

Genetic improvement of curry leaf in India: Challenges and future prospects

Curry leaf is a perennial leafy vegetable with numerous uses and benefits. It is an integral part of Indian Cuisine. Several medicinal uses are known for this crop. Essential oils and other bio-active chemicals in curry leaf have several industrial applications. Constant domestic and international demands have encouraged the farmers to cultivate curry leaf as sole crop under high density planting. Low input costs, three harvests per year, low post harvest losses; perennial nature with more than 10 years of plantation viability makes curry leaf a best alternative profitable crop for climate resilient agriculture to small and marginal farmers. Despite several benefits attached to curry leaf, research progress in terms of genetic improvement, PGR management and production technologies appears to be infant stage in India. The present article highlights status of genetic improvement, opportunities and challenges for curry leaf in India.

CURRY leaf (*Murraya Koenigii* (L.) Spreng) is an aromatic, semi-evergreen perennial leafy vegetable distributed widely in tropical and sub-tropical regions of the world. It is used for several culinary, nutraceutical, medicinal, therapeutic and industrial purposes owing to the presence of wide range of bio-active and aromatic compounds. Sabinene, Pinene, Cadinol, Caryophyllene and Cadinene are the major compounds responsible for characteristic intense flavour. Monoterpenoids and their oxygenated derivatives are the chief chemical constituents present in essential oil of curry leaf. Carbazole alkaloids having anti-cancerous, antidiabetic and anti-oxidant properties are the bio-active compounds present abundantly in curry leaf. The crude extract from different parts of curry leaf is an important ingredient in Indian systems of medicine like Ayurveda, Siddha and Unani. The distill extraction of aromatic and volatile oils from curry leaf plant has applications in several cosmetic, perfumeries, soap and food processing industries.

Curry leaf is an indispensable part of India systems of food preparation. It is a cheap and rich source of nutrients like calcium (Ca), vitamin A, amino acids and dietary fiber. Other elements present in trace amounts like iron (Fe) and Magnesium (Mg) are also a valuable sources of nutrients to daily consumers. Curry leaf plant is commonly seen in every kitchen garden in South India. However, in recent years, the constant demand in export and local market has encouraged several small and marginal farmers to take up curry leaf cultivation on commercial scale in many districts of Southern India. Thus, its genetic improvement and development of suitable production technologies is very essential to ensure sustainable and profitable cultivation of curry leaf in India. With this background, the present article briefly discusses on present status of

genetic improvement of curry leaf and its opportunities and challenges in India.

Curry leaf usages and benefits

Curry leaf is a perennial leafy vegetable with multiple uses and benefits. It is used as fresh leaves, dried leaves, dried powder and processed powder with other spices. The shelf life of curry leaf can be enhanced by reducing the leaf moisture level under shade or sun drying. The fresh leaves are integral part of curries, chutny, sambar and other food preparations in Southern India. It not only adds flavor to food but also enhance taste and palatability. Nutritional composition of the food with respect to Ca, vitamin A, amino acids, digestible fiber and other micro-elements is improved due to curry leaves. Regular use of curry leaves is known to reduce blood sugar level. Several anti-oxidants, anti-diabetic, anti-cancerous properties present in curry leaves will aid to better functioning of kidney, heart, liver and other vital organs and thus, is regarded as functional food for the man. The nutrient composition of fresh and dehydrated curry leaves is as follows.

Nutrient	Fresh leaves (100 g)	Dehydrated leaves (100 g)
Carbohydrate	8.7 g	64.31 g
Protein	6 g	12 g
Fat	1 g	5.4 g
β -carotene	7560 μ g	5292 μ g
Calcium	830 mg	2040 mg
Iron	0.93 mg	12 mg

Source: Indian Journal of Natural Products and Resources Vol. 2(4), December 2011, pp. 508-511.



Morphotypes in curry leaf

Curry leaf makes an important part of Ayurveda and other traditional medicinal systems. The ethno-botanical use of curry leaf for medicinal purposes is known since centuries. The crude extracts from different parts of the curry leaf plant is used to treat several diseases and disorders such as piles, influenza, dropsy, itching, bronchial eruptions, fever, asthma, body aches, diarrhoea, kidney pains and vomiting. The green leaves are eaten raw to cure dysentery. The pulped bark and root of curry leaf are externally applied to cure eruptions, fresh cuts and bites of poisonous animals. Besides, essential oil extracted on steam distillation has applications in several industries such as soap, perfumeries, pharmaceutical, nutraceutical and other functional food industries. Owing to its growing demands in both domestic and international markets, the curry leaf cultivation as a commercial leafy vegetable has made its way into several districts of Karnataka, Tamil Nadu, Andhra Pradesh, Telangana and Kerala. India is regularly exporting fresh and dried leaves to Gulf and European countries and earning a considerable amount of foreign returns. The fresh leaves are sold as leafy vegetable in local markets all round the year. This has encouraged many small and marginal farmers to cultivate curry leaf as a sole crop. Besides, low input demand, low post harvest losses and access to local markets has ensured assured income to the growers throughout the year. Curry leaf is perennial crop, a well maintained plantation can last more than 10 years, which provides continuous income to the farmers.

Plant genetic wealth of curry leaf in India

Curry leaf plant is originated from India and its adjoining regions of Sri Lanka, Bangladesh and Nepal. Later, it has spread to other parts of the world by Indian migrants. In India, it is distributed throughout its mainland including Andaman and Nicobar Islands, and found naturally in semi-deciduous to evergreen forests with medium to high rainfall. Foot hills of Himalayas in North, continued through Terai region, Sikkim hills, Darjeeling hills and end up in Khasi-Garo hills in far east, reaching far up to Nilgiri and Annamalai hills in South, covering deciduous and semi-deciduous forests in Middle India and Eastern Ghats, including evergreen

forests of Western Ghats are the major diversity regions for curry leaf in India. A huge morphological and chemical diversity is reported in curry leaves. Broadly, curry leaf is classified into three morphological types *viz.*, Brown/Gamthi (GM), Regular (RE) and Dwarf (DF) based on growth habit, colour and size of leaves and flavor. Slow growing genotypes with dark brown small and thick leaves having serrated edges are Brown/Gamthi (GM). It is most fragrant type of curry leaf. Whereas, genotypes grow very fast, sometimes turn into small-medium-sized trees and produces exstipulate, bipinnately compound dark leaves with long reticulate venation are referred to as regular type (RE) and this type is available throughout India. Dwarf types (DF) are moderately growing genotypes with spreading branches to form bushy habit and its leaves are light green, exstipulate, bipinnately compound with long reticulate venation and having unique aromacity. Besides, these morphotypes vary for anti-oxidant activity in the order of Gamthi>Dwarf>Regular types.

Similarly, a tremendous variability for chemical composition of essential oils in curry leaves was observed with respect to different regions. The variation is highly inherited and is recognized as chemotypes. Two main chemotypes with essential oils predominant in monoterpenoids and sesquiterpenoids were recognised in India. The chemotypes of Western Ghats were dominated by monoterpenes such as sabinene (6.90-40.59%), β -phellandrene (1.39-45.89%) and α -pinene (1.93-63.66%), followed by sesquiterpene like β -caryophyllene (6.68-18.46%). Four chemotypes *viz.*, β -phellandrene, sabinene, α -pinene and β -caryophyllene were reported from Western Ghats. Besides, four other genetically diverse chemotypes of curry leaves such as β -pinene, α -pinene, β -caryophyllene and β -phellandrene were reported from other parts of India.

Genetic improvement of curry leaf in India

Despite multiple use and numerous benefits, the curry leaf is still an under-utilized and unexplored vegetable in terms of efforts towards its genetic improvement and area under cultivation. The genetic improvement of curry leaf still is in nascent stage and unsystematic in India. Earlier, few efforts were made to characterize



Senkaampu, a popular farmers variety of curry leaf commercially being cultivated in different parts of Tamil Nadu

curry leaf germplasm for different morphological and biochemical traits. More often, they are isolated programmes, characterized by limited use of plant genetic resources (PGR), and has narrow genetic base. Moreover, in majority of the studies, the sampling was done on natural populations, wherein, such samples lack replications and uniform environments. The inferences made from such studies, especially on traits like bio-chemical composition and essential oils content which vary greatly with locations and seasons, often failed to provide comprehensive information regarding extant of genetic base of plant diversity. Further, some other studies have done nutrient analysis and profiling in curry leaf. However, in those studies, genotype $\times$ environment interaction components has not been dissected for nutritional related traits. Thus, it implied that, no comprehensive efforts have been made to collect and conserve curry leaf germplasm covering different geographical regions, and characterize under uniform environmental conditions. Further, an inclusive field gene bank contains broad based germplasm in terms of number, regions and traits, is lacking in curry leaf.

In spite of lack of comprehensive PGR activities in curry leaf, a few and scanty breeding initiatives were made in the past. Towards this end, two improved varieties of curry leaf namely, DWD-1 and DWD-2 (Suhasini) were developed and released by University of Agricultural Sciences (UAS), Dharwad. Basically, these two varieties were developed by clonal selections from the germplasm collected from Western Ghats. Both have good aroma and suitable for fresh leaves. The oil content reported to be 5.22% and 4.09% in DWD-1 and Suhasini, respectively. DWD-1 is cold sensitive and shows poor growth in winter season. Whereas, Suhasini is insensitive to low temperature and thus produces higher yield than DWD-1. Besides, several local landraces and farmers' varieties are being popularly grown by the farmers; these were selected based on appearance, fragrance and response to local environments. Senkaampu is such local landraces or farmers' variety are being popularly grown in many

parts of Tamil Nadu. It has pigmented petiole, shiny and leathery leaves with good fragrance. It has huge local demand for fresh leaves. Lately, ICAR-Indian Institute of horticultural Research (ICAR-IIHR), Bengaluru, has initiated comprehensive breeding programme in curry leaf. Till now, it has collected more than 150 germplasm from different parts of India covering Himachal Pradesh, Odhisa, Karnataka, Tamil Nadu and Kerala, and successfully established a field gene bank to conserve them. Germplasm characterization with respect to different morphological traits, bio-chemical and nutritional traits including chemical profiling for essential oils are being taken up in different seasons. Further, germplasm augmentation is being done through regular exploration programmes concentrating in different states and regions.

Challenges ahead

Expansion of area under curry leaf cultivation

In India, more than 60% of cultivable area is under rain fed and more than 80% farmers are small and marginal. Curry leaf can be easily introduced to such farmers and provides assured income with low input cost over long period of time. However, commercial cultivation of curry leaf is presently confined to few districts of Southern states. Thus, curry leaf cultivation can be expanded to other parts of the country, wherever local demand for curry leaf is exists.

Collection and conservation of PGR in curry leaf

Curry leaf is native to India. A tremendous variability exists for this crop. In order to understand the extant of genetic diversity for important agronomical and bio-chemical traits, and identification of trait specific genotypes followed by allele mining and traits discovery requires comprehensive exploration of PGR, and its characterization and documentation, and conservation through field gene banks. Regular germplasm exchange between working institutes will further augment the PGR in curry leaf.

Comprehensive research efforts in curry leaf

A breeding programme inclusive of development and utilization of different genomic resources in PGR management, trait discovery and allele mining, identification of trait specific genotypes and its successful introgression into elite lines is need of the hour in curry leaf. Being a perennial tree species, different breeding methods like clonal selection, mutation breeding and polyploidy breeding should be integrated in curry leaf. Further intensive efforts towards ideotype breeding in curry leaf is required for development of bushy, evergreen, winter insensitive genotypes with high fragrance.

Development of Distinctness, Uniformity and Stability test guidelines in curry leaf

Several local landraces and traditional and farmers' varieties of curry leaf are being popularly grown in different parts of India. These varieties possess several unique traits with many pharmaceutical, nutraceutical and functional food properties. Protection and conservation of such unique germplasm requires novelty, distinctness, uniformity and stability tests conducted through nationally or internationally accepted guidelines. However, there is no internationally or nationally accepted DUS test guidelines available in curry leaf, which is a mandatory requirement to protect unique germplasm under PPV&FRA, New Delhi.

Inter-institutional linkages

Collaborative germplasm exploration and exchange programmes, collaborative research between ICAR

institutes, SAUs and other research establishments is required to accelerate the curry leaf improvement in India.

SUMMARY

Curry leaf is a multi-utility commercial crop with low investment cost and huge export value. Crop improvement in terms of research progress and area under cultivation is still in nascent stage for curry leaf in India. PGR management needs to be strengthened by more and more exploration programmes and establishment of field gene banks. Multi-environmental systematic evaluation of genetic resources with broad genetic base with increasing use of latest genomic resources for trait specific characterization and trait discovery for pharmaceutical and nutraceutical properties has to be given emphasis. To harness benefits out of present growing demands and new found horizons of applications, area under curry leaf needs to be expanded to small and marginal farmers. To achieve towards this end, farmers' friendly technologies like high yielding varieties with inbuilt resistance to biotic and abiotic stresses are to be developed in addition to suitable protection techniques. By doing this, in near future, curry leaf will be proved to be very good alternative crop to small and marginal farmers for climate resilient agriculture.

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Vegetable soybean

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Vegetable-soybean [*Glycine max* (L.) Merrill] is also known as green beans. Its green-pods can be consumed in various ways such as snacks, salad, etc., while its green-seeds (beans) can be consumed like peas. On an average it contains 13% protein, 5.7% cholesterol-free fatty acids, 6.5% TSS, 158 mg/100g of phosphorus, 78 mg/100 g of calcium, 0.4 mg/100g of vitamin B1 and 0.17 mg/100g of vitamin B2.

In addition, it is also a good source of isoflavones and tocopherols. It is one of the few green-vegetables that have all essential amino acids in their protein compositions thus be considered as 'complete proteins', at par with meats, milk products and eggs.

At present, Jharkhand is the only state where commercial cultivation of this crop has been started, and it is becoming popular especially among children. Since research on vegetable soybean in India is still in blooming phase, there is urgent need to focus research on this crop to harness its nutritional potential especially for the new niches of the country. An initiative has been taken at ICAR-Indian Institute of Vegetable Research, Varanasi by adopting Vegetable soybean as a new underexploited vegetable crop.