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Medicinal Plants of the Indigenous Tribes in Peninsular Malaysia: Current and Future Perspectives

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Abstract

The main aim of this paper is to compile information on plant that is known to be medicinal to the indigenous tribes in Peninsular Malaysia. Information is compiled from various sources. Current trends on studies of medicinal plants of the indigenous tribes and threats to the sustainability of the plants are also discussed. Focus of future studies on medicinal plants utilized by the indigenous tribes will also be discussed.

Keywords: Jah Hut, medicinal, Negrito, Semai, Semang, Temuan, proto-Malay

1. Introduction

The indigenous tribes in Peninsular Malaysia are collectively known as the Orang Asli. The Orang Asli consists of 18 subethnic groups or tribes which anthropologists and administrators grouped into the Semang (Negrito), Senoi, and aboriginal Malay (proto-Malay). Documentation on the plant resources, particularly medicinal plants, utilized by the people is still far from complete as most of the villages of the tribes have not been studied. Documentation on traditional uses of medicinal plants is important because it helps to preserve traditional culture of indigenous tribes, provide leads to the discovery medicinal compounds, and find ways to conserve the medicinal plants.

The main aims of this paper are to compile information on medicinal plants of the indigenous tribes in Peninsular Malaysia based on previous studies and to provide direction for future studies on the medicinal plants of the indigenous tribes.

2. List of medicinal plants of the indigenous tribes in Peninsular Malaysia

Two hundred and thirteen species of plants (**Table 1**) have been reported as medicinal to the indigenous tribes in Peninsular Malaysia. The medicinal plants were based on uses by the tribes Jah Hut, Semai, Semang and Temuan. Information on the plants is compiled from Refs. [1–8]. Leaves and roots are the most common parts that have medicinal uses. Destructive harvest, i.e., those that involve the removal of barks, roots, or whole plants, is among the most susceptible to overharvest because of destruction of the entire plants [9].

3. Current approaches of research on medicinal plants of indigenous tribes in Peninsular Malaysia

The most common approach to illicit information on the medicinal plants of the indigenous tribes is through semistructure interviews with traditional medicine practitioners known as *batin*. Two issues that have not been adequately addressed in previous studies are the veracity of information obtained from such approach and the extent of use or usage of medicinal by the indigenous tribes.

The veracity of information on medicinal properties plants utilized by the indigenous tribes in Peninsular Malaysia can be verified by laboratory analysis of bioactive compounds extracted from the plants. Several such studies have already been carried on some of the species that are listed in **Table 1**. Mohd Zin et al. [10] had carried out antioxidative activity of extracts from *Morinda citrifolia* L. and had concluded that active compounds in root of the plant might be both polar and nonpolar in nature, whereas compounds that contribute to antioxidative activity of both its leaf and fruit are probably nonpolar in nature. Hakimi Wan Salleh et al. [11] studied the chemical compositions and antioxidant and antimicrobial activities of essential oils of *Piper caninum* Blume. Safrole, β -caryophyllene, β -pinene, and germacrene D were the main components from the leaf and stem oil of the plant. They noted that the highest activity was observed for inhibition of lipid peroxidation in the β -carotene/linoleic acid system by the stem oil and the essential oil showed strong antimicrobial activity. Ang et al. [12] studied that aphrodisiac property of *Eurycoma longifolia* Jack has been studied by examining the effects of *E. longifolia* Jack on sexual qualities in middle-aged male rats. They demonstrated that *E. longifolia* Jack enhanced the sexual qualities of the middle-aged male rats. Bhat and Karim [13] reviewed the ethnobotany and pharmacological importance and *E. longifolia* Jack and noted that the plant possesses adequate therapeutic potential and could be explored further for commercial purposes and could be designated as a “wonder drug plant.”

Information on usages of medicinal plants by the indigenous tribes was very limited in previous reports, thus making the assessment of this aspect of traditional culture practice difficult. Persistent usage of the medicinal plants by the tribes is important to ensure that the knowledge on the medicinal uses of plants is conserved and subsequently should contribute to the conservation of the plants. This is of concern because as modernization moves toward the

No.	Species	Indigenous tribe(s) [plant part(s) used]	Sources of information
1.	<i>Abutilon indicum</i> L.	Semang [leaves]	[3]
2.	<i>Acorus calamus</i> L.	Semai [rhizomes]	[6]
3.	<i>Acrotrema costatum</i> Jack	Semang [roots and leaves]	[7]
4.	<i>Agelaea macrophylla</i> (Zoll.) Leenh.	Semang [leaves]	[3]
5.	<i>Aglaia odorata</i> Lour.	Semang [flowers]	[3]
6.	<i>Aglaia yzermannii</i> Boerl. & Koord.	Semang [leaves]	[1]
7.	<i>Albizia myriophylla</i> Benth.	Jah Hut [roots]	[5]
8.	<i>Aloe barbadensis</i> Mill.	Jah Hut [leaves], Temuan [leaves]	[4, 5]
9.	<i>Alpinia galanga</i> (L.) Willd.	Temuan [rhizomes]	[4]
10.	<i>Alstonia angustiloba</i> (L.) Miq.	Jah Hut [leaves]	[2]
11.	<i>Ancistrocladus extensus</i> Wall. ex Planch	Jah Hut [roots]	[5]
12.	<i>Ancistrocladus tectorius</i> (Lour.) Merr.	Semang [roots]	[7]
13.	<i>Annona muricata</i> L.	Semang [leaves]	[3]
14.	<i>Apama tomentosa</i> Engl.	Temuan [roots]	[4]
15.	<i>Aquilaria malaccensis</i> Lamk.	Jah Hut [stems and leaves], Semai [barks]	[5, 6]
16.	<i>Archidendron ellipticum</i> Blume	Semang [leaves]	[3]
17.	<i>Archidendron jiringa</i> Niels.	Temuan [barks, leaves, and roots]	[4]
18.	<i>Ardisia colorata</i> Roxb.	Semang [leaves]	[3]
19.	<i>Ardisia crenata</i> Sims.	Jah Hut [leaves], Semang [whole plants]	[3, 5]
20.	<i>Ardisia crispa</i> (Thunb.) DC	Semang [whole plants]	[7]
21.	<i>Ardisia sanguinolenta</i> Bl.	Jah Hut [roots]	[5]
22.	<i>Areca catechu</i> L.	Semang [fruits]	[7]
23.	<i>Argostemma pictum</i> Wall.	Semang [whole plants]	[7]
24.	<i>Artemisia argyi</i> Levi. et Vant.	Semang [leaves]	[3]
25.	<i>Arthrophyllum diversifolium</i> Blume	Semang [roots]	[3]
26.	<i>Averrhoa bilimbi</i> L.	Semang [leaves]	[3]
27.	<i>Averrhoa carambola</i> L.	Temuan [barks, leaves, and roots]	[4]
28.	<i>Azadirachta indica</i> Juss.	Temuan [leaves]	[4]
29.	<i>Barringtonia acutangula</i> (L.) Gaertn.	Semang [stems]	[7]
30.	<i>Baccaurea motleyana</i> (Muell. Arg.) Muell. Arg.	Temuan [fruits]	[4]
31.	<i>Baccaurea ramiflora</i> Lour.	Jah Hut [roots]	[5]
32.	<i>Barleria lupulina</i> Lindl.	Semang [leaves]	[3]
33.	<i>Barleria prionitis</i> L.	Semang [leaves]	[3]
34.	<i>Bauhinia semibifida</i> Roxb.	Semang [roots]	[3]

No.	Species	Indigenous tribe(s) [plant part(s) used]	Sources of information
35.	<i>Bixa orellana</i> L.	Semai [seeds]	[6]
36.	<i>Blechnum orientale</i> L.	Semai [leaves]	[6]
37.	<i>Bombax ceiba</i> L.	Semang [leaves]	[3]
38.	<i>Bonnaya veronicaefolia</i> Spreng.	Temuan [leaves]	[4]
39.	<i>Bulbophyllum mutabile</i> (Bl.) Lindl.	Semang [leaves]	[3]
40.	<i>Caesalpinia crista</i> L.	Semang [seeds]	[3]
41.	<i>Calamus ornatus</i> Bl.	Semai [stem saps]	[6]
42.	<i>Cassytha filiformis</i> L.	Semang [whole plants]	[3]
43.	<i>Catharanthus roseus</i> (L.) Don	Temuan [whole plants]	[4]
44.	<i>Centella asiatica</i> (Linn.) Urban	Semang [whole plants], Semang [leaves] Temuan [whole plants]	[3, 4, 7]
45.	<i>Champereia manillana</i> (Bl.) Merr.	Semang [roots]	[7]
46.	<i>Chassalia chartacea</i> Craib	Semang [roots]	[7]
47.	<i>Chroesthes longifolia</i> (Wight) Hansen	Jah Hut [roots]	[5]
48.	<i>Cinnamomum aureofulvum</i> Gamb.	Jah Hut [roots]	[5]
49.	<i>Cinnamomum iners</i> Reinw. ex Blume	Semang [roots]	[7]
50.	<i>Cinnamomum javanicum</i> Bl.	Temuan [leaves]	[4]
51.	<i>Citrus medica</i> L.	Jah Hut [fruits]	[5]
52.	<i>Cnestis platantha</i> Griff.	Semang [leaves]	[3]
53.	<i>Cnestis ramiflora</i> Griff.	Semang [roots]	[7]
54.	<i>Cocos nucifera</i> L.	Temuan [fruits]	[5]
55.	<i>Conarus grandis</i> Jack	Jah Hut [roots]	[5]
56.	<i>Coptosapelta tomentosa</i> (L.) (Blume) Valetton ex K. Heyne	Jah Hut [roots]	[2]
57.	<i>Costus speciosus</i> (Koenig.) Smith	Semang [stems], Jah Hut [leaves], Semai [leaves]	[5–7]
58.	<i>Crinum asiaticum</i> L.	Temuan [leaves]	[4]
59.	<i>Croton caudatus</i> Geisel	Semang [roots]	[3]
60.	<i>Curcuma longa</i> L.	Temuan [rhizomes]	[4]
61.	<i>Curcuma petiolata</i> Roxb.	Semang [rhizomes]	[3]
62.	<i>Curcuma xanthorrhiza</i> Roxb.	Semang [rhizomes]	[7]
63.	<i>Cyclea laxiflora</i> Miers	Semai [whole plants]	[6]
64.	<i>Cymbopogon citratus</i> (DC.) Stapf.	Jah Hut [leaves]	[5]
65.	<i>Cymbopogon nardus</i> (L.) Rendle	Jah Hut [leaves], Temuan [leaves]	[4, 5]
66.	<i>Cyrtandra pendula</i> Bl.	Jah Hut [roots]	[5]

No.	Species	Indigenous tribe(s) [plant part(s) used]	Sources of information
67.	<i>Daemonorops didymophyllus</i> Becc.	Semang [saps]	[1, 7]
68.	<i>Dendrophoebe constricta</i> Dans.	Semang [leaves]	[3]
69.	<i>Desmos chinensis</i> Lour.	Jah Hut [roots]	[5]
70.	<i>Dianella ensifolia</i> Red.	Semai [roots]	[6]
71.	<i>Dicranopteris linearis</i> (Burm.) Underw.	Semai [leaves]	[6]
72.	<i>Dioscorea hispida</i> Dennst.	Temuan [tubers]	[4]
73.	<i>Dipteracanthus repens</i> (L.) Hassk.	Semang [leaves]	[3]
74.	<i>Durio zibethinus</i> Murray	Semang [leaves]	[1, 2, 7]
75.	<i>Dysoxylum alliaceum</i> (Bl.) Bl.	Semang [roots]	[7]
76.	<i>Elephantopus scaber</i> L.	Temuan [leaves]	[4]
77.	<i>Elephantopus tomentosus</i> L.	Temuan [leaves]	[4]
78.	<i>Etlingeria elatior</i> (Jack) Smith	Semang [leaves]	[7]
79.	<i>Eleiodoxa conferta</i> (Griff.) Burret	Semang [stems]	[8]
80.	<i>Epiprinus malayanus</i> Griff.	Jah Hut [roots]	[5]
81.	<i>Eranthemum borneense</i> Hook f.	Semang [leaves]	[3]
82.	<i>Eugenia urceolata</i> King.	Jah Hut [roots]	[5]
83.	<i>Eupatorium odoratum</i> L.	Semang [leaves]	[3, 7]
84.	<i>Euphorbia hirta</i> L.	Jah Hut [latex]	[5]
85.	<i>Euphorbia tirucalli</i> L.	Semang [latex]	[3]
86.	<i>Eurycoma apiculata</i> Benn.	Semai [leaves]	[6]
87.	<i>Eurycoma longifolia</i> Jack	Semang [roots], Jah Hut [roots], Temuan [leaves, roots], Semang [roots]	[2-5, 7]
88.	<i>Fibraurea chloroleuca</i> Miers	Semang [roots]	[7]
89.	<i>Ficus aurantiaca</i> Griff.	Jah Hut [stems and roots], Temuan [stems]	[4, 5]
90.	<i>Freycinetia javanica</i> Bl.	Semang [roots]	[7]
91.	<i>Garcinia mangostana</i> L.	Semang [fruits]	[3]
92.	<i>Garcinia scortechinii</i> King.	Jah Hut [roots]	[4]
93.	<i>Gnetum leptostachyum</i> Blume	Semang [whole plants]	[3]
94.	<i>Gomphandra lanceolata</i> King.	Temuan [roots]	[4]
95.	<i>Goniothalamus macrophyllus</i> (Bl.) Miq.	Jah Hut [roots], Semai [barks]	[5, 6]
96.	<i>Guioa pubescens</i> (Zoll. & Mor.) Radlk.	Semang [roots and leaves]	[7]
97.	<i>Gynura procumbens</i> (Lour.) Merr.	Semang [leaves]	[3]
98.	<i>Hedyotis capitellata</i> (L.) Wall. ex G. Don	Jah Hut [roots], Semai [roots]	[2, 5]
99.	<i>Hevea brasiliensis</i> Muell. Arg.	Jah Hut [stems]	[5]

No.	Species	Indigenous tribe(s) [plant part(s) used]	Sources of information
100.	<i>Hedychium longicornutum</i> Baker	Semang [roots]	[7]
101.	<i>Helminthostachys zeylanica</i> (L.) Hook.	Semang [whole plants], Jah Hut [roots]	[5, 7]
102.	<i>Hibiscus rosa-sinensis</i> L.	Temuan [leaves], Semang [roots and barks]	[3, 4]
103.	<i>Hibiscus tiliaceus</i> L.	Semang [barks]	[3]
104.	<i>Hippocratea indica</i> Willd.	Jah Hut [roots]	[5]
105.	<i>Homalanthus populneus</i> (L.) (Geisel.) Pax	Jah Hut [leaves]	[2]
106.	<i>Homalomena griffithii</i> Hk.f.	Semai [stems]	[6]
107.	<i>Homalomena rostrata</i> Griff.	Jah Hut [roots]	[5]
108.	<i>Hoya coronaria</i> Blume	Semang [leaves]	[3]
109.	<i>Iguanura geomorformis</i> Mart.	Semai [leaves]	[6]
110.	<i>Imperata cylindrica</i> (L.) Beauv.	Semang [whole plants]	[3]
111.	<i>Jasminum sambac</i> (L.) Ait.	Semang [leaves]	[3]
112.	<i>Jatropha curcas</i> L.	Semai [saps], Semang [leaves]	[3, 6]
113.	<i>Justicia betonica</i> L.	Jah Hut [leaves]	[5]
114.	<i>Kaempferia galanga</i> L.	Semang [rhizomes]	[3]
115.	<i>Kalanchoe pinnata</i> (Lam.) Pers.	Semang [leaves]	[7]
116.	<i>Labisia pothoina</i> Lindl.	Jah Hut [roots and stems], Semai [roots]	[5, 6]
117.	<i>Labisia pumila</i> (Blume) Mez	Semang [roots]	[7]
118.	<i>Languas conchigera</i> Burkill	Semang [rhizomes]	[3]
119.	<i>Lantana camara</i> L.	Semang [leaves]	[3]
120.	<i>Lasia spinosa</i> Thwaites	Semang [tubers], Jah Hut [leaves]	[5, 7]
121.	<i>Lasianthus oblongus</i> King & Gamble	Jah Hut [roots]	[5]
122.	<i>Lasianthus villosus</i> Ridl.	Semai [leaves]	[6]
123.	<i>Lawsonia inermis</i> (L.) Pers.	Semang [leaves]	[7]
124.	<i>Leea indica</i> (Burm. f.) Merr.	Semang [leaves]	[7]
125.	<i>Lepidagathis incurva</i> Buch.-Ham.	Jah Hut [leaves]	[5]
126.	<i>Leptaspis urceolata</i> R. Br.	Jah Hut [roots]	[5]
127.	<i>Licuala spinosa</i> Wurm	Jah Hut [meristems]	[5]
128.	<i>Limacia oblonga</i> (Miers.) Hk.f. et. Thoms.	Temuan [stems]	[4]
129.	<i>Lindera lucida</i> (Bl.) Boerl.	Semai [leaves]	[6]
130.	<i>Lindera pipericarpa</i> (Miq.) Boerl.	Jah Hut [roots]	[5]
131.	<i>Lophatherum gracile</i> Brongn.	Semang [roots], Semai [roots]	[7]
132.	<i>Loranthus cochinchinensis</i> Lour.	Semang [whole plants]	[7]

No.	Species	Indigenous tribe(s) [plant part(s) used]	Sources of information
133.	<i>Luvunga scandens</i> Buch.-Ham.	Semai [leaves]	[5]
134.	<i>Lycopodiella cernua</i> (L.) Pic. Serm.	Jah Hut [leaves]	[2]
135.	<i>Lygodium circinnatum</i> (Burm.) Sw.	Semang [leaves]	[3, 7]
136.	<i>Lygodium flexuosum</i> (L.) Sw.	Jah Hut [leaves]	[2]
137.	<i>Lygodium microphyllum</i> (Cav.) R.Br.	Semai [leaves]	[6]
138.	<i>Maranta arundinacea</i> L.	Jah Hut [roots]	[2]
139.	<i>Marumia nemorosa</i> Bl.	Semai [leaves]	[6]
140.	<i>Melastoma malabathricum</i> L.	Jah Hut [roots]	[2]
141.	<i>Mikania micrantha</i> Kunth ex H.B.K.	Semang [whole plants]	[7]
142.	<i>Millettia sericea</i> Benth.	Semai [stems]	[6]
143.	<i>Mitragyna speciosa</i> Korth	Semang [leaves]	[7]
144.	<i>Morinda citrifolia</i> L.	Semang [fruits], Jah Hut [leaves and fruits]	[2, 3]
145.	<i>Musa sapientum</i> L.	Semang [fruits]	[7]
146.	<i>Neodissochaeta gracilis</i> (Jack) Bakh.	Semang [leaves]	[7]
147.	<i>Nephelium lappaceum</i> L.	Semang [leaves]	[7]
148.	<i>Oldenlandia diffusa</i> (Willd.) Roxb.	Semang [leaves]	[3]
149.	<i>Orchidantha longiflora</i> Ridl.	Semai [leaves]	[6]
150.	<i>Oroxylum indicum</i> (L.) Kurz	Semang [barks]	[7]
151.	<i>Oryza sativa</i> L.	Semai [seeds]	[6]
152.	<i>Parameria barbata</i> (Blume) K.Schum.	Semang [roots]	[7]
153.	<i>Parkia speciosa</i> Hassk.	Semai [roots], Temuan [roots], Semang [seeds]	[3, 4, 6]
154.	<i>Peliosanthes lurida</i> Ridl.	Semang [roots]	[7]
155.	<i>Peliosanthes violacea</i> Wall.	Semang [roots], Jah Hut [roots], Semai [leaves]	[5–7]
156.	<i>Pellacalyx saccardianus</i> Scort.	Semai [leaves]	[6]
157.	<i>Peltophorum pterocarpum</i> (DC.) K. Heyne	Semang [barks]	[3]
158.	<i>Peristrophe acuminata</i> Nees	Jah Hut [leaves]	[5]
159.	<i>Peucedanum japonica</i> Thunb.	Temuan [roots]	[4]
160.	<i>Phyllagathis rotundifolia</i> (Jack) Bl.	Jah Hut [roots]	[5]
161.	<i>Phyllanthus niruri</i> L.	Semang [whole plants]	[3]
162.	<i>Phyllanthus oxyphyllus</i> Miq.	Temuan [whole plants]	[4]
163.	<i>Phyllanthus pulcher</i> Wall. ex Muell. Arg.	Jah Hut [roots]	[5]
164.	<i>Phyllanthus urinaria</i> L.	Semai [whole plants]	[6]
165.	<i>Physalis minima</i> L.	Jah Hut [leaves]	[2]

No.	Species	Indigenous tribe(s) [plant part(s) used]	Sources of information
166.	<i>Pinanga polymorpha</i> Becc.	Jah Hut [leaves]	[5]
167.	<i>Piper betle</i> L.	Temuan [leaves]	[4]
168.	<i>Piper caninum</i> Blume	Semang [fruits and barks]	[7]
169.	<i>Piper muricatum</i> Bl.	Semai [leaves]	[6]
170.	<i>Planchonella obovata</i> (R. Br.) Pierre	Semang [leaves]	[3]
171.	<i>Platyserium bifurcatum</i> (Cav.) C. Chr.	Semang [tubers]	[7]
172.	<i>Plumeria obtusa</i> L.	Semai [flowers]	[6]
173.	<i>Polyalthia bullata</i> King.	Jah Hut [roots]	[5]
174.	<i>Pongamia pinnata</i> L.	Semang [leaves and seeds]	[3]
175.	<i>Pseuderanthemum crenulatum</i> (L.) Lindl.	Jah Hut [leaves]	[2]
176.	<i>Pseuderanthemum piloselloides</i> (L.) M.G. Price	Jah Hut [leaves]	[2]
177.	<i>Psidium guajava</i> L.	Jah Hut [leaves], Temuan [leaves]	[4, 5]
178.	<i>Psychotria montana</i> Bl.	Jah Hut [roots]	[5]
179.	<i>Rafflesia cantleyi</i> Solms.-Laub.	Semai [flowers]	[6]
180.	<i>Rennellia speciosa</i> (Wall. ex Kurz) Hk.f.	Jah Hut [roots]	[5]
181.	<i>Rourea concolor</i> Bl.	Temuan [roots]	[4]
182.	<i>Salacca affinis</i> Griff.	Jah Hut [leaves]	[5]
183.	<i>Sambucus javanica</i> Reinw. ex Blume	Semang [leaves]	[3]
184.	<i>Sansevieria trifasciata</i> Prain	Semang [leaves]	[3]
185.	<i>Smilax calophylla</i> Wall.	Semang [roots], Temuan [whole plants]	[4, 7]
186.	<i>Smilax lanceifolia</i> (L.) Roxb.	Jah Hut [leaves]	[2]
187.	<i>Smilax myosotiflora</i> L.	Jah Hut [bulbs]	[2]
188.	<i>Solanum nigrum</i> L.	Semang [fruits and leaves]	[3]
189.	<i>Spilanthes paniculata</i> Wall. ex DC.	Semang [flowers]	[7]
190.	<i>Stachyphrynium jagoranum</i> Schum.	Jah Hut [roots]	[5]
191.	<i>Stachytarpheta jamaicensis</i> (L.) Vahl.	Semang [whole plants]	[3]
192.	<i>Striga asiatica</i> (L.) Kuntze	Jah Hut [whole plants], Temuan [whole plants]	[4, 5]
193.	<i>Strobilanthes crispus</i> Blume	Semang [leaves]	[3]
194.	<i>Styrax benzoin</i> Dryand	Jah Hut [resin], Semai [resin]	[5, 6]
195.	<i>Syzygium cerina</i> Hend.	Semang [roots]	[3]
196.	<i>Syzygium samarangense</i> Blume	Semang [leaves]	[3]
197.	<i>Tagetes patula</i> L.	Semai [flowers]	[6]
198.	<i>Talinum triangulare</i> (Jacq.) Willd.	Semang [flowers]	[3]

No.	Species	Indigenous tribe(s) [plant part(s) used]	Sources of information
199.	<i>Tectaria angulata</i> (Willd.) Copel	Semang [roots]	[7]
200.	<i>Tetracera macrophylla</i> Wall. ex Hk.f. & Thoms	Jah Hut [leaves], Temuan [leaves]	[4, 5]
201.	<i>Timonius wallichianus</i> (Korth.) Val.	Semang [roots], Jah Hut [whole plants]	[5, 7]
202.	<i>Tinospora crispa</i> (L.) Miers. ex Hk.f. and Thoms.	Temuan [stems], Semang [stems]	[3, 4]
203.	<i>Trema orientalis</i> (L.) Bl.	Temuan [leaves and shoots]	[4]
204.	<i>Trichilia trijuga</i> Roxb.	Semang [barks]	[3]
205.	<i>Urena lobata</i> L.	Semai [stems]	[6]
206.	<i>Uvaria sorsogonensis</i> C.Presl.	Semang [leaves]	[3]
207.	<i>Vernonia arborea</i> Buch.-Ham.	Jah Hut [roots]	[5]
208.	<i>Vernonia cinerea</i> (L.) Less.	Jah Hut [leaves and roots]	[2]
209.	<i>Zingiber griffithii</i> Baker	Semai [rhizomes]	[6]
210.	<i>Zingiber officinale</i> Rosc.	Temuan [rhizomes]	[4]
211.	<i>Zingiber ottensii</i> Valetton	Semang [rhizomes]	[3]
212.	<i>Zingiber spectabile</i> Griff.	Jah Hut [leaves], Semai [leaves]	[5, 6]
213.	<i>Zingiber zerumbet</i> (L.) Roscoe ex Sm.	Semang [latex]	[7]

Table 1. Annotated medicinal plant species list of the indigenous tribes in Peninsular Malaysia.

doorstep of the indigenous tribes, knowledge and usage of biodiversity decrease and eventually become adulterated or lost to humanity [4].

4. Future studies on medicinal plants of indigenous tribes in Peninsular Malaysia

Future studies on medicinal plants should be extended to more villages of the indigenous tribes in Peninsular Malaysia. The studies should include aspects that have not been adequately addressed in the previous studies. Other aspects that can be included in future studies are the use of geographical information system to analyze the spatial trend on medicinal plants of the indigenous tribes and also the development of automated identification system for medicinal plant species.

Geographic information systems (GIS) have not been used in any studies on the medicinal plants in Peninsular Malaysia, although the use of GIS for conserving medicinal and herbal plants elsewhere has been reported [14–17]. GIS application together with remote sensing data could be used for comprehensive vegetation mapping and analysis of data attained from ground surveys. In terms of mapping medicinal plants, remote sensing data can be useful to obtain information on land usage or coverage, vegetation, terrain attributes, distribution, and accessibility to area. Besides this, GIS could be used to produce map layers and to develop

comprehensive databases on physical, biological, and environmental parameters which govern the spatial distribution and abundance of medicinal plants.

Serious consideration should be given to the use of machine learning for rapid identification of medicinal plants, especially those utilized by the indigenous tribes in Peninsular Malaysia. As medicinal plants utilized by most of the indigenous tribes have not been studied, these techniques will facilitate urgent documentation of the plants which are needed for their conservation. Machine learning methods such as artificial neural networks (ANN) and support vector machine (SVM) have been used to develop automated plant species identification despite the claims that leaf morphology is not a reliable indicator in identifying tree species. ANN is a mathematical model composed of many processing units that communicate by interconnected variables. It is trained using data for which the classes are known, followed by being used for class prediction of unidentified data. Multilayer structure of ANN enables learning from complex input image features and generates single output. Support vector machine (SVM) is a supervised learning method proposed by Cortes and Vapnik [18], generating hyperplanes for classification, based on statistical learning theory and structural risk minimization. The boundary of hyperplanes separates the sample data mapped in space, clearly dividing them into categories. New data will be predicted to belong to a category by the hyperplanes.

Studies conducted by Clark et al. [19] applied ANN to extract features from species of the genus *Tilia* and achieved 44% accuracy rate. Kumar et al. [20] developed a "Leafsnap," a computerized system that searches on database for species matching and retrieval. Hearn [21] used a combination of Fourier analysis and Procrustes analysis (a simple shape registration method, based on rotation, translation, and scaling) to perform species identification using a large database of 2420 leaves from 151 different species.

5. Conclusion

Two hundred and thirteen species of plants have been reported as medicinal to the indigenous tribes in Peninsular Malaysia. Leaves and roots are the two most common medicinal plant parts used by the indigenous tribes in Peninsular Malaysia. Medicinal use of roots requires destructive harvesting which may lead to overharvesting of the plant species. Future studies on medicinal plants of the indigenous tribes in Peninsular Malaysia should extend to more tribes as information that is available up to now is only to the Jah Hut, Semai, Semang, and Temuan tribes. Aspects of the medicinal plants of the indigenous tribes have been overlooked in previous studies; such veracity of information and usage need to be emphasized in future studies. To facilitate spatial analysis and identification of the medicinal plants, geographical information system and machine learning techniques can also be employed in future studies.

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