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Review

Amomum subulatum Roxb: Traditional, phytochemical and biological activities-An overview

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***Amomum subulatum* Roxb. (Large Cardamom) is a perennial herbaceous crop, cultivated in swampy places across hills around water streams. It has been a well known spice since time immemorial; used as flavouring agent to various dishes indigenous to the Eastern Himalayan region particularly Nepal, Bhutan, and India. Sikkim State of India is the largest producer of cardamom that is around 50% of the world's production. Large cardamom contains 8.6% moisture, 5% total ash value, 1.5% ash insoluble in acid, 3.5% water soluble ash value, 4.88% alcohol extract, 4% non-volatile ether extract and 91.4% of total solid. It contains 1.95 to 3.32% of essential oil having characteristic aroma and possesses medicinal properties. It is reported as an official drug in Ayurvedic Pharmacopoeia due to its curative as well as preventive properties for various ailments. The major constituent of large cardamom essential oil is 1,8-cineole. The monoterpene hydrocarbon content is in the range of 5 to 17% of which lamonene, sabeinene, and pinenes are significant components. The terpinols comprise approximately 5 to 7% of the oil. Due to the presence of these compounds, it has pharmacognostic properties such as analgesic, antimicrobial, cardiac stimulant, carminative, diuretic, stomachic etc. This paper recapitulates traditional, phytochemical and biological activities of *A. subulatum*.**

Key words: *Amomum subulatum*, ethno-medico-botany, physicochemical, phytochemical, biological properties.

INTRODUCTION

The genus *Amomum* is the second largest genus and comes under the family Zingiberaceae (formerly known as Scitamineae) with *ca.* 150 species (Thomas et al., 2009). Large cardamom or Nepal cardamom (*Amomum subulatum* Roxb.) is a large perennial spice crop cultivated in the swampy places in north-eastern and the central Himalayan region of India. In India, it was used as early as the 6th century BC in Ayurvedic preparations, as mentioned by Susrata (Sharma et al., 2000). It has been given the name large cardamom, as it is being cultivated in a larger extent and also due to its position in the trade. Large cardamom is called greater cardamom in English, Sthulaila, Bhadraila in Sanskrit, Bara Ilachi in Bangla, Badi Ilayachi in Hindi, Peralam in Malayalam, Periya elam, Kattelam and Perelam in Tamil, Pedda Yelakaya in Telegu and Didda yelakki in Kannada. Roxburgh (1820a) was first to describe this plant in his 'Plants of the Coast of Coromandel' and in 'Flora Indica' (1820b). It has been a well known spice since ancient time and has been valued for its pleasant aromatic odour due to which it is extensively used for flavouring vegetables and many food preparations in India. Apart from aroma, large cardamom also has high medicinal value. India with the production of 4000 metric tonne (MT) is the largest producer followed by 2500, and 1000 MT respectively, by Nepal and Bhutan (Berrig et al., 1993).

In India, Sikkim is the largest producer with 23,500 ha of area under cultivation with 80 to 85% of the total production of India. The species considered as boon to the people of the Himalaya. This plant has been recognised for its spice and wide range of physiological and pharmacological properties. It contains 1.95 to 3.32% of essential oil (Gupta, 1986) having typical characteristic flavour and possesses medicinal properties like stimulant, stomachic, alexipharmic and astringent properties

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(Annon, 2006). For this reason, this species prescribed for the treatment of indigestion, vomiting, biliousness, abdominal pains and rectal diseases (Nadkarni, 1976). Due to its pleasant aroma, it has been used as an essential ingredient in mixed spices. Sikkim State of India, alone contributes 50% of the world's production of large cardamom (Sharma et al., 2007). Due to the pleasant aromatic odour present in it, it is used as a flavouring agent to various vegetables and meat preparation, confectionery, hot or sweet pickles and beverages. Fruit powder is also used as essential ingredients in spice masala mixtures.

Inspite of several traditional and medicinal uses and pharmacognostical reports attributed to this spice, there is still meagre information regarding to these aspects. Hence, the present paper elaborates the comprehensive information on the progress of the *A. subulatum* research in terms of traditional uses, chemical constituent analgesic properties, antimalarial properties, antimicrobial properties, antioxidants, antidiabetic, anthelmintic activities and focusing on the most recent findings.

Habit, habitat and agrotechnology

A. subulatum is a large perennial, evergreen, herbaceous monocot plant indigenous to eastern Himalaya. The plant consists of subterranean rhizomes and several leafy aerial shoots/tillers and spikes that grow up to 1.5 to 2.5 m tall. The plant has several tillers consisting of pseudo-stems with leaves and formed by long, sheath like stalks encircling one another. The plant matures during the third year of its growth. Leaves are green, distichous, simple, linear and lanceolate, glabrous on both side with prominent mid rib. Inflorescence is a condensed spike on a short peduncle bearing 40 to 50 flower buds in an acropetal sequence. The spikes are globose, very dense, and shortly peduncled. Calyx and corolla tube segments are sub-obtuse, shorter than the tube and the upper one is cuspidate. Lip is obovate-cuneate, emarginate, yellowish white and rather longer than the corolla-segments. Capsules are 2.5 cm long, irregularly obcordate, echinate, trilocular, dark red-brown in color, containing several aromatic seeds in each cell and held together by a viscous sugary pulp. The fruit is anterio-posteriorly flattened, having 15 to 20 irregular, dentate-undulate wings which extend from the apex to downward for two-thirds of its length and contain many-seeded capsules. The capsule wall is echinated and is reddish brown to dark pink (Rao et al., 1993). Capsules are on an average 20 to 25 mm long, oval to globose, grayish brown to dark red brown and contain 40 to 50 seeds.

Large cardamom is cultivated under imperative tree species to make available shade such as *Alnus nepalensis*, *Schiima wallichii, Engelhardtia acerifolia, Eurya acuminata, Leucosceptrum canum, Maesa chisia, Symplocos theifolia, Ficus nemoralis, Ficus hookeri, Nyssa sessiliflora, Osbeckia paniculata, Viburnum corifolium, Litsaea polyantha,* and *Macaranga pustualata, Juglans regia, Quercus leucotrichophora, Celtis australis* in the hills of the Himalayas in Nepal, Sikkim, Bhutan, Darjeeling district of West Bengal and Uttarakhand (Sharma et al., 2000; Bisht et al., 2010) on the swampy slopes with plenty of water and shade of forest canopy (25 to 70% full daylight interception). Traditionally, this crop is mainly cultivated between elevational ranges of 700 to 1800 m above mean sea level with annual rainfall of 2800 to 3500 mm (Bisht et al., 2010) that harnesses the local mountain niche (Singh et al., 2005). It grows well with a spacing of 1.0-1.5 × 1.0-1.5 m between plant to plant and line to line depending on cultivars. There are many popular cultivars of large cardamom namely Ramsey, Dzongu Golsey, Madhusay, Ramnag, Sawney and Varlangey.

The plant is propagated vegetatively by division of rhizome with one mature tiller and a bud or through seed. Seeds were sown immediately after harvesting to get better germination. However, seed germination is often poor and irregular but the plants obtained are more resistant to viral diseases while through the former method the plants bear fruits one year earlier and are more susceptible to diseases. The flowering season starts in April and May and continues up to further two months. Fruiting takes about five months and are harvested during October to November. Harvested capsules were dried in shade for 5 to 10 days or by curing bhattis where it takes 5 to 8 h. In Uttarakhand, the average yield after three years of plantation was found in the range of 248 to 429 kg ha^{-1} $year^{-1}$ (Bisht et al., 2010) which is much higher than the production of 150 kg ha^{-1} $year^{-1}$ of Sikkim (Thomas et al., 2009).

Ethno-medico-botany

Traditionally, large cardamom has been used as preventive as well as a curative for throat trouble, congestion of lungs, inflammation of eyelids, digestive disorders and in the treatment of pulmonary tuberculosis (Verma et al., 2010). It is also useful in treatment of flatulence, loss of appetite, gastric troubles, congestion and liver complaints (Jafri et al., 2001). The seeds are reported an official drug in Ayurvedic Pharmacopoeia which are marketed under the name of Greater Cardamom (Annon, 1999). Seeds and fruits of *A. subulatum* are added to cooked food items as spices by the general population on a daily basis and can play a preventive role in the occurrence of gastrointestinal disorders, respiratory problems, and through increasing palatability and flavor of foods make them more digestible and serve to maintain good health (Rahmatullah et al., 2009.

A preparation called "*Alui*" is prepared for the treatment of malaria by administering the mixture of cumin (*cuminium cyminum*) and large cardamon (Thakur et al. 1989). The decoction of the seeds is useful as a gargle

inaffections of the teeth and gums while the pericarp is useful in headache and stomatitis (Shukla et al., 2010). The seeds are also useful as antidote to scorpion sting and snake bite (Bisht et al., 2010). Seeds and fruits were found to be useful in prevention of hyperlipidaemia (Joshi and Joshi, 2007). Ashes of burned leaves are mixed with mustard oil and taken twice daily for cough and sexually transmitted diseases (Rahmatullah et al., 2009).

Essential oil, oleoresin, encapsulated flavour, cardamom cola, flavoured biscuits and flavoured liquors are some of the products developed for diversifying the uses of large cardamom. Cardamom cola is prepared by blending caramel acid, large cardamom flavour and carbonating the mixture. Mixture of *A. subulatum* fruit (30 g), *Melia azedarach* fruit (30 g), *Punica granatum* seed (30 g), *Foeniculum vulagare* seed (125 g), *Withania coagulans* fruit (60 g), *Hordeum vulgare* seed (250 g), *M. azedarach* leaf (125 g) and Jaggery (125 g) was given to dairy animals in diarrhoea (Deeba et al., 2009). An anti-wrinkle cream containing *A. subulatum* was evaluated in the treatment of facial skin wrinkles and thus shows antioxidant activity (Ravichandran et al., 2005). Dilshad et al. (2010) reported that the fruit (25 g) is given orally for treatment and control of mastitis in Pakistan. One teaspoon of fruit/seed powder of *A. subulatum*, if taken with honey twice a day, will be beneficial to patients suffering from ischemic heart diseases (Sarkar, 1986).

Physicochemical parameters

A. subulatum composition varies with variety, region and age of the product. The fruit on average comprises 70% seeds and 30% skin (Pruthi, 1993). Seeds contains 8.6% moisture, 5% total ash value, 1.5% ash insoluble in acid, 3.5% water soluble ash value, 4.88% alcohol extract, 4% non-volatile ether extract and 91.4% of total solid (Shukla et al., 2010). Gupta (1986) reported the volatile oil content varies between 1.95 to 3.32% in different varieties of the cardamom. Hussain et al. (2009) reported that cardamom seeds contain Copper (7.4 mg kg^{-1}), Nickel (<0.006 mg kg^{-1}), Zinc (57.6 mg kg^{-1}), Lead (<0.015 mg kg^{-1}), Cobalt (5.4 mg kg^{-1}), Cadmium (0.2 mg kg^{-1}), Iron (111.2 mg kg^{-1}) and Chromium (<0.003 mg kg^{-1}).

Chemical constituents

Qualitative chemical examinations of various extracts of *A. subulatum* revealed the presence of carbohydrates, flavonoids, amino acids, steroids, triterpenoids, glycosides, tannins (Shivanand and Mahalaxmi, 2010), anthovyanins, aurone, flavanone (Sen et al., 2009) and alkaloids, fixed oil and fats (Shukla et al., 2010). The composition of the essential oil of large cardamom are 1,8-cineole (65 to 80%) and limonene (10.3%) as a major constituent (Patra et al., 1982). The monoterpene hydrocarbon content is in the range of 5 to 17% of which lamonene, sabeinene, the terpinenes and the pinenes are significant components. The terpinols comprise approximately 5 to 7% of the oil. The high cineole and low terpenyl acetate probably account for the very harsh aroma of this spice in comparison with that of true cardamom (Pruthi, 1993). The seed of the cardamom contain mainly essential oil, flavonoids, carbohydrates and fats (Chatterjee and Pakrashi, 2003).

Total phenolic content in seed was found to be 0.00366% w/w (weight by weight) which has been reported as gallic acid while total flavonoid content in seed was observed to be 0.0361% w/w (Shukla et al., 2010). The extract of seeds also contains few glycosides such as subulin, petunidin-3,5-diglucoside, leucocyanadin-3-O-β-D-glucopyranoside along with cardamom and alpinetin (Lakshmi and Chauhan, 1976). Steam distillation of seed contains essential oil having cineole as principal constituent. Other constituents are α- and β-pinenen, sabinene, p-cymene, terpinen-4-ol, α- and β-terpineol, nerolidol, terpinene, terpinyl acetate and bisabolene (Hussain et al., 1992). Protocatechualdehyde, 1,7-bis (3,4-dihydroxyphenyl) hepta-4E,6E-dien-3-one, Protocatechuic acid, and 2,3,7-trihydroxy-5-(3,4-dihydroxy-E-styryl) -6,7,8,9- tetrahydro - 5H – benzocycloheptene, are isolated from greater cardamom (Kikuzaki et al., 2001). Protocatechualdehyde and protocatechuic acid, which have potent antioxidant activity (Kikuzaki et al., 2001).

Biological properties

Analgesic activity

Methanolic extract of seeds of *A. subulatum* at dose 100 and 300 mg/kg and ethyl extract at dose of 200 and 400 mg/kg, showed significant ($p<0.001$) analgesic effect (Shukla et al., 2010).

Anti-inflammatory

The ethanolic and aqueous extract showed anti-inflammatory activity with a dose of 100mg/ml and 200mg/ml respectively (Alam et al.,2011)

Antimicrobial activity

For thousands of years, natural plant products have been used in traditional medicine and predates the introduction of antibiotics to the modern drugs. These antibiotics used for therapy of microbial (bacterial and fungal) infections. *A. subulatum* has a wide variety of secondary metabolites such as tannins, alkaloids and flavonoids having antimicrobial activities. Petroleum ether extracts of large cardamom showed antimicrobial activity and were found active on *Staphylococcus aureus*, *Escherichia coli* (-ve)

and *Pseudomonas aeruginosa* (-ve) bacteria (Kumar et al., 2010).

Likewise, the essential oil from seed was found to have significant inhibitory effect against various keratinophilic and dermophytic fungi (Jain and Agarwal, 1976). Similarly, the acetonic, methanolic and ethanolic extracts (Hussain et al., 2011) of *A. subulatum* showed antimicrobial inhibitory activity against two bacteria causing dental caries, *Streptococcus mutans* and *S. aureus* and two fungi *Candida albicans* and *Saccharomyces cerevisiae* (Aneja and Joshi, 2009).

Antioxidant activity

Antioxidant is the term used to describe a dietary component that can function to decrease tissue damage by reactive oxygen. Antioxidants thus have great value in preventing the oxidative diseases such as chronic fatigue, premature ageing symptoms, degenerative cardiovascular and neurovascular diseases associated with ageing (Willet, 1994). The 1,8-ceineoil and alpha-terpineol, protocatechualdehyde and protocatechuic acid present in the seeds of *A. subulatum* showed antioxidant activity (Kikuzaki et al., 2001) and has potential health benefits by inhibiting lipid peroxidation (Jessie and Krishnakantha, 2005). The seed has antioxidant activity on hepatic and cardiac antioxidant enzymes and is attributed to their ability to activate antioxidant enzymes (Verma et al., 2010).

Antiulcer activity

Ulcer is one of the most common global health problems affecting a large number of people worldwide and shows major cause of morbidity and mortality (Chan and Leung, 2002). Crude methanolic extract of the fruits of *A. subulatum* shows antiulcer activity (Jafri et al., 2001). Similarly, methanolic fraction, petrol soluble fraction, ethyl acetate soluble fraction, ethyl acetate soluble fraction produces significant ulcer protection against ethanol induced ulcer (Sen et al., 2009). Likewise, essential oil of *A. subulatum* inhibit ulcer formation by 60.91% ($p<0.001$), significantly in ethanol and aspirin induced gastric ulcer (Farah et al., 2005). Methanolic extract of *A. subulatum* seeds possessed the hepatoprotective activity against ethanol-induced liver damage in rats, as evidenced by the functional, physical, biochemical and histological parameters (Parmar et al., 2009).

Cardio-adaptogen activity

A. subulatum has protective effect against the effect of acute or severe stress induced myocardial damages (Verma et al., 2010). Regular consumption of greater cardamom may therefore be useful in treatment for patients with Ischemic Heart Disease (IHD), facing regular stressful conditions.

Hypolipidaemic activity

Hafidh et al. (2009) reported that large cardamom has significant ability to suppress lipid peroxidation due to the presence of polyphenol content. Similarly, Dhuley (1999) found that *A. subulatum* supplementation increases the antioxidant enzyme activities, and the lipid conjugated dienes and hydroperoxides. Yadav and Bhatnagar (2007) also reported the inhibition of lipid peroxidation in rat liver homogenate due to their polyphenol content, strong reducing power and superoxide radical scavenging activity.

CONCLUSION

Large cardamom due to its environmental flexibility, social suitability and mountain precise niche has been described as high value, low volume and a perishable cash crop. As this crop does not require much input, and has value for its medicinal as well as spices point of view, further investigations are required to isolate and characterize the specific active components of this plant. There are, of course, no established varieties or lines for *A. subulatum*. Similarly, studies pertaining to biodiversity, ecological, morphological, biochemical, and genetic levels will enable the researcher and scientist to extend the research which ultimately helps in development and conservation of the plant.

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