Coleus aromaticus: a therapeutic herb with multiple potentials

Dadasaheb D. Wadikar¹ · Prakash E. Patki¹

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Abstract The herb *Coleus aromaticus* belonging to Lamiaceae family and *Coleus* genus is known by numerous names in different parts of the world and several language specific vernacular names. The herb has been extensively studied as well as reported in several fields of science. The multiple potential of the herb includes allelopathic potential, antibacterial property, antimicrobial activity, insecticidal property; free radical scavenging and radio-protective components from herb extracts and most recently the appetizing potential of the herb have been reported. The herb has carvacrol and thymol as the major components responsible for the flavour; while chlorogenic acid, rosmarinic acid etc. as the phenolic components. The herb has been used in therapeutic and medicinal applications as well as in culinary preparations.

Keywords *Coleus aromaticus* · Therapeutic herb · Antioxidant activity · Antimicrobial activity · Appetising effect

Introduction

The use of medicinal plants as culinary adjuncts for treating or as a precautionary measure is an ancient practice as the great scholar Hippocrates said ‘Let food be thy medicine and medicine be thy foods’. The herb *Coleus aromaticus* (CA) has got multiple potentials and is used for

variety of reasons in different pockets of the world. The herb *Coleus aromaticus/amboinicus* belong to the botanical family Lamiaceae (Labiatae) and *Coleus* (now referred as *Plectranthus*) genus. It is a large succulent aromatic perennial herb with approximately 30–90 cm in height and with thick fleshy stem and leaves. Much branched, fleshy highly aromatic pubescent herb with distinctive smelling leaves. The plant is distributed through out India, cultivated in the gardens. It is a folkloric medicinal plant used to treat malarial fever, hepatopathy, renal and vesical calculi, cough, chronic asthma, hiccough, bronchitis, helminthiasis, colic, convulsions, and epilepsy (Kirtikar and Basu 1975; Chopra et al. 1956; Nadkarni 1996; Warriar 1994). The various names of the herb have been summarized in Table 1. The leaves of CA are used in many places around the world to add a punch to their dishes. Several culinary usages have been reported in South America, Philippines, Indonesia, Africa, India and South East Asia. The strong flavour and aroma of these leaves make them ideal for flavouring certain meats and fish, helping to mask their strong odour. In Indian subcontinent, the leaves added with coconut, dhal, red chillies, coriander leaves and curry leaves are used for chutney preparation. It is also eaten raw with bread and butter, used as fried snack, and used for flavouring beer and wine. It is also used as condiment for sour soup in Vietnam, as principal flavouring in Cuban black bean soup and as salads in the Caribbean. The plant is also used as a food supplement and a flavoring for drinks. No Cases of toxic ingestion have been reported except some cases of handling allergy (skin).

The juice of CA leaves with honey is helpful in cold and cough, the concentrated decoction consumed while warm is effective in respiratory infections. The juice mixed with sugar is a powerful carminative. These health benefits are reported as traditional or folkloric usage (Prajapati et al.

✉ Dadasaheb D. Wadikar
ddwadikar@gmail.com

¹ Food Preservation and Sensory Science Department, Defence Food Research Laboratory, Siddharthanagar, Mysore, Karnataka State 570011, India

Table 1 Different name of *Coleus aromaticus* (Prajapati et al. 2003; Shastri 1962; Rout et al. 2010; Weli et al. 2011)

Botanical names		<i>Plectranthus amboinicus</i> (Lour.) Spreng, <i>Coleus aromaticus</i> Benth. <i>Plectranthus aromaticus</i> Roxb. <i>Coleus amboinicus</i> Lour., <i>Coleus suganda</i> Blanco	
Common Names in world		Indian borage; Puerto Rican oregano brujo/Cuban oregano, Mexican mint/Soup mint/Indian mint, All-Purpose herb, Five Seasons Herb	
Names in Languages used in India		Names used in other countries	
English	Country borage, Indian borage	Cambodia	<i>Sak dam ray</i>
Hindi	Patta ajavayin, Patharchur	Philippines	<i>Latai, suganda, oregano</i>
Kannada	dodda pathre, Karpurahalli, dodda pathre soppu	West Indies	French thyme/Spanish thyme/Broad-leaf thyme
Marathi	Patharchur, Pan ova	Indonesia	<i>Ajeran, daun jinten, daun kucing</i>
Malaylam	Kannikkurkka, Panikkurkka	Malaysia	<i>Daun bangun-bangun</i>
Sanskrit	Karpuravalli, Sugandhavalakam	Singapore	<i>Po-hor</i>
Tamil	Karpuravalli, Omavalli	Thailand	<i>Hom duan huu suea, niam huu suea</i>
Telugu	Sugandhavalakam, Vamu-aku, Kapparillaku	Vietnam	<i>Can day la</i>
Bengali	Pattharchur	Chinese	<i>Da shou xiang</i>
Oriya	Hemakedar, Amarpoi	Oman	<i>Al-Zamota</i>

2003). The juice of the leaves is applied on the affected part of the skin in cases of Insect bites, allergic skin thickening, itching and skin irritation. To reduce 'Kapha' (mucus, phlegm) in the body, a decoction prepared by boiling CA leaves in water and added with cardamom, cloves and a teaspoon of honey is quite helpful if taken twice a day for 3 days Senthil (2009). Considering the medicinal value of the plant and various folkloric uses, the present review was carried out to outline the significance of the herb with respect to functional dietary potential and scope for further research.

Volatile constituents of the herb

Essential oil of *Coleus aromaticus*, grown in India, is rich in carvacrol, thymol, eugenol, chavicol, ethyl salicylate (Dutta 1959). In CA leaves, the ether volatiles were found to be 74.41 mg % (Wadikar 2012) while Rout et al. (2010) reported water soluble extractive 24 %, petroleum ether extractives 2.23 % and alcohol soluble extractives 8.5 %. Mangathayaru et al. (2005) reported that the fresh leaves hydro-distilled for 3 h resulted in viscous golden yellow volatile oil (yield 0.24 %) which was highly soluble in 80 % ethanol and diethyl ether. Baslas and Kumar (1981) reported that the oil obtained by steam distillation (0.04–0.05 %), has been found to contain terpinolene (3.75 %), α -pinene (3.20 %), β -pinene (2.50 %), β -caryophyllene (4.20 %), methyl eugenol (2.10 %), thymol (41.3 %), 1, 8-cineole (5.45 %), eugenol (4.40 %), carvacrol (13.25 %) and β -phellandrene (1.90 %). Methanolic extract of leaves of *Coleus aromaticus* contains chlorogenic acid, caffeic acid, coumaric acid polyphenolic compounds with strong antioxidant property (Rasineni et al.

2008). In general, the various reports reveal that the carvacrol content of the herb ranged from 50 to 67 % of the total volatiles (Bos et al. 1983; Prudent et al. 1995; Mallavarapu et al. 1999). The presence of eucalyptol in CA leaves has been reported by Knab et al. (2009) when extracted through steam distillation and solid phase micro extraction (SPME) methods. Ragasa et al. (1999) reported that the chloroform fraction of this plant shows the presence of three flavones; Salvigenin, Cristimartin and Chrysoeriol. Brieskorn and Riedel (1977) isolated eight triterpenic acids from the leaves of the South-American variant of CA. Joshi et al. (2011) reported that 77 % of essential oil of the aerial parts of CA herb was constituted by carvacrol followed by β -caryophyllene (5.74 %), caryophyllene oxide (3.72 %) etc. In another regional variant of the herb, Haque (1988) detected fifteen components in the essential oil (0.1 %) obtained from dry steam distillation of the fresh stalk and leaves of CA. Thymol (79.6 %) was shown to be the principal component of the oil. Kumaran and Karunakaran (2006) reported the antioxidant potential of the aqueous extract in different in vitro models. Kumaran and Karunakaran (2007) studied free radical scavenging components from aqueous extracts of CA which was further separated into hexane, ethyl acetate and water 4 fractions. Among these ethyl acetate fraction showed strong activity. Three compounds showing DPPH radical scavenging activity were identified: Chlorogenic acid, Rosamarinic acid (major component) and Caffeic acid. Pino et al. (1989) investigated the essential oil of *Coleus amboinicus* Lour by means of LSC, GLC and GC-MS and 20 components were identified, including 13 terpene hydrocarbons and 7 oxygenated compounds. The oils contained about 64 % carvacrol. Pino et al. (1996) isolated volatile compounds from CA leaf by

steam distillation, hexane extraction and super critical CO₂ extraction and identified 26 components by GC–MS. Mallavarapu et al. (1999) analyzed the essential oils of CA distilled in different seasons by capillary GC and GC–MS. The oils were found to contain carvacrol, p-cymene and gamma-terpinene as major constituents. The oil produced in September was found to contain higher contents of carvacrol and β -caryophyllene and oxygenated constituents than the oil produced in May. Singh et al. (2002) investigated the essential oil of CA leaves GC and GC–MS techniques which indicated the presence of six components, accounting for 97 % of the total oil. Tewari et al. (2012) reported that the GCMS analysis of the essential oil of the CA leaves revealed 16 identified constituents with Thymol (83–89 %), 1-octene-3-ol, terpene-4-ol, eugenol, trans-caryophyllene, caryophyllene oxide and α -cadinol as significant contributors. Kaliappan and Viswanathan (2008) reported that the phytochemical study reveals the presence of various flavonoids like quercetin, apigenin, luteolin, salvigenin, genkwanin and volatile oil in the leaves.

Thymol, a major component of some *Coleus* essential oils, has been widely studied for its antimicrobial properties. It can be added to chewing gum at levels as high as 100 ppm and in non-alcoholic beverages, at concentrations of 2.5–11 ppm (Furia and Bellanca 1975). The reported lethal dose (LD₅₀) in the rat is 980 mg/kg of body-weight (BW) when given orally. Carvacrol, an isomer of thymol, is found in essential oils isolated from oregano, thyme and CA. Like thymol, carvacrol also displays antimicrobial activity. Carvacrol may be added to the baked goods at levels as high as 120 ppm and in non-alcoholic beverages at 26 ppm (Furia and Bellanca 1975). The LD₅₀ of carvacrol in rats is 810 mg/kg of BW when administered by gavage (Lee et al. 2003). Weli et al. (2011) reported that Oman variant of CA referred as *Al-Zamota* contains 26 constituents in the essential oil of the leaves. The major constituents being m-thymol (63.4 %) followed by terpenene, p-cymene, caryophyllene and beta-selinene. Valera et al. (2003) analysed the essential oil of *C. amboinicus* collected from two sites (Rancherías and Mérida in Venezuela) and observed that the oil was rich in carvacrol and p-cymene (74.5 %, Mérida; 74.1 %, Rancherías). Manjamalai and Berlin-Grace (2012, 2013) reported the in vivo and in vitro antioxidant activities of *P. amboinicus* essential oil comprising of Carvacrol, Thymol, cis-Caryophyllene, trans-Caryophyllene, p-cymene as the major volatile compounds. They also reported the potent chemotherapeutic/chemopreventive effect of the essential oil over lung metastasis. In case of Mexican variants (Dunford and Vazquez 2005), the plant yield increases significantly with increasing moisture and age. Although on an average, the older plants contained less oil than the

younger foliage. Total thymol and carvacrol content from younger plants was higher than the mature plants.

Functional and dietary potentials

Singh et al. (2002) reported insecticidal property for the herb. The light yellow oil (yield 0.6 %) from the leaves of *Coleus amboinicus* Lour was insecticidal to white termites with 100 % mortality at a dose of 25 μ g/cc for 5 h exposure (77 μ g/cc for 2 h). The oil was more active than synthetic insecticides Thiodan and Primoban-20. Gnanaivel and Kathiresan (2007) compared the effect of manuring, drying methods and soaking time on the allelopathic potential of CA on Water hyacinth (*Eichhornia crassipes*), a troublesome aquatic weed. They reported that none of the fertilizer levels applied to the *Coleus* field was found to affect its allelopathic effect on *E. crassipes*. Among the different methods of drying of *coleus* leaves, shade drying for 25 days followed by oven drying at 65 °C for 2 h was most effective method in reducing the fresh weight and chlorophyll content of *E. crassipes*. Among the different incubation periods, the cent per cent reduction in chlorophyll content and fresh weight were registered on 3 and 12 days after treatment, respectively with the treatments viz., soaking duration of 48, 36 and 24 h.

A potential wound healing property of CA leaves has been reported by Soni et al. (2011). They reported that an herbal suspension made of peel extract of *Punica granatum*, leaves extract of *Coleus aromaticus* was found to show wound healing property in albino rats. Pritima and Pandian (2007) reported that the leaf extract helped in controlling urinary tract disorders in women. *Candida krusei* showed the highest zone of inhibition of growth, followed by *Candida albicans*, *Proteus mirabilis*, *Escherichia coli*, *Staphylococcus aureus*, *Enterococcus faecalis*, *Klebsiella pneumoniae* and the least inhibition was observed for *Neisseria gonorrhoeae*. Revathi et al. (2011) reported that the essential oil extracted from CA leaf showed maximum activity against *Salmonella typhi*, *Staphylococcus aureus*, and *Bacillus subtilis*. The essential oil does not have any influence on *Escherichia coli*. The standard drug used was chloramphenicol. The antifungal activity against two fungal species *Candida albicans*, *Aspergillus niger* were investigated and the essential oil was reported to have maximum zone of inhibition against *C. albicans*. The essential oil exhibited concentration dependent activity. Botelho et al. (2007) reported that thymol and carvacrol have antibacterial activity against *S. mutans*, one of the most important cariogenic bacteria which leads to demineralization of dental enamel, and may be useful for maintaining oral hygiene by reducing

bacterial growth. Activity was also shown against *Streptococcus mitis*, *Streptococcus sanguis*, and *Streptococcus salivarius*.

The CA oil was found to be effective against various fungi tested, as it inhibited the radial growth of mycelia and exhibited broad fungitoxic properties against *Aspergillus flavus*, *Aspergillus niger*, *Aspergillus ochraceus* CFR 221, *Aspergillus oryzae*, *Candida versatilis*, *Fusarium* sp. GF-1019, *Penicillium* sp., and *Saccharomyces cerevisiae* (Murthy et al. 2009). The ethanol and hot water extracts of CA leaves exhibited antibacterial activity against both Gram positive (*Staphylococcus aureus*, *Bacillus subtilis*, *Bacillus cereus*) and Gram negative (*E. coli*, *Salmonella enteritidis*) human pathogen bacterial strains. The zone of inhibition ranged from 9 to 14 mm for hot water CA extract and 16–27 mm for ethanolic CA extract for 100 µg concentrations (Subhaschandruppa et al. 2010). Deena et al. (2002) reported that the essential oils of CA in vitro microbiocidal activity against seven bacteria. The oil showed potent activity against Gram +ve as well as Gram –ve bacteria (*S. aureus*, *E. coli*, *P aeruginosa*, *Klebsiella pneumoniae*) but did not show any antifungal (*Candida albicans*) activity (Weli et al. 2011). Thus the CA leaves exhibit an effective antifungal and marked antibacterial activity. The leaves helped to control postpartum bleeding and ‘acted as a uterine cleansing agent’ (Damanik et al. 2001).

The water, ethanol, acetone and salt water (1.2 % NaCl) extracts of CA were studied (Hebbani et al. 2012) for their antibacterial efficacy by disc diffusion method on both Gram positive (viz. *Bacillus subtilis*, *Staphylococcus aureus* and *Streptococcus pyogenes*) and Gram negative (viz. *Escherichia coli*, *Klebsiella pneumonia* and *Pseudomonas aeruginosa*) bacteria. Results of the study disclosed that the salt water extract of the leaf exhibited a profound antibacterial activity on both Gram types of bacteria, in comparison with the other extracts. The results thus support the age old practice of consuming the leaf in combination with salt, as a better smoothening (antitussive) agent against throat infections and a natural cure for tonsils. It is used against various disorders in indigenous system of medicine, such as severe bronchitis, asthma, diarrhoea, epilepsy, renal and vesicle calculi, fever (Warrier et al. 1995). Leaves are antilithic, antispasmodic, carminative, cathartic, stimulant and stomachic. They are useful in urinary diseases, vaginal discharge (Shamachar 1967). It is externally used in conjunctivitis and bruised leaves locally applied in headache. The expressed juice is used in epilepsy and other convulsive disorders and plant extracts used in the treatment of gastrointestinal troubles (Chatterjee and Pakrashi 1997). The water extract of CA leaves was found to produce significant diuresis in rats (Sur et al. 2003).

The diuretic property of ethanolic and aqueous extracts of the CA herb was also reported by Patel et al. (2010).

Gurgel et al. (2009) reported that the hydro-alcoholic extract of *P. amboinicus* possesses anti-inflammatory and antitumor activities, supporting the folk use of this medicinal specie. Shyama et al. (2002) reported anticlastogenic potency of the ethanolic extract of CA wherein their study indicated the protective effect against cyclophosphamide and mitomycin-c induced cytogenetic damage.

The DPPH radical is widely used as a model system to investigate the free radical scavenging activities of several plant extracts. The CA leaves have got excellent antioxidant potential with % DPPH free radical scavenging activity of 60–69 %. Rasineni et al. (2008) reported the total antioxidant activity expressed in Trolox equivalent antioxidant capacity for *Coleus aromaticus* leaves was 11.32 mM/g fresh weight. Satish Rao et al. (2006) reported that the CA leaves have antioxidant and radio-protective properties. The hydro-alcoholic extract of the leaves scavenged the DPPH radicals in a concentration dependent manner with maximum scavenging activity of 80 %. The radio protective property of the *C. aromaticus* hydroalcoholic extract (CAE) was studied by irradiating Chinese hamster fibroblast cells (V79). Post irradiation, a significant ($P < 0.0001$) radio-protective effect was observed when the cells were treated with an optimum dose of CAE (5 mg/ml) 1 h prior to 0.5, 1, 2 and 4 Gy of gamma radiation. It suggests a potential use for chemoprevention. Annapurni and Priya (1999) reported the anti-tumour and anti-mutagenic activities of the polyphenol extracts of the CA herb. Annapurni and Bhagavathy (2001) reported antioxidant potential of protein fraction of the CA leaves. The protein content was found to be 1.375 mg/g. They recommended the herb as natural and economical source of antioxidants against free radical induced toxicity. Mast cell stabilization property of the herb was reported by Kumar et al. (2007). The results suggested that aqueous and hydro-alcoholic CA extracts stabilizes mast cells in the rat mesenteric tissues. Concentrations of 10–100 µg/ml of both aqueous and hydro-alcoholic extracts produced dose dependent and significant stabilization of mast cells. Mast cells play major role in Type-1 Hypersensitivity mediated diseases like allergic asthma and rhinitis. Buznego and Perez-Saad (1999) reported antiepileptic potential of *Plectranthus amboinicus* (Lour.) Spreng. (French marjoram). A special property as a result of traditional usage was reported (Damanik et al. 2001) that the consumption of bangun–bangun leaves (*Coleus amboinicus* Lour) to increase breast milk production among Batakneese women in North Sumatra Island, Indonesia.

The appetising potential of the CA herb has been explored by Wadikar (2012) through development appetisers based on it. Among the commercially available several soup mixes reviewed (Premavalli and Wadikar

2011) it was found that CA was not explored for soup mix preparation. A ready to reconstitute soup mix based on CA has been reported with a shelf life of 6 months (Wadikar and Premavalli 2013). Another product, a ready to drink shelf stable Karpuravalli beverage has been reported and claimed to have appetising effect (Wadikar and Premavalli 2011b). This appetiser beverage prepared from the CA leaves was found to cause reduction in leptin levels in experimental animals and sustained consumption resulted in increased food intake and weight gain thereby indicating appetizing effect. The beverage was found to give better appetising effect than the ginger and ajowan beverage studied simultaneously (Wadikar and Premavalli 2011a). The karpuravalli beverage when further evaluated with human volunteers, was found to cause reduction in leptin levels in human volunteers and resulted in improved appetite rating post consumption. The karpuravalli beverage with 12 % CA juice was most effective and acceptable (Wadikar and Premavalli 2014). The karpuravalli beverage when irradiated showed reductions in its carvacrol content as well as antioxidant activity (Wadikar, 2012). A ready to eat appetiser i.e. karpuravalli munch has been reported (Pawan et al. 2012) with a shelf life of 8 months. The appetiser munch has CA to the level of 40 % along with other ingredients such as jaggery, ginger and raisins. The CA leaves can also be used for preparation of chutney, fried snack etc.

Nutritional profile

Coleus aromaticus (CA) has got importance due to its flavour and functional properties. Various aspects of the nutritional strength and functional characteristics of the leaves in terms of carotenoids, minerals, phenols, dietary fibre and antioxidant activity have been reported by several researchers. Gupta et al. (2005) reported that the herb has 81 % edible portion and its moisture, protein, ash and total dietary fibre contents were 95.3, 0.6, 1.06 and 1.87 %, respectively. Among the vitamins ascorbic acid (3 mg) and thiamine (0.08 mg) per 100 g of leaves have been reported. It also contains 10.38 mg % total carotenoids with 1.50 mg % β -carotene content. Kumar and Vallikannan (2010) reported total xanthophylls (0.356 mg/g of dry weight of plant); neoxanthin, violaxanthin, leutin, zeaxanthin, α -carotene (0.157 mg/g of dry weight) and β -carotene (0.0035 mg/g of dry weight). Wadikar (2012) reported total carotenoids as β -carotene in the leaves was found to be 0.269 mg/g and contained 44.11 mg chlorophyll 'a' and 22.98 mg chlorophyll 'b' per 100 g CA leaves. The minerals analysis of CA leaves by Inductively Coupled Plasma Optical Emission Spectrometer (ICP/OES) revealed the presence of Calcium-207.3 mg, Magnesium-150.4 mg

and Potassium-98.92 mg as the major minerals followed by Phosphorous-23.31 mg and Sodium-7.13 mg per 100 g fresh leaves. Other minerals present in trace amounts in descending order were copper, iron, zinc and manganese (Wadikar 2012). Gupta et al. (2005) reported that the major minerals present in CA leaves were Ca-158 mg; P-16 mg, K-138 mg, Na-4.7 mg and Mg-88 mg while the contents of minor minerals such as iron, zinc, copper and chromium were 2.62, 0.33, 0.12 and 0.022 mg, respectively per 100 g fresh leaves. Rout et al. (2010) reported that the chloroform extract of CA leaves had none of the heavy metals i.e. mercury (Hg), lead, (Pb), arsenic (Ar), cadmium (Cd); while the iron (Fe), copper (Cu), zinc (Zn) and chromium (Cr) were present at 2.62, 0.11, 0.03 and 0.021 ppm, respectively. Among other minerals checked manganese (Mn), nickel (Ni), and cobalt (Co) were absent.

The dietary fibre content of the CA leaves was found to be 3.26 % with soluble fibre content of 2.32 % (Wadikar 2012) while Gupta et al. (2005) reported the soluble dietary fibre content of 0.31 % and insoluble dietary fibre 1.56 % and among the anti-nutrients the total oxalates (50 mg) with soluble oxalate (20 mg), phytic acid (0.92 mg) and tannins 15 mg per 100 g of CA leaves. Rout et al. (2010) reported a higher percent total ash content of 15.04 with 1.68 % acid insoluble ash while the protein content was 0.617. The tannins and fibre content were 15.37 and 9.14 %, respectively. Thus, CA is a good source of nutritious compounds and can be used as a food supplement.

Conclusion

The herb karpuravalli (*Coleus aromaticus*) is household herb in Asian countries. It can be grown in kitchen gardens and used for culinary purpose. The antimicrobial, antioxidant and flavoring potentials are continuously being explored and validated by researchers in different parts of the world. There is enough scope for research on its application in nutraceuticals and functional food industry which may exponentially develop in near future. However, the digestive and appetizing properties of the herb still need to be proved substantially by modern science apart from the traditional claims. There are very limited human studies reporting therapeutic potentials which need to be taken to further heights.

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