflammatory and antipyretic properties of <i>Melastoma malabathricum</i> leaves aqueous extract in experimental animals	Leaves	Not specified	Aqueous	Zakaria <i>et. al.</i>
2007	Antioxidant and cytotoxic flavonoids from the flowers of <i>Melastoma malabathricum</i>	Flowers	Not specified	Ethyl acetate and methanol	Susanti <i>et.al.</i>
2008	Antimicrobial activity and ethnomedicinal uses of some medicinal plants from Similipal Biosphere Reserve Orissa.	Leaf and bark	Not specified	Aqueous	Thatoi <i>et.al.</i>
2008	Gastroprotective effects of <i>Melastoma malabathricum</i> aqueous leaf extract against ethanol induced gastric ulcer in rats	Leaf	Not specified	Aqueous	Hussain <i>et. al.</i>
2008	Selective Inhibition of genes in Methicilin Resistant <i>Staphylococcus Aureus</i> (MRSA) TREATED WITH <i>Melastoma malabathricum</i> methanol	Leaf	Not specified	Ethanol	Zulaikah <i>et. al.</i>

	extract.				
2008	Cytotoxicity and antiviral activity of <i>Melastoma malabathricum</i> extracts	Leaf	Not specified	Methanol	Nazlina <i>et al.</i>
2009	Antidiarrhoeal activity of leaves of <i>Melastoma malabathricum</i> linn	Leaf	Not specified	Water	Sunilson <i>et al.</i>

#### 4.0 Chemical Constituents of *Melastoma Malabathricum*

##### 4.1 Leaves of the Plant

Yoshida *et al.* (1992) have obtained several hydrolysable tannins isolated from the dry leaves of *M. malabathricum* with light pink magenta petals. The main tannins were oligomers named nobotanin B, dimers named malabathrins B, malabathrins C, and malabathrins D and monomers named 1,4,6-tri-O-galloyl- $\beta$ -D-glucoside, 1,2,4,6-tetra-O-galloyl- $\beta$ -D-glucoside, strictinin, casuarictin, pedunculagin, nobotanin D, pterocarininand, nobotanin G, nobotanin H and nobotanin J. Nuresti *et al.* (2003) isolated  $\beta$ -sitosterol,  $\alpha$ -amyrin and uvaol from the hexane fraction. Ethyl acetate fractions yielded sitosterol 3-O- $\beta$ -D-glucopyranoside, quercetin and quercitrin. Susanti *et al.* (2008) noted that to the best of their knowledge, this is the only reported chemical composition of the light pink magenta petal variety of *M. Malabathricum* so far.

Susanti *et al.* (2008) were the first to report isolation of  $\alpha$ -amyrin, patriscabratine, auranamide, quercetin, quercitrin and kaempferol-3-O-(2'', 6''-di-O-*p-trans*-coumaroyl)- $\beta$ -glucoside from the leaves of the white petal variety of *M. malabathricum*. They noted that this was the first report of kaempferol-3-O-(2'', 6''-di-O-*p-trans*-coumaroyl)- $\beta$ -glucoside being isolated from leaves of the genus *Melastoma* (Susanti *et al.*, 2008)

Three pentacyclic triterpenoids, namely ursolic acid, 2-hydroxyursolic acid and asiatic acid, glycerol-1,2-dilinolenyl-3-O- $\beta$ -D-galactopyranoside and glycerol 1,2-dilinolenyl- 3-O-(4,6-di-O-isopropylidene)- $\beta$ -D-galactopyranoside were isolated from the methanolic extract of leaves of *M. malabathricum* - the variety of the plant (by flower colour) was not specified (Nurest *et al.*, 2003).

##### 4.2 Flowers of the Plant

The ethyl acetate extract of *M. malabathricum* flowers yielded three compounds, identified as naringenin, kaempferol and kaempferol -3-O-D-glucoside while the methanolic extract yielded kaempferol-3-O-(2'', 6''-i-O-*p-trans*-coumaroyl)- $\beta$ -glucoside and kaempferol -3-O-D-glucoside. This is the first report of the isolation of these four flavonoids from the flowers of this plant; once again the variety of the plant (by flower colour) was not mentioned (Susanti *et al.*, 2007). Generally, the flowers of the plant contain orange, red and blue anthocyanins. Anthocyanins are (glycosylated polyhydroxy derivatives of 2-phenylbenzo pyrylium salts) are natural, water soluble, nontoxic pigments responsible for the colours of fruits, vegetables, flowers and other plant tissues. Besides its attractive colour, anthocyanins are also beneficial to health, with potential beneficial physiological effects and have also been observed to possess potent antioxidative properties (Janna *et al.*, 2006). According to Janna *et al.*, (2006), the fully formed petals of a bud yet to open have the highest anthocyanin concentration (Janna *et al.*, 2006).

##### 4.3 Fruits of the Plant

The chemical constituents of the fruit of this plant have yet to be reported.

#### 4.4 Bark of the Plant

The chemical constituents of the bark of this plant have yet to be reported.

#### 4.5 Roots of the Plant

From the ethanolic extract of the roots, a dyestuff,  $\beta$ -sitosterol and a triterpenoid designated as melastomic acid (5-hydroxylup-20(29)-en-28-oic acid) were isolated by Manzoor-I-Khuda *et al.*, (1981).

#### 5.0 Antimicrobial Activity

##### 5.1 Antibacterial Activity and Antifungal Activity

A mixture of the flower, leaf and stem of *M. malabathricum* has been used to study antimicrobial activity against *Staphylococcus aureus*, *Escherichia coli*, *Saccharomyces cerevisiae* and *Fusarium oxysporum*. The results showed large and clear inhibition zones for *Staphylococcus aureus* whereas smaller inhibition zones were obtained for *Saccharomyces cerevisiae* and *Fusarium oxysporum* (Grosvenor *et al.*, 1995). The variety of the plant used was not specified.

The leaf and the bark part separately have been used to study antimicrobial activity against a range of bacterial species i.e. *Staphylococcus aureus*, *Shigella flexneri*, *Bacillus licheniformis*, *Bacillus brevis*, *Vibrio cholerae*, *Pseudomonas aeruginosa*, *Candida kruesi*, *Staphylococcus epidermidis* and *Bacillus subtilis* (Thatoi *et al.* 2008).

**Table 3.0: Antimicrobial Activity of the Aqueous Extract of *M. Malabathricum* as reported by Thatoi *et al.* (2008)**

*The numbers indicate the zone of inhibition in mm*

Parts used	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
Leaf	-	-	-	21	20	-	-	13	-	13	ND
Bark	16	-	-	16	20	-	-	-	-	-	ND

S1: *Staphylococcus aureus*; S2: *Shigella flexneri*; S3: *Bacillus licheniformis*; S4: *Bacillus brevis*; S5: *Vibrio cholerae*; S6: *Pseudomonas aeruginosa*; S8: *Candida kruesi*; S9: *Staphylococcus epidermidis*; S10: *Bacillus subtilis*; S11: *Escherichia coli*; ND: Not Detected.

Data in Table 3.0 indicates the presence of a component in the bark which was very active against *Staphylococcus aureus*. Interestingly, this component was not present in the leaf extract. In addition, the leaf contained special bioactive components that inhibited the growth of *Candida krusei* and *Bacillus subtilis* and this active component of the leaf was not present in the bark (Thatoi *et al.*, 2008).

Zulaikah *et al.* (2008), demonstrated that the methanolic extract of *M. malabathricum* leaves inhibit the growth of *Staphylococcus aureus* and six clinical isolates of Methicillin Resistant *Staphylococcus aureus* (MRSA). However, once again, the variety they had used (by flower colour) was not specified (Zulaikah *et al.*, 2008).

In considering the bioactivity of the pure components of *M. malabathricum*, Wong, 2004

states that asiatic acid from the methanolic extract of the leaves was active against *Bacillus subtilis* and *Staphylococcus aureus* while the ethyl acetate-soluble extract of the flower yielded ellagic acid, quercetin and kaempferol, which were the most potent components against these bacteria (Wong, 2004).

## 5.2 Antiviral Activity

Lohezic-Le Devehat *et. al.* (2002) described the mixture of the aerial parts of *M. malabathricum* methanolic extract as having a moderate effect on HSV-1 and significant activity against Poliovirus. However, the same extracts exhibited cytotoxic effects on murine cell lines (Lohezic-Le Devehat *et. al.*, 2002).

This was further confirmed by Nazlina (2008) that methanolic extracts of leaves were capable inhibiting HSV-1 and measles virus during the early stages of viral replication. Interestingly, *M. malabathricum* methanolic extracts were also found to be non-cytotoxic to kidney and fibroblast cell lines (Nazlina, 2008). However, yet once again, the variety of the plant used (by flower colour) was not specified.

## 6.0 Discussion

### 6.1 Botanical Nomenclature of Three Varieties of *Melastoma Malabathricum*

Meyer, 2001 stated that in many species especially *Melastoma malabathricum*, morphological characters vary locally, which resulted in the taxonomic recognition of numerous geographically, restricted entities. Many researchers have recognised three varieties of *Melastoma malabathricum* in Malaysia and locally known as “Senduduk putih”; “Senduduk merah tua” and “Senduduk ungu” for white, pink-magenta, and purple-magenta petal varieties respectively. Till to date, there are no botanical names for these varieties. Further studies could focus on the phylogenetic analysis on these petal varieties of *Melastoma malabathricum* and identify the botanical nomenclatures for those varieties.

### 6.2 The Test Organisms Used for Antimicrobial Activity

Grosvenor *et. al.*, (1995) had used National Collection of Industrial and Marine Bacteria (NCIMB), *Escherichia coli* NCIMB 102281; *Staphylococcus aureus* NCIMB 6571 and the fungal strains from International Mycological Institute (IMI) were *Saccharomyces cerevisiae* (IMI 061263) and *Fusarium oxysporum* (IMI 141119). However, Thatoi *et.al.* (2008) had used Microbial Type Culture Collection (MTCC) for *Staphylococcus aureus* MTCC 1144; *Bacillus licheniformis* MTCC 7425; *Bacillus brevis* MTCC 7404; *Pseudomonas aeruginosa* MTCC 1034; *Staphylococcus epidermidis* MTCC 3615; *Bacillus subtilis* MTCC 7164; *Escherichia coli* MTCC 1089; However, laboratory collection of *Vibrio cholera*; *Candida kruesi*; *Shigella flexneri* had used for this studies. Nevertheless, Zulaikah *et.al.* (2008), used American Test Culture Collection (ATCC) for *Staphylococcus aureus* ATCC 25923 and 6 clinical isolates from Hospital Putrajaya and Hospital Pulau Pinang, Malaysia.

The test organism suggested is from ATCC, as it is a well recognized organization and the strains are well characterized. The studies also could focus on the biofilms forming bacteria, as these bacteria produce extracellular polymeric substances (EPS) as their defence mechanisms to resist antimicrobial agents. Thus, it will be very interesting to use the biofilm producer cultures and these are available from ATCC as well. So far, only

Zulaikah *et.al* (2008) had studied the multi drug resistant bacteria MRSA. However, scientist also focused on formulating drugs for Vancomycin resistant Enterococci (VRE). Thus, *M. malabathricum* extracts could use to study on VRE cultures and other range of ATCC test organisms of drug resistant Gram positive and Gram negative bacterial, fungus, protozoan and virus.

### 6.3 Solvents for Extractions to Obtain More Bioactive Components

The ultimate objective of the natural products extract is to elucidate the active constituents. Most of the researchers, used methanol, ethanol, ethyl acetate and aqueous extract of the plant. However, for extraction of hydrophilic compounds from natural products, polar solvent such as methanol, ethanol and ethyl acetate can be used. Lipophilic compounds can be extracted by using dichloromethane or a mixture of dichloromethane/methanol 1:1 and the extraction in hexane can be used to remove chlorophyll. (Cos *et. al.* 2006). Petroleum ether also can be use as solvent for extraction. According to Elhag *et.al* (1999), the highest growth inhibition was found in the petroleum ether and chloroformic successive extracts of an evergreen tree Khat, (*Catha edulis* Forssk, Celastraceae).

### 6.4 Further Laboratory Approaches

Clearly, *M. malabathricum* contains one or more components with promising potential as an antibacterial antibiotic(s) against selective Gram positive and Gram negative bacteria. However, further studies are needed to elucidate the relative efficacy of the three varieties of the plant (by flower colour). In addition, the relative efficacy of the different parts of the plant i.e. flower, leaf, stem, root and fruit, need to be determined for elucidation of the overall potency of the plant. Furthermore, more extensive screening is required to test the efficacy of the plant to other Gram negative bacterial pathogens like *Salmonella typhimurium*, *Proteus vulgaris* and *Proteus mirabilis*, *Klebsiella pneumoniae*, *Yersinia enterocolitica*, *Campylobacter jejuni*, *Acinetobacter baumannii*, *Acinetobacter iwoffii*, *Stenotrophomonas maltophilia*, *Haemophilus influenzae* and *Neisseria meningitides*, and Gram positive bacterial pathogens like *Streptococcus pneumoniae* and *Enterococcus faecalis*. Amongst the numerous medically important fungi, *M.malabathricum* has only been tested against *Candida krusei* and *Fusarium oxysporum* so far. Thus, screening efforts need to be extended to include other medically important fungi such as *Candida dubliniensis*, *Candida parapsilosis*, *Candida glabrata*, *Candida lusitaniae*, *Candida albicans*, *Candida guilliermondii*, *Cryptococcus neoformans*, *Cryptococcus laurentii*, *Aspergillus fumigatus*, *Rhizopus arrhizus*, *Rhizopus microsporus* var. *rhizopodiformis*, *Rhodotorula* spp., *Penicillium marneffeii*, *Trichophyton* spp., *Epidermophyton floccosum*, *Microsporum* spp., *Fonsecaea pedrosoi*, *Phialophora verrucosa*, *Pseudallescheria boydii*, *Exophiala jeanselmei*, *Madurella* spp. and *Sporothrix schenckii*. This study proposes to address some of these oversights. Antiviral activity of *M.malabathricum* extracts have only been undertaken on HSV-1, Poliovirus and measles virus, Thus, the researchers should also spotlight on the large number of recalcitrant viral infections that exist today such as malaria, dengue, rotavirus, AIDS, cholera, tuberculosis, Human papillomavirus (HPV) and so on.

The white petal variety plants are very rare to find. Thus, if the bioactive constituents of this variety can be identified, then the synthetic compounds of these constituents can also be extracted. Nevertheless, genetic engineering technology could utilize the white petal

variety of *Melastoma malabathricum* by altering the molecular structure and characteristics of the gene to produce more active constituents.

### 7.0 Conclusion

In conclusion, the studies that were done on this herbarium plant are very limited. More studies are needed to focus on identifying the pure active components of the plant that inhibit the growth of infection causative agents. This finding could lead to the development of drugs for medical use.

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