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Review: Antibacterial, Antioxidant and Chemical Profile of *Centella asiatica*

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ABSTRACT

Plants have been used since ancient times whether as foods/seasoning or medicinal purposes. The used of plants for medicinal purposes can be found almost every parts of the world; from Africa to Europe. Nowadays, there are increasing trends of using natural products. From the discovery that effective life span of any antibiotic is limited. Scientists try to discover alternatives. One of the sources is from plants. As they have an almost limitless ability to synthesize aromatic substances especially plant secondary metabolites. Most of plant secondary metabolites serve as plant defense mechanisms against predation by microorganisms, insects, and herbivores. Thus this is where the hypothesis of using plants as alternative antimicrobial agents. Not only that, plant also contains phenolic compounds that can be served as natural antioxidants. Interestingly herbs are considered to be one of the alternatives consumers choose to use. In Thailand, *Centella asiatica* can be found in local market and locally called Buabok. *C. asiatica* is famous in Ayurvedic medicine for the treatment of leprosy, insanity, asthma, ulcers, eczema, skin tuberculosis, wounds, stomach aches, arthritis, varicose veins and high blood pressure. By that, gathered information of antibacterial, antioxidant and chemical profile of *C. asiatica* could serve as stepping stone.

Key words: Antibacterial, Antioxidant, Chemical profile, *Centella asiatica,* Review

INTRODUCTION

Centella asiatica (L.) Urban. (Bua-bog, Tiger Herbal, pennywort, or gotu kola) stem, leaves, and aerial parts are used to the traditional drug formular to decrease blood pressure, cure the fresh wound, heal bruised and diuretic[1]. The herb contains many types of active compounds, Terpenes or Terpenoids[2,3]. From the work of Arumugam and others [4], it was found that different extraction solvents would yield different phytochemical compounds. From that finding, the different in phytochemical compounds could affect the antibacterial and antioxidant activity. Later in this review will show previous work that have been done using different extraction solvents on antibacterial and antioxidant activity including chemical profile obtained from GC-MS.

Antibacterial properties of *Centella asiatica*

Centella asiatica (L.) Urban. (Bua-bog, Tiger Herbal, pennywort, or gotu kola) stem, leaves, and aerial parts are used to the traditional drug formular to decrease blood pressure, cure the fresh wound, heal bruised and diuretic[1]. The herb contains many types of active compounds, Terpenes or Terpenoids[2,3]. Several reports showed that the crude extraction of *C. asiatica* by 95% ethanol exhibited antimicrobial activity against Bacillus *cereus* and *Listeria monocytogenes* under normal, osmotic stress, and low pH[5,6]. Mamtha and others [7] also reported the ethanolic *C. asiatica* extract against enteric pathogens. Lee and Vairappan [8] studied antioxidant, antibacterial and cytotoxic activities of essential oils and ethanol extracts of selected South East Asian herbs. One of the selected South East Asian herbs was *C.*

asiatica. Ethanolic extract of *C. asiatica* showed antibacterial activity against *Salmonella enteritidis* and *Salmonella typhimurium* while essential oil of *C. asiatica* showed no inhibition at same concentration.

Samy and Ignacimuthu[9] studied folklore medicinal plants used by tribals in Western Ghats of India. One of the medicinal plants was *C. asiatica*. They found that various fraction of solvent used in extraction showed antibacterial activity against *B. subtilis*. The solvents that had been used were hexane, dichloromethane, ethylacetate, diethylether and methanol. All solvent fractions showed antibacterial activity. However methanol and diethylether showed higher antibacterial activity against *B. subtilis* compare to hexane, dichloromethane and ethylacetate. Similar to the work of Samy and Ignacimuthu[9], Dash and others[10] studied antibacterial and antifungal activities of several extracts of *C. asiatica* against some human pathogenic microbes. Five different solvents were used in extraction. They were petroleum ether, ethanol, chloroform, n-hexane and aqueous. The results showed that ethanol extracts gave highest antibacterial activity against *B. subtilis* followed by petroleum ether, chloroform, n-hexane and aqueous; respectively. Jagtap and others[11] also studied antimicrobial and antifungal activity of *C. asiatica* (L.) Urban, Umbeliferae. They used three different solvents and concentration of petroleum ether, ethanol and water extracts. They found out that ethanolic extracts gave highest antibacterial activity against *B. subtilis* followed by petroleum ether and water, respectively.

Antioxidant properties of *Centella asiatica*

Antioxidative properties of essential oils and various extracts from many plants are of great interest in both academics and the food industry, since their possible use as natural additives has emerged from a growing trend to replace synthetic antioxidants by natural ones[12]. *C. asiatica* is well known to have a high antioxidant activity[13]. Antioxidant activity of *C. asiatica* is comparable to the activity of rosemary and sage and has very good potential to be explored to as source of natural antioxidants[14]. From the work of Hashim and others[15] reported that antioxidant in *Centella* (84%) is comparable to Vitamin C (88%) and grape seed extract (83%).

From the work of Wong and others[16] were studied the antioxidant properties of *C. asiatica*, expressed as Trolox equivalent antioxidant capacity (TEAC), using DPPH and FRAP assays. They find out a strong correlation between TEAC values obtained for the DPPH assay and those for the FRAP assay which implied that compounds in the extracts were capable of scavenging the DPPH free radical and reducing ferric ions. *C. asiatica* leaves exhibited higher antioxidant activities using boiled aqueous extraction compared to aqueous extract in DPPH and FRAP assays

Gupta and Prakash[17] found out that *C. asiatica* cultivated in India showed good antioxidant activity which was assessed by DPPH, reducing power and ferrous ion chelating capacity methods. They also find out that *C. asiatica* is a good source of antioxidants like ascorbic acid, total and beta

Table 1: Summary of work on different solvent extraction in antibacterial activities of *C. asiatica*

Extraction Condition	Microorganisms	Reference
Ethanol	*Bacillus cereus*	[5,6]
	Listeria monocytogenes	
	Salmonella typhimurium	[7]
	Salmonella enteritidis	[8]
	Salmonella typhimurium	
	Bacillus subtilis	[10,11]
	Bacillus subtilis	[10]
Chloroform	*Bacillus subtilis*	[10]
Hexane	*Bacillus subtilis*	[9,10]

Table 2: Chemical composition of C*. asiatica* essential oil.

Compounds	Essential oil [2]		Essential oil [8]		Essential oil (CA_TR)[28]	
	KI[a]	% composition	RI	% relative conc.	RRI[e]	% calculated from FID data
a-Thjuene	935	0.20	-	-	-	-
a-Pinene	940	3.49	-	-	1032	1.9
Camphene	962	0.86	-	-	-	-
b-Pinene	984	0.37	-	-	-	-
Myrcene	994	6.55	-	-	1174	3.3
Decane	-	-	-	-	1000	<0.1
a-Phellandrene	1005	0.19	-	-	-	-
a-Terpinene	1019	0.47	-	-	-	-
p-Cymene	1033	0.71	-	-	-	-
Limonene	1038	1.00	-	-	-	-
c-Terpinene	1061	5.77	-	-	-	-
Hexanal	-	-	-	-	1093	1.4
Terpinolene	1096	0.59	-	-	-	-
Linalool	1101	0.2	-	-	-	-
b-Pinene	-	-	-	-	1118	3.6
3-Nonen-2-one	1150	0.49	-	-	-	-
Menthone	1162	1.43	-	-	-	-
Terpinen-4-ol	1199	0.24	-	-	-	-
Limonene	-	-	-	-	1203	<0.1
1,8 Cineole	-	-	-	-	1213	0.8
Methyl thymol	1235	0.22	-	-	-	-
Amyl Furan	-	-	-	-	1244	1.1
Pulegone	1248	0.21	-	-	-	-
Methyl cavacrol	1250	0.64	-	-	-	-
Chrysanthenyl acetate	1266	0.59	-	-	-	-
Bornyl acetate	1291	1.44	-	-	1591	0.4
Bicycloelemene	1341	0.62	-	-	-	-
a-Copaene	-	-	1375[b]	1.37	1497	22
b-Elemene	1391	1.99	1390 [b]	1.29	1600	0.8
Nonanal	-	-	-	-	1400	<0.1
g-Muurolene	-	-	1435[d]	0.97	-	-
(E)-2-Octenal	-	-	-	-	1441	0.3
b-Caryophyllene	1442	19.08	-	-	1612	7.1
b-Farnesene	-	-	1452 [b]	15.19	1668	1.2
1-Octen-3-ol	-	-	-	-	1452	0.6
Butanedioic acid, methyl- bis(1-methylpropyl) ester	-	-	1456[c]	0.27	-	-
c-Elemene	1456	1.58	-	-	-	-
a-Cubebene	-	-	-	-	1466	0.6
Aromadendrene	1470	0.20	-	-	1661	7.6
a-Humulene	1483	21.06	1454 [b]	9.20	1687	6.7
allo-Aromadendrene	1484	0.45	-	-	-	-
Germacrene D	1485	4.01	-	-	1726	3.6

c-Curcumene	1486	1.48	-	-	-	-
Valencene	-	-	1492 [b]	4.29	-	-
Caryophyllene	-	-	1494 [c]	10.02	-	-
Bicyclogermacrene	1494	11.22	1497 [b]	2.85	-	-
Germacrene A	1495	0.24	-	-	-	-
Decanal	-	-	-	-	1506	<0.1
g-Cadinene	-	-	1512 [b]	26.44	1773	1.4
d-Cadinene	1523	0.34	1518 [b]	1.21	-	-
Germacrene B	1551	6.29	-	-	-	-
Ledol	-	-	1530 [d]	0.28	2057	0.7
b-Cubebene	-	-	-	-	1549	5.9
Nerolidol	-	-	1562 [b]	0.61	2050	0.9
8-Isopropenyl-1,5-dimethyl-cyclodeca-1,5-diene	-	-	1570 [c]	0.44	-	-
Tridec-2(E)-enal	-	-	1573 [b]	0.48	-	-
Spauthulenol	1576	1.44	-	-	-	-
Caryophyllene oxide	1588	1.66	-	-	2008	2.2
b-Ylangene	-	-	-	-	1589	0.5
Viridiflorol	1590	0.26	-	-	-	-
Humulene epoxide	1592	0.27	-	-	-	-
b-Copaene	-	-	-	-	1597	0.4
a-Muurolol	-	-	1641 [b]	0.23	-	-
Isopauthenol	1645	0.27	-	-	-	-
a-Cadinol	-	-	1669 [b]	0.74	-	-
a-Muurolene	-	-	-	-	1740	<0.1
Mintsulfide	1748	0.76	-	-	2186	1.0
Trans-Piperitone oxide	-	-	-	-	1754	1.6
E-10-pentadecenol	-	-	1763 [c]	0.20	-	-
Cadina-1,4-diene (-Cubenene)	-	-	-	-	1799	<0.1
(E,E)-2,4-Decadienal	-	-	-	-	1827	0.4
Neophytadiene	1840	0.24	1836 [b]	5.15	-	-
Epi-Cubebol	-	-	-	-	1900	1.1
Tetradecanal	-	-	-	-	1933	1.0
Piperitenone oxide	-	-	-	-	1983	<0.1
Diphenyl oxide	-	-	-	-	2036	1.1
3,7,11,15-tetramethyl-2-hexadecen-1-ol	-	-	2045 [c]	0.40	-	-
Humulene epoxide-I	-	-	-	-	2045	<0.1
Humulene epoxide-II	-	-	-	-	2071	1.5
Cubenol	-	-	-	-	2080	<0.1
1-Epi-cubenol	-	-	-	-	2088	0.3
Hexahydrofarnesyl acetone	-	-	-	-	2131	0.8
Torilenol	-	-	-	-	2278	0.7
Oxo-alpha- ylangene	-	-	-	-	2289	0.8
Caryophylla-2(12),6(13)-dien-5b-ol (-Caryophylladienol I)	-	-	-	-	2316	0.9
Caryophylla-2(12),6(13)	-	-	-	-	2324	2.1

-dien-5a-ol (-Caryo phylladienol II)						
Caryophylla-2(12),6-dien-5b-ol (-Caryophyllenol II)	-	-	-	-	2392	0.6

a = Calculated retention time (Kovat indices) on an HP-5 capillary column at 5 C/min from 70 to 240 C.
b = FFCNS
C = NIST08
d = NIST08S
e = Relative retention indices calculated against n-alkanes

carotene and total phenolics. Their regression analysis showed that the relationship between antioxidant activity and antioxidant contents was highly significant. Subhasree and others[18] also studied the antioxidant contents and antioxidant activity of *C. asiatica* cultivated in India. Their results showed that *C. asiatica* had a good antioxidant activity and good source of antioxidant contents.

Hamid and others[19] found that among three solvent, water, ethanol and light petroleum used to extract *C. asiatica* at 25 ºC for 24 hours, ethanol showed highest antioxidant activities, followed by water while light petroleum yielded negative antioxidant activities.

Chemical profile

Centella asiatica (L.) Urban, known by several local names as "Gotu Kola, Asiatic pennywort, Indian pennywort, marsh penny ship rot, tiger herb", is a tropical edible plant growing naturally in Southeast Asian countries and has been used in ayurvedic medicine since centuries[20].

The plant is indigenous to South-East Asia, India, Sri Lanka, parts of China, the western South Sea Islands, Madagascar, South Africa, South-East USA, Mexico, Venezuela, Columbia and eastern South America[21]. Previously, triterpenoid acids[22,23], volatile and fatty oils[24], alkaloids, glycosides[21], flavonoids[24], and steroids[24] have been isolated from the different parts of the plant[25].

C. asiatica has been reported to contain triterpene derivatives in major amounts and the earliest examples of this compounds present in *C. asiatica* were identified in late 1940s as "asiatic acid and madecassic acid" along with their heterosides named as "asiaticoside" and "madecassoside" constituting approximately up to 10% of the plant[20]. Later on, compounds from various chemical classes have been also isolated such as flavonoids[26], polyacetylenes[27], and phenolic acids[24].

From the literature research found out that only essential oil form of *C. asiatica* have been studied. The In following table different works have been done using GC-MS to investigate the chemical compounds inside *C. asiatica* essential oil form. Oyedeji and Afolayan[2] studied essential oil form of *C. asiatica* grew in South Africa. They used Hewlett Packard gas chromatography HP 5973 (USA) interfaced with a VG analytical 70-280s double-focusing mass spectrometer. Electron ionization was at 70 eV. The column that they used was HP-5 column. Helium was used as the carrier gas. 0.2 ml of essential oil was injected. n-Alkanes were run at the same condition for the determination of Kovats indices.

Similar work has been done by Lee and Vairappan[8]. They used *C. asiatica* that grew in Malaysia and hydrodistillated to get essential oil. The analysis of essential oils was carried out on a Shimadzu GC-2010 gas chromatographer equipped with a SGE BPX-5 capillary column. Electron ionization energy and carrier gas used was the same as Oyedeji and Afolayan[2]. Diluted samples (2% w/v, in *n*-hexane) of 1 ìl were injected. The retention indices were determined in relation to a homologous series of n-Alkanes were run at the same condition.

From the work of Orhan and others[28], they comparative studied on Turkish and Indian *C. asiatica*. They used GC–MS analysis with an Agilent 5975 GCMSD system on Turkish *C. asiatica* essential oil. Innowax FSC column was used. Electron ionization energy and carrier gas used was the same as Oyedeji and Afolayan[2] and Lee and Vairappan[8]. Mass range was from m/z 35 to 450. The GC analysis was carried out using an Agilent 6890 N GC system. FID detector temperature was 300 æ%C. Relative percentage amounts of the separated compounds were calculated from the FID chromatograms. Identification of the essential oil components was carried out by comparison of their relative retention times with those of authentic samples or by comparison of their relative retention index (RRI) to series of n-Alkanes.

CONCLUSION

The used of plants for medicinal purposes can be found almost every parts of the world; from Africa to Europe. Nowadays, there are increasing trends of using natural products. From the discovery that effective life span of any antibiotic is limited. Scientists try to discover alternatives. One of the sources is from plants. *C. asiatica* has been mentioned in Ayuravedic record. It can be used to treat leprosy, insanity, asthma, ulcers, eczema, skin tuberculosis, wounds, stomach aches, arthritis, varicose veins and high blood pressure. By that, *C. asiatica* seem to be interesting candidate for investigation. Thus obtain data of antibacterial activity profile against different microbial strains under different extraction conditions of *C. asiatica* (L.) Urban would provide a basic knowledge of solvent selection in extracting *C. asiatica*. Not only that data of antioxidant activity profile under different extraction conditions of the *C. asiatica* (L.) Urban could also serve as scientific proved data as the stepping stone to develop and promote *C. asiatica* as herbal medicine.

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