The Biobrio ISSN : 2393-9508 e-ISSN: 2582-4902
An International Quarterly Journal of Life Sciences
Website: www.thebiobrio.in SJIF 2024:8.259
11 (1&2): 1159-1164, 2024

Medicinal properties, therapeutic applications and the economic impact of lemongrass cultivation on rural livelihoods in Jharkhand

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Received :07th January, 2024 ; Accepted : 8th February, 2024
DOI:- https://doi.org/10.5281/zenodo.13285037

ABSTRACT

Lemongrass (*Cymbopogon citratus*) is a widely recognised medicinal plant utilised for centuries in traditional medicine systems worldwide. Lemongrass (*C. citratus*) is a member of the Poaceae family. It is an ideal shed-loving crop for cultivation in rainfed areas, salt-affected areas up to 9 soil pH, wind and water erosion-prone areas, and Land slopes. The prominent cultivation of lemongrass (*Cymbopogon* spp.) relies on the pharmacological incentives of its essential oil. Lemongrass essential oil (LEO) carries a significant amount of numerous bioactive compounds, such as citral (mixture of geranial and neral), mineral, geraniol, geranyl acetate, citronellal, citronellol, germacrene-D, and lemon, in addition to other bioactive compounds. These components confer various pharmacological actions to LEO, including antifungal, antibacterial, antiviral, anticancer, and antioxidant properties. This review paper aims to provide a comprehensive overview of lemongrass's medicinal properties, therapeutic applications, phytochemical composition, pharmacological activities, and potential health benefits, shedding light on its diverse roles in promoting human well-being. The study of the cost of cultivation and returns from lemongrass, estimated from primary and secondary data collection. Estimation of a regression model indicated a positive and significant influence of expenditure on machine use, lemongrass slips and manures/fertiliser on returns from lemongrass.

Key Words - Economic feasibility, *C. citratus*, Poaceae, phytoconstituents

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INTRODUCTION

Cymbopogon is a genus of about 55 species, which are indigenous in tropical and semi-tropical areas of Asia and are cultivated in South and Central America, Africa and other tropical countries. These are tufted perennial C_4 grasses with numerous stiff stems arising from a short, rhizomatous rootstock (Weiss 1997; Kumar *et al.*, 2000) as with citrus flavour, and can be dried and powdered or used fresh. The name *Cymbopogon* is derived from the Greek words "kymbe" (boat) and "pogon" (beard), referring to the flower spike arrangement. (Plants data base, 2003) *Cymbopogon citrates*, generally known as Lemongrass, is a tall perennial grass. It belongs to the genus *Cymbopogon* of aromatic grasses and contains essential oils with a pleasing lemon flavour. In Asia, Lemongrass is widely used as an essential component for health. In India, it is used as a sedative for the central nervous system (Plants data base, 2003). The *Cymbopogon* essential oils are characterized by monoterpene constituents like limonene, citral, lemon, citronellal, 1,8 cineole, citronellol, linalool, geraniol, methylheptenone, b-caryophyllene, geranyl formate and geranyl acetic acid derivation. Chemical characterization of essential oils is generally done with the use of GC-MS (Reitz 1982.; Onawunmia *et al*. 1984).

Cymbopogon citratus, a herb which is known throughout the world as lemongrass, is widely used as a source of medicine in tropical countries (Melo *et al.* 2001). This herb is widely consumed as an aromatic herb in Latin and African countries. In addition, its aerial components are widely utilized in folk medicine for the treatment of digestive disorders, diabetes, nervous disorders, inflammation and fever (Syed *et al.* 1984). Extracts from *Cymbopogon citratus* leaves have demonstrated antioxidant, antifungal and antimicrobial action (Schaneberg & Khan, 2002). Lemongrass is widely used in herbal teas and other non-alcoholic beverages in baked food and also in confections. Essential oil from lemongrass is commonly used as a fragrance in perfumes and cosmetics, such as creams and soaps. Citral, extracted from the oil of lemon grass, is used in the flavouring of soft drinks, in scenting detergents and soaps, as a fragrance in perfumes and cosmetics, and as a mask for dis-agreeable odours in various industrial products. Citral is also used in the formation of ionones used in perfumery. Lemon grass, a medicinal plant, has been considered as an insect repellent and carminative.

TAXONOMIC CLASSIFICATION

Kingdom	:	Plantae
Division	:	Magnoliophyta
Class	:	Liliopsida
Order	:	Poales
Family	:	Poaceae
Genus	:	*Cymbopogon*
Species	:	*C. citratus*

COMMON NAMES

English: Lemongrass, Citronella, Squinant

Hindi: Sera, Verveine

PARTS USED

Leaves and whole plant.

BOTANICAL DESCRIPTION

Lemongrass is equally versatile in the garden. This tropical grass grows in dense clumps that can grow to 6 ft (1.8 m) in height and about 4 ft (1.2 m) in width, with a short rhizome (Ahmad *et al.* 2008)

Phytochemical constituents

The qualitative and quantitative phytochemical screening of *C. citratus* reveals important bioactive chemical compounds which could be linked to the therapeutic potency of the plant (Maskri *et al.* 2011). Bioactive constituents such as ketones, alcohols, phenols, terpenes, flavonoids, saponins, steroids, tannins, alkaloids, geranial, terpenoids, polyphenols, esters, aldehyde and fatty acids have been isolated and analysed (Arshad, *et al.* 2011; Costa, 2007). The essential compounds in *C. citratus*, according to the literature, are essential oil and flavonoids, which contribute to the pronounced therapeutic and pharmacological activities of the plant (Amirdivani & Baba, 2011; Hanaa *et al.*, 2012). The structures of the main phenolic constituents are given in Figure 1,

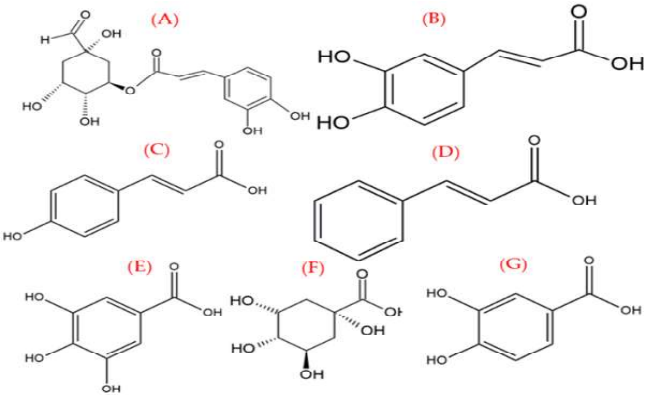

Figure 1. Structures of chlorogenic acid (A), caffeic acid (B), p-coumaric acid (C), cinnamic acid (D), gallic acid (E), quinic acid (F), and protocatechuic acid (G).

PHARMACOLOGY

Although many pharmacological investigations have been carried out based on the ingredients present, much more can still be explored, exploited, and utilized. A summary of the findings of these studies is presented below.

Antibacterial Activity

The chromatographic fraction of the essential oil in agar plate was active on *Bacillus subtilis, Escherichia coli, Staphylococus aureus* (Soares *et al.*, Carmo *et al.*, 2013) and *Salmonella paratyphi* and *Shigella flexneri*. Essential oils such as α-citral (geranial) and β-citral (neral) have been isolated, characterised and analysed from *C. citratus* leaf.

These compounds are active antibacterial compounds with predominant activities against gram-positive and negative bacterial isolates (Sessou *et al.,* 2012).

Dermatotoxicity activity

Cymbopogon citratus has been incorporated into herbal soap to treat rashes and itchy and swollen skin. Herbal soap produced from *C. citratus* leaf, tea tree oil and orange peel was investigated for their dermatoxicity potency using clinical samples. Significant activity of 60% ($p < 0.05$) was observed after 40 days of treatment with the soap (Banu, 2013).

Insecticidal activity

Essential oils from *C. citratus* have been applied in the control of pathogens and insects (Hirschmann *et al.*, 2014). It has been reported to be effective against *Aedes aegypti* (Lu *et al.*,2014), *Phemacoccus solenopsis* (Shah *et al.*, 2014], *Musca domestica* and *Dermatophagoides* sp (Francisco *et al.,* 2013; Katsukawa *et al.* 2010).

Antidiabetic activity

Diabetes is one of the most lethal diseases of the twentieth century. It inhibits the pancreas from producing adequate insulin and could prevent the regulation of blood sugar. The *in-vivo* antidiabetic potency of *C. citratus* was investigated via molecular docking at dosage rate of 400 and 800mg. The extracts show pronounced reduction in the level of insulin ($p < 0.001$), glucose ($p < 0.001$) and triglycerides ($p < 0.001$) (Sharma *et al*.).

Antioxidant activity

Cymbopogon citratus contain natural antioxidants, such as caffeoylquinic acid, flavonoids, chlorogenic acids, phenolic aciids, swertiajaponin and isoorientin. These compounds could be responsible for the diminishing low-density lipoprotein (LDL) oxidation induced by Cu^{2+} (Sharma *et al*.), reducing capability of plasma (FRAP), β-carotene and 1,1-diphenyl-2-picryl-hydrazyl (DPPH) assays (Cheel *et al.* 2005).

Anti-obesity and antihypertensive activities

Lemon grass has been incorporated into hypolipidemic and hypoglycemic drugs. In folk and Ayurvedic medicine, it has been used to regulate glucose, lipid, and fat levels in the blood serum, which could prevent obesity and hypertension. It is usually taken as tea (Viana *et al.* 2000)

Antifungal activities of *C. citratus*

Essential oils from lemon grass have been reported to show significant resistance to pathogenic fungi cells causing disorder in proper secretion of mycotoxins during storage of grain and other food substances.

Anti-inflammatory activity

Chronic inflammation is one of the prominent global health challenges and had been linked with life-threatening diseases, such as cancer. It has also been reported to suppress tumour necrosis factor (TNF)-α-induced neutrophil adherence at a concentration of 0.1%, inhibit inducible nitric oxide synthase (iNOS), nitric oxide production (NO) and another lipopolysaccharide (LPS)-induced pathways, covalently bind to the receptors thereby inhibiting the nuclear factor-kappaB (NF-kB) pathway, 60-70% suppression of COX-2 and peroxisome proliferator-activated receptor alpha (PPAR-α) and orally and topically inhibit tissue inflammation (80-90%) (Cheel *et al.* 2005).

Production

In India, lemongrass is traditionally cultivated as a rainfed crop Kerala state. Although, under semi-arid tropical conditions, it is grown as an irrigated crop in Karnataka, Tamil Nadu, West Bengal, Chattisgarh, Odisha, Uttar Pradesh, Assam, Jharkhand, Bihar, Maharashtra, Madhya Pradesh and Rajasthan in about 4000 hectares and the annual production is around 250 tonne. Since 2018, CSIRI-CIMAP introduced different aromatic crops like Palmarosa, Lemongrass, Tulsi and Vetiver in highly drought-prone areas of the Bundelkhand region of Uttar Pradesh and Madhya Pradesh. Among these aromatic crops, Lemongrass emerges as the most profitable crop among the marginal landholding and resource-poor farmers. The area under cultivation of lemongrass increased continuously in this region. At present, about 250 hectares are covered under the cultivation of

aromatic crops. In which about 61.00 per cent area has covered under lemongrass cultivation

Economics of Lemongrass Cultivation in Jharkhand State

CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP) Lucknow undertook the technology demonstration on scientific cultivation of lemongrass in Ranchi, Khunti, Simdega, Hazaribagh, Gumla, and Bokaro districts of Jharkhand during the 2018-20. The random sampling technique was used for comprised of 75 farmers through a personal interview using a pre-tested interview survey schedule on the socio-economic profile of the farmers and cultivation aspects. The technology demonstration was carried out under a collaborative project of CSIR-CIMAP, Lucknow, and Jharkhand Livelihood Promotion Society, Department of Rural Development, Government of Jharkhand. The cost and return were calculated at the prevailing market prices. A simple analytical tool and technique used for the data analysis method were followed to examine the costs, and returns and comparisons were made.

Socio-economic profile of the farmers

Data from the selected farmers were collected and analysed regarding average family size, literacy status, occupation, land holding, cropping pattern, average farm assets, etc., as discussed in Table 1.

Cost Structure of Lemongrass Cultivation

The cost structure of lemongrass cultivation calculated at the current price prevailing in the market has been presented in Table 2. The observed Sharma et al. Print ISSN: 0424-2513 508 Online ISSN: 0976-4666 operation cost of lemongrass cultivation was ` 51713 (75.28 per cent) per ha per year.

Returns from lemongrass cultivation

The cost and return from lemongrass cultivation are presented in Table 3. It was found that the farmers have got 112 kg of lemongrass oil from ha of land, which amounted to a total return were ` 1, 40,000 per ha per year. The net return of farmers from lemongrass oil production over different types of costs is presented in Table 3.

Table 1: Socio-economic profile of the farmers

Particulars		Averages
Average family size		5.95
Literacy status		72.58
Occupation: Agriculture		85.33
Agriculture crops:		
	Paddy	17.98
	Wheat	3.71
	Maize	19.91
	Potato	8.17
	Mustard	2.82
Medicinal and aromatic crop		
	Kalmegh	0.14
	Tulsi	4.37
	Lemongrass	22.54
	Satavar	0.85
Average farm asset		3049

Table 2: Cost structure of lemongrass cultivation in Jharkhand (Rs /ha)

Particulars	Amount	Percent
Hired manpower charges	7900	11.50
Machine	3611	5.26
Slips	21046	30.64
Manures and fertilisers	3557	5.18
Irrigation	3006	4.38
Transportation	1160	1.69
Distillation charge	8050	11.72
Rent paid to leased land	5171	75.28
Rental value of own land	3000	4.37
Interest on fixed cost capital	3383	4.92

Table 3: Net return over cost (Rs per hectare per year)

Particular	Amount
Oil production (kg.)	112
Price Rate (Rs per kg)	1250
Total return (Rs)	140000

CONCLUSION

Cymbopogon citratus contains various phyto constituents such as flavonoids and phenolic compounds, terpenoids and essential oils, which may be responsible for the different biological activities. Hence, we can isolate some pure phytopharmaceuticals, which in turn can be used as lead molecules for synthesizing novel agents having good therapeutic activity. In the changing global scenario, the interest toward plants with medicinal value is increasing substantially in the primary healthcare system both in the developed

and in the developing countries. It may also be concluded that the farmers' primary livelihood source has been agriculture and allied activity in the study areas. In the selected area of Jharkhand, farmers are inclined to adopt new crop and technologies faster as lemongrass cultivation for their livelihood security and income enhancement. The total cost per hectare was observed at 51713, and in this respect, the total net return obtained from the cultivation of lemongrass was 88287 with a B: C ratio of 1:1.04, which implies that the farmers expense the Rs.1 and get the profit of 1.04. Therefore, lemongrass crop cultivation in Jharkhand is more profitable than other traditional crops. However, it is recommended from this study that lemongrass cultivation can be promoted in Jharkhand and other states, where problematic areas like unutilized land, rainfed area, and animal-affected areas for improve their social and economic life.

ACKNOWLEDGEMENT

The authors show their gratitude to the Compensatory Afforestation Fund Management and Planning Authority (CAMPA) And Ministry of Environment, Forests and Climate Change (MOEFCC) for providing financial support and assistance for All India Coordinated Research Project - 29 (AICRP-29) on "Management of NTFPs through Conservation and Value addition". We are thankful for the generous support, encouragement and motivation of the Director, ICFRE- Institute of Forest Productivity (IFP), Ranchi. We sincerely thank SPF and JPF Sh. Pragya Samridhi, Mr. Tulsi Mandal, and Bitan Goswami for their support in data collection and analysis.

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