PHYTOCHEMISTRY AND THERAPEUTIC POTENTIAL OF TURMERIC (*Curcuma longa)*

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Summary

Medicinal plants are rich resources of materials with ingredients of therapeutic value. They have a vital role in traditional medicines and also in the development of new drugs. The role of medicinal plants in healthcare, cultural values and well-being of people is acknowledged in many regions of the world. It is a fact that demand for herbal medicines is about 80% of population and is growing as the people are increasingly depending on herbal medicines. Herbal medicines are very effective, economically viable and useful as alternative to allopathic medicines due to the absence of additional medical complications.

This chapter presents the medicinal properties of plants in addressing many ailments and diseases including COVID 19, the rampant global pandemic. Section 1 introduces the medicinal importance of plants, followed by phytochemical, nutritional, pharmacological and major therapeutic uses of *Curcuma longa* of Zingiberaceae family. Recent developments and findings are presented to support these.

1. Introduction

Humans have been using plant parts as a phytomedicine for thousands of years in the past. Plants have bioactive constituents as primary and secondary compounds. Secondary metabolites are both chemically and taxonomically different compounds, and are being used in many areas like human therapy, agriculture, scientific research, veterinary applications and many other areas. According to the World Health Organization (WHO) nearly 80% of the people in developed countries use allopathic medicines derived from medicinal plants (Pawar et al, 2015). Different parts of the plants, such as roots, stems, leaves, flowers, fruits or seeds are rich in phytochemicals and also the outer layer of plant tissue that consists of pigmented molecules (Saxena et al, 2013). The accumulation of bioactive phytochemicals in the plant tissue constitutes primary and secondary metabolites, contributing to pharmacological potential of medicinally important plants. Primary metabolites are essentially organic compounds such as glucose, starch, polysaccharide, protein, lipids and nucleic acid, which aid in the growth and development in humans, while secondary metabolites are pharmacologically active compounds such as alkaloids, flavonoids, saponins, terpenoids, steroids, glycosides, tannins, volatile oils etc., which play an important role in curing diseases (Egamberdieva et al, 2016; Shakya, 2016). Secondary plant metabolites are classified based on their chemical structure (sugar), biosynthetic pathways (tannins) chemical composition (nitrogen), or their solubility in various solvents. Figure 1(a) shows the bioactive ingredients of plants in general.

Phytochemical composition of secondary metabolites includes the following:

(a) Alkaloids: These are generally present in higher plants (in whole plant or certain organs), particularly in dicots, but usually minimal in lower plants. Alkaloids are derivates of amino acids with one or more carbon rings (for example nitrogen). The position of nitrogen atom in the carbon ring determines alkaloids (Egamberdieva et al, 2016). Therapeutically alkaloids are antispasmodic, immunoregulative, cerebro-

protective, anti-mutagenic, vaso-relaxing, antioxidant, antimalarial, analgesic, and diuretic (Bribi, 2018).

(b) Terpenes: These are hydrocarbons in which terpenoids are either altered chemically or denatured by oxidation. Modified terpenes with either removal or moving of methyl groups or addition of oxygen atoms constitute terpenoids. Terpenoids are therapeutically antiviral, anthelmintic, antibacterial, anticancer, inhibition of cholesterol synthesis, antimalarial, anti-inflammatory, etc.

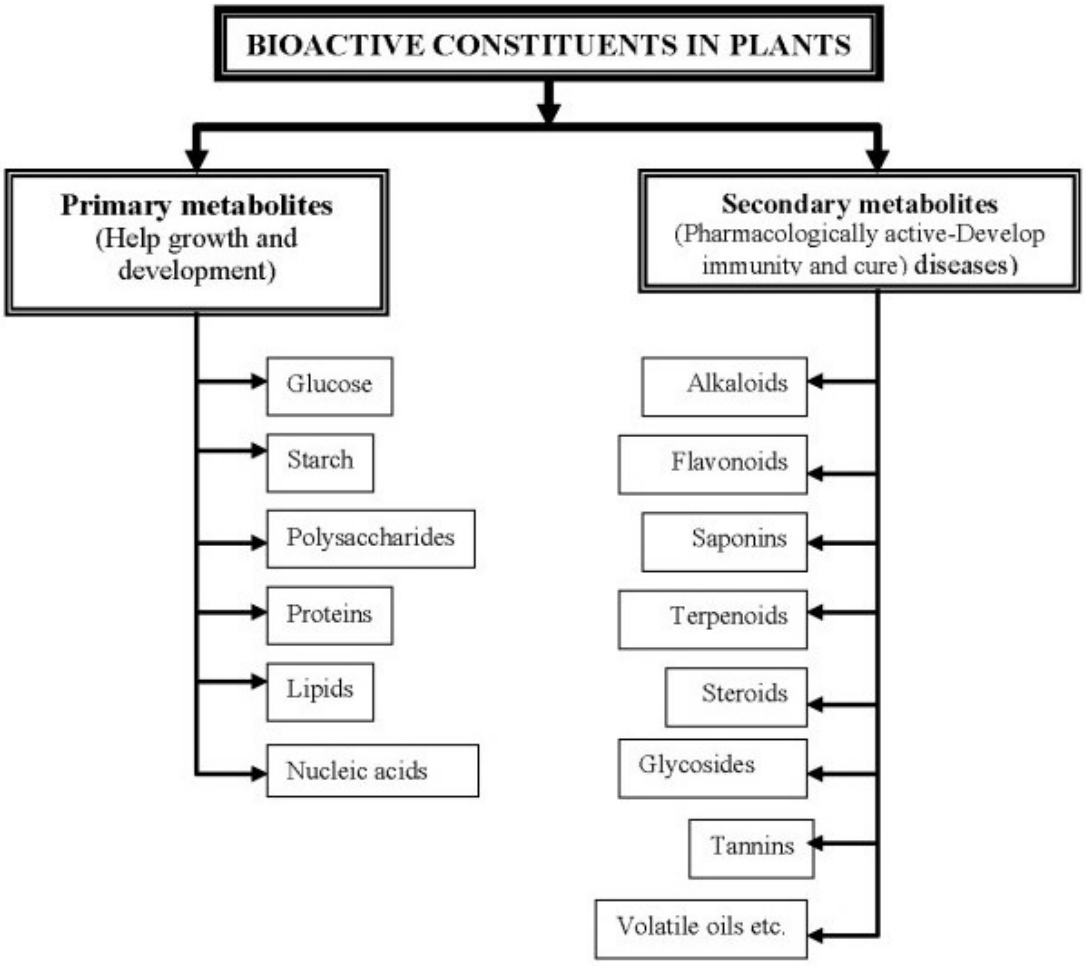

Figure 1(a). Bioactive constituents of plants

(c) Glycosides: These are known for their antifungal and antibacterial properties, corticoid and anti-inflammatory effects. They constitute two molecules of (i) sugar which is primarily D-glucose, and Lrhamnose, L-fructose, etc., (ii) aglycone composed of flavonoid or a terpene. Aglycones are part of cardiac glycosides which are found in a number of plants and are highly toxic. Aglycones of cardiac glycosides can be categorized as (a) cardenolides and (ii) bufadienolides.

(d) Flavonoids with varying phenolic structures contribute to antioxidant, anti-allergic, antibacterial anti-microbial, anticancer, cardioprotective, antihypertensive, antiulcerogenic, antidiabetic properties among others. Based on the position of the

benzenoid substituent such as flavone (2-position) and isoflavone (3- position), flavonoids are divided into two classes.

(e) Saponins are chemically classified as glycosylated steroids, triterpenoids, and steroid alkaloids, which are present widely in monocots, and less frequent in dicots. The therapeutic values of saponins are anti-inflammatory, antiviral, plant defense activities, haemolytic activity (Maurya et al, 2008; Chopra and Doiphode, 2002; Saxena et al, 2013; Clement et al, 2014). An agylone is the residual compound of the glycosyl group with the replacement of a glycoside by hydrogen atom. Derivatives of steroid aglycones are spirostan and furostan. Sapogenin (aglycone) links with the carbohydrate, consisting of one or more sugar moieties containing glucose, galactose, xylose, arabinose, rhamnose, or glucuronic acid glycosidically is the part that saponins contain.

Therapeutic values of the medicinal plants have been useful in herbal medicine for the treatment of many ailments in humans and animals. The significance of naturally occurring plants of medicinal plants continues to be the economic and therapeutic value to humankind and hence they continue to be important sources for new drug development throughout the world. The global biodiversity hotspot – the Western Ghats in India is a repository of exceptional diversity of biota (plants and animals) with immense medicinal values and only a fraction of this diversity is explored and a major fraction of plants is yet to be described taxonomically and also for phytochemical compositions. Medicinal values of plants are evident from the immunity acquired by humans in the Western Ghats for ensuring diverse plants in the daily diet and hence the region has reported lesser instances of COVID 19 among the residents of the Western Ghats. Daily food preparation with spices, turmeric (*Curcuma longa*), etc. has been an integral part of their diet. However, accentuated deforestation due to unplanned developmental activities is fragmenting the contiguous intact native forests and also large scale transition to monoculture species plantations of exotic species has not only altered hydrologic regime (Ramachandra et al, 2019), but also threatened the survival of ecologically fragile habitats in the Western Ghats leading to the extirpation of plants and animals of vital conservation importance. ***Curcuma longa*** consisting of various bioactive compounds is one of the most potent medicinal plants, for their value in therapeutic uses.

1.1. *Curcuma longa*

1.1.1. General Description

Curcuma longa is a perennial erect and leafy herb; it belongs to the Zingiberaceae family, and is used widely by the traditional medical practitioners for the treatment of various ailments. Turmeric is a product of *Curcuma longa*, and the yellow powder (curcumin) extracted from rhizome is used for medicinal purposes and also in religious practices. The genus name *Curcuma* which was included dates back to the ancient Indian "*kunkumam*"(saffron)" or turmeric from middle India. The yellow saffron of rhizomes -long roots of this plant- grow like fingers slanting downwards. Dried *Curcuma longa* is the source of the spice turmeric used widely in curry powder and condiments.

Turmeric and other members of the Zingiberaceae are sterile plants and reproduce by asexual clonal propagation of the rhizomes. The genus *Curcuma* includes various other essential economically important species, including. *C angustifolia* (wild arrowroot, narrow-leaved turmeric), *C.amada* (mango ginger), *C. zedoaria* (zedoary) and *C. aromatica* (Cochin turmeric, wild turmeric).

Leaves **Flower** **Rhizome**

(2a). Morphology of *Curcuma longa* (Source: Pandey N.K., Santhosha G.R. 2017)

Fresh rhizome **Powder from dry rhizome**

(2b). Fresh turmeric rhizome and powder from dried rhizome

Figure 2. *Curcuma longa*

2. Geography and Distribution

Curcuma longa originated and spread throughout tropical and subtropical regions and is cultivated widely in Asia - India and China.

3. History

The use of turmeric dates back to nearly 4000 years to the Vedic times in India, where it was used as a culinary spice and also had some religious significance. It probably reached China by 700 AD, East Africa by 800 AD, West Africa by 1200 AD, and Jamaica in the eighteenth century. According to Sanskrit medical treatises and Ayurvedic and Unani systems, turmeric has a long history of medicinal use in South

Asia. Susruta's Ayurvedic *Compendium*, dating back to 250 BC, prescribes an ointment of turmeric to relieve the effects of food poisoning (Prasad and Aggarwal, 2011).

Countries	Common Name
India	Haldi,halud,arisinia
Bangladesh	Haldi,halud
Pakistan	Haldi
Myanmar	nanwin
Malayasia	Kunyit, temu kuniyit
Indonesia	Koneng,kunir,kuniyit,tius
Thailand	Khamin,khamin-chan
China	jiang huang
Japan	Ukon, Tamerikku
United States	Indian saffron,turmeric
Russia	Koren, kurkumy, Kurkuma
France	Curcuma , Safran des Indes
Germany	Gelbwurzel
Italy	Curcuma
Spain	Curcuma, Azafran arabe
Portugal	Açafrão da Índia, Curcuma

Table 1. Common Names of *Curcuma longa*

4. Taxonomical Classification

Figure 1(b) shows the taxonomical classification of *Curcuma longa* in a Venn diagram.

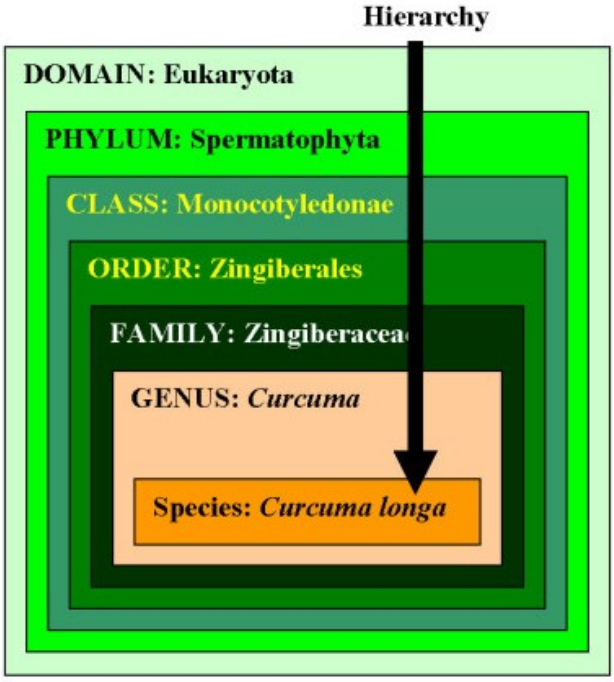

Figure 1(b). Taxonomical classification of *Curcuma longa*

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Biographical Sketches

Sayantani Chanda Received her B.Sc (Bachelor of Science) degree in Botany from University of Calcutta, Kolkata, India, in the year 2012 and Post-Graduation degree, M.Sc.(Master of Science) in Genetics from West Bengal University of Technology, Kolkata, India in 2014. After that she joined in Energy & Wetlands Research Group, Indian Institute of Science, Bangalore-560012, India, as research intern. She worked there about 2 years. The area of research was Pharmacological, Phytochemical and spatial aspects of plants in Indian sacred groves and its relevance towards maintenance of ecosystem and their sustainable utilization. There after she has been associated with Agricultural and Ecological Research Unit, Biological Sciences Division, Indian Statistical Institute, Kolkata, India. She is now working in the area of Cultivation and regeneration of medicinal plants by natural as well as tissue culture method and conserve them in their natural habitat. Further she is going to undertake the project on Squalene (C30H50), a naturally occurring highly unsaturated triterpene, is an intermediate in the cholesterol biosynthesis both in plant and animal world. This compound plays various biological roles, therefore makes it a favorite choice in the pharmaceutical, cosmetics and food supplement industries. Basically, in this regard she is interested to explore the rich, natural, renewable and cost-effective sources of squalene from the abscisic leaves of the plants. She published many papers in different national and

international journal and also taken part in various international conferences. She has been awarded "Young Achiever Award 2020" for her outstanding contribution and recognition in the field of Plant Molecular Genetics from Agricultural and Environmental Technology Development Society, India.

T.V. Ramachandra Received Ph.D. in Ecology and Energy from Indian Institute of Science, Bangalore, India. At present, he is Coordinator of Energy and Wetlands Research Group (EWRG), Convener of Environmental Information System (ENVIS) at Centre for Ecological Sciences (CES). During the past fifteen years he has established an active school of research in the area of energy and environment (http://ces.iisc.ernet.in/energy). He was a Member of Karnataka State level Environment Expert Appraisal Committee (2007-2010), appointed by the Ministry of Environment and Forests, Government of India. He is a recipient of Energy Legend (2011), Energy Engineer ((international) 2009) of Association of Energy Engineers (USA), Johny Biosphere Award for Ecology and Environment (2004) and Satish Dhawan Young Scientist Award, 2007 of Karnataka State Government. He is an associate faculty at Centre for Sustainable Technologies (astra) and Centre for infrastructure, sustainable Transportation and Urban Planning (CiSTUP) at Indian Institute of Science. He is an Elected Fellow of the Institution of Electrical Engineers (IEE, UK; 2005), Indian Association of Hydrologists (India; 2006), Institution of Engineers (IE, India; 2003), and a Senior Member, IEEE (USA; 2000) and Association of Energy Engineers (USA; 2000), National Institute of Ecology (2011). His areas of specialization are on Biodiversity-Ecology-Hydrology linkages, Ecological Modeling, Energy, Wetlands, Soil and Water Pollution, GIS and Remote sensing, Environment Education, Conservation of Terrestrial and Aquatic ecosystems, Environmental Impact Assessment (EIA),Cumulative Environmental Impact Assessment etc. He has published 309 papers in National and International journals and 40 book chapters.